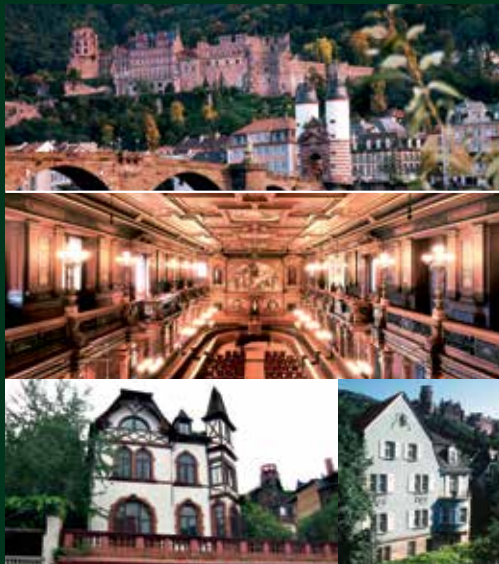


Michael Welker (ed.)

The Science and Religion Dialogue

Past and Future



PETER LANG
EDITION

Michael Welker (ed.)

The Science and Religion Dialogue

This book documents the conference on *The Science and Religion Dialogue: Past and Future*, held at the University of Heidelberg, Germany, October 25-29, 2012. The conference commemorated the 100th anniversary of the birth of Sir John Templeton and the 25th anniversary of the establishment of the John Templeton Foundation. It brought together about 60 active participants, all of them prominent scholars from many countries and many academic fields. Most of them have been engaged in the *Science and Religion Dialogue* for the last two or three decades. This book reports on multi-year international and interdisciplinary research projects at leading institutions. The contributions start with presentations

by Hans Joas, Martin Nowak and John Polkinghorne and range from Astronomy, Mathematics, Physics and Biology to Philosophical Theology and Religious Ethics. Special topics of the dialogue between Science and Religion are also dealt with, such as *Eschatology and Anthropology*; *Cosmology, Creation, and Redemption*; *Evolutionary Biology and the Spirit*; and *The Role of Thought Experiments in Science and Theology*.

The Editor

Michael Welker is a senior professor at the University of Heidelberg and the director of the Research Center International and Interdisciplinary Theology.

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Introduction

This book documents a four-day conference in commemoration of the **100th anniversary of the birth of Sir John Templeton and of the 25th anniversary of the establishment of his John Templeton Foundation**. It brought together about 60 active participants, most of them leading scholars, from many countries and many academic fields, who have been engaged in the “Science and Religion Dialogue” or, as some preferred to say, the “Science and Theology Dialogue” in the last two or three decades. The book reports on multi-year international and interdisciplinary research projects at leading institutions as well as on the Foundation’s strong support of upcoming generations of researchers.

The conference started on 25 October 2012 with a public event **in the Great Hall of the University of Heidelberg, Germany**. It continued the following days at the **Internationales Wissenschaftsforum der Universität Heidelberg (IWH)** with presentations and discussions among the scholars. The complete conference was streamed and documented on the web. In the first year, it has already been visited over 11,000 times. This book documents the main results of the event, which was planned and orchestrated by the **Forschungszentrum Internationale und Interdisziplinäre Theologie (FIIT) Heidelberg** in a readable form.

On the first day, in honor of Sir John Templeton and the two anniversaries mentioned above, addresses were given by John M. Templeton, Jr., President of the JTF, Stephen Post and Michael Murray, and from the Vice-President of the University of Heidelberg, Thomas Pfeiffer and Michael Welker, director of the FIIT. These addresses were followed by three lectures addressing the general topic:

On the Engagement of Science and Religion,

1. Hans Joas (University of Freiburg and University of Chicago): *The Natural History of Religion*;
2. Martin Nowak (Harvard University): *God and Evolution*;
3. John Polkinghorne (Cambridge University): *The Search for Truth*.

The following days, presentations were given and discussed on the sub-topics:

The Science and Theology Dialogue. Multi-Year Research Projects

John Polkinghorne and Michael Welker spoke about multi-year projects on topics of Eschatology, Anthropology and Concepts of Law, which they had chaired

at the Center of Theological Inquiry in Princeton (CTI), in Cambridge, UK, and in Germany (Heidelberg, Düsseldorf and Berlin).

Denis Alexander reported the success story of the Faraday Institute, Cambridge, UK, which hosted many academic events on the topic, but also many educational projects for the broader public.

Robin Lovin and Friederike Nüssel presented a multi-year project that they had organized at the CTI, Princeton, with support from the Templeton Foundation.

Ted Peters and Robert Russell explained interfaces between theology and science that had stimulated research and discourse at the Center for Theology and the Natural Sciences (CTNS), Berkeley.

The Science and Religion Dialogue: Multicontextual Dimensions

Cyril Hovorun reported on the dialogue between science and religion in Russia. From a European and a North American perspective, Niels Gregersen and Wentzel van Huyssteen sketched postfoundational approaches to the dialogue and the impact on it by a “post-modern” climate of thinking. Contributions from **Astronomy and Mathematics** (Chris Impey, Matthias Baaz and Harvey Friedman), from **Physics and Biology** (Andrew Briggs, Simon Conway Morris and Gunter Wagner) and finally from **Religious Ethics and Philosophical Theology** (Kelly James Clark and William Schweiker) gave an impression of the enormous breadth of the fields and concerns that have shaped this dialogue in the past.

The conference was concluded with the unit **Philanthropic Investment and the Future Academic Generation**. We document presentations from three of the sixty winners of the *John Templeton Award for Theological Promise* (2007–2011), by the German scholar for American studies Jan Stievermann, the Orthodox theologian Daniel Munteanu from Romania and the Austrian Protestant theologian Eva Harasta.

Heidelberg, Spring 2014

Michael Welker

I. Celebrating the Past – Shaping the Future

Thomas Pfeiffer

The Science and Religion Dialogue: Past and Future

It is my pleasure to welcome you all on behalf of the University of Heidelberg at the opening ceremony of the three-day conference on *The Science and Religion Dialogue: Past and Future*. My particular greetings go to the participants in this conference.

You have come here from leading universities from all over the world and from many fields: physics, biology, mathematics and astronomy, philosophy, psychology, theology and religious, historical and ethical studies. Most of you have been engaged in the *dialogue* between scientific modes of thought on the one hand and the rationalities of different faith traditions on the other. These faith traditions cover not only the broad spectrum of Christian confessions, but also Judaism, Islam and Hinduism.

Apart from the highly established scholars in their fields, I extend my greetings to the group of doctoral and postdoctoral scholars, most of whom were winners of the *John Templeton Award for Theological Promise*, a prize they received here in Heidelberg; and to the five international winners of the recent essay contest on the *Science and Religion Dialogue*.

It is my special pleasure today to welcome Dr. John Templeton, Jr., Dr. Pina Templeton and the representatives of the *John Templeton Foundation*. We are delighted to host the celebration of the 25th anniversary of the chartering of the Templeton Foundation, as well as the 100th anniversary of Sir John Templeton's birth. He established his foundation as a philanthropic organization that funds interdisciplinary research to advance human progress through new discoveries. One of the main goals of the foundation was the stimulation and support of academic discourses between the areas of science and religion or, rather, science, theology, religious studies and the philosophy of religion. These areas of knowledge have very much moved apart from each other, especially in modernity. It has been doubted whether any meaningful exchange between them is possible, and there have even been fears that the contact between these two areas of knowledge leads to obscurantism.

The second half of the twentieth century, however, saw the emergence of academic and civil societal institutions that regarded this split of rationality as unfortunate and initiated the dialogue on topics crucial for both sides,

such as cosmology, anthropology, eschatology and ethical responsibility. Leading academic institutions, particularly in the USA and Great Britain, created university chairs for Theology and Science, or Science and Religious Studies.

Sir John had not only a genius perception of the powers of the economic markets. He also had a deep sense for the creative potentials of the dialogue between scientific and religious thought despite its uncertainties and risks. Accordingly, for the past 25 years, the *John Templeton Foundation* has supported many research projects in this field. The University of Heidelberg and its Research Center for International and Interdisciplinary Theology were among the institutions that received major grants from the *John Templeton Foundation*. Above all, in one of his last founding decisions, Sir John established the *John Templeton Award for Theological Promise* at this university. Young scholars from across the globe were invited to apply for it with their doctoral dissertation or their first post-doctoral work in the area of “God and Spirituality” (broadly understood). Each year, 12 of them received a substantial prize after a strict evaluation process by 25 scholars from different fields and from 19 countries. In the days following the award ceremony (held in this room) they presented their next academic projects at the *Internationales Wissenschaftsforum*, where an academic conference will start tomorrow. The award very quickly made a name for itself on a global scale. When the *John Templeton Foundation* had to terminate it after five years because of its legal rules, the Heidelberg *Manfred Lautenschlaeger Foundation* decided to continue the prize as the *Manfred Lautenschlaeger Award for Theological Promise*.

This opening ceremony, apart from commemorating Sir John and celebrating the 25th anniversary of his foundation, intends to mirror the broad spectrum of its support in the science and religion discourse. We are very glad to welcome the three speakers from different fields, namely Professor Hans Joas from the Universities of Freiburg and Chicago, who will give a short presentation on “The Natural History of Religion.” We are grateful that Professor Martin Nowak from Harvard University will deal with the topic “God and Evolution.” Finally, it is a particular joy to welcome Professor John Polkinghorne from the University of Cambridge, UK; he has repeatedly been a guest professor in Heidelberg and is also a Von Humboldt prize winner. His lecture is entitled “The Search for Truth.”

We are looking forward to a stimulating event tonight and a fruitful conference.

Michael Welker

The Science and Religion Dialogue: Past and Future

The Science and Theology Dialogue has been well established in Heidelberg since 1958. Located above Heidelberg's famous castle, the Research Center of Protestant Churches in Germany, the FEST, has cultivated this dialogue in consultations, workshops and publications. Its current topics are interdisciplinary anthropology, concepts of nature and questions of bioethics. In 1987, the year the John Templeton Foundation was established, one of the FEST's members, Professor Jürgen Hübner, biologist and theologian, published a book of more than 500 pages titled *The Dialogue between Theology and the Natural Sciences: A Bibliographical Report*.¹ Today, it would probably need ten volumes of similar size to provide an update of the bibliography.

My own serious interest in this dialogue dates back to a multi-year project at the Center of Theological Inquiry in Princeton, the CTI, in the early 1990s, designed by its former director, Daniel Hardy. I had the privilege to meet international colleagues who had been engaged in the Science and Religion Dialogue for quite some time. From this group of longtime dialogue partners, I am most happy to welcome today the distinguished colleagues John Polkinghorne and Janet Soskice from Cambridge, UK, John Headley Brooke from Oxford and Durham, William Schweiker and Kathryn Tanner from, respectively, the University of Chicago and the Yale Divinity School, Wentzel van Huyssteen from Princeton, Ted Peters and Robert Russell from Berkeley, Owen Gingrich from Harvard, Willem Drees from Leiden and Niels Gregersen from Copenhagen.

When we first met, several of these colleagues had already established a cooperation with the John Templeton Foundation. In the late 1990s, the Foundation offered me a grant to explore and document the Science and Theology Dialogue in German-speaking countries. First, in a rather complicated search, we identified more than 20 doctoral students and postdocs who worked on the topic. We brought them together for a workshop in the International Scientific Forum, the IWH Heidelberg. For several of them, it was a turning point in their view of themselves, because they realized that they were not academic loners,

1 Jürgen Hübner (ed.), *Der Dialog zwischen Theologie und Naturwissenschaft. Ein bibliographischer Bericht*, München: Kaiser, 1987.

strange people with a strange academic hobby, but rather part of a community of researchers. It was a moving event. In another project we explored various models of discourse and their potentials, models that had been established and cultivated in Princeton and Cambridge, UK, in Zurich and Berkeley, in Marburg and Heidelberg, and in the Papal summer residence Castel Gandolfo. It was very interesting to see and discuss the question: Where do the strengths and potentials for further development in the individual projects lie?

My next contacts with the Foundation occurred through several excellent consultations orchestrated by Dr. Mary Ann Meyers and individual scholars under the heading *The Humble Approach Initiative*. I had the privilege to co-organize with Dr. Meyers one consultation with the first generation of academic Pentecostal theologians in New York and one consultation with Russian Orthodox scientists and theologians here in Heidelberg.²

At the CTI in Princeton, we had had very good experiences with international and interdisciplinary multi-year consultations in Science and Theology and achieved fine results.³ We convinced the Foundation to support three such multi-year consultations in Heidelberg. One of them was *Body, Soul, Spirit: The Complexity of the Human Person*.⁴ The second series of consultations explored *Concepts of Law in the Sciences, Legal Studies and Theology*.⁵ The third project dealt with *Law and Love: Science and Religion in China and the West*.⁶ All these initiatives, together with the very successful *John Templeton Award for Theological Promise*⁷ mentioned earlier by the Vice-President, have greatly contributed

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- 2 Cf. Michael Welker (ed.), *The Work of the Spirit: Pneumatology and Pentecostalism*, Grand Rapids: Eerdmans, 2006; idem, *The Spirit in Creation and New Creation: Science and Theology in Western and Orthodox Realms*, Grand Rapids u. Cambridge / UK: Eerdmans, 2012; Russian translation by Sergii Bortnyk, Moscow: St. Tikhon Orthodox University Press, 2013.
 - 3 One particularly successful example: John Polkinghorne and Michael Welker (eds.), *The End of the World and the Ends of God: Science and Theology on Eschatology*, Harrisburg: Trinity, 2000; second printing 2000; Korean translation by Joon Ho Shin, Seoul: The Christian Literature Society of Korea, 2002; Chinese translation by Wang Tao, Logos and Pneuma Translation Series 16, Hong Kong: Institute of Sino-Christian Studies, 2010.
 - 4 Michael Welker (ed.), *The Depth of the Human Person: A Multi-Disciplinary Approach*, Grand Rapids: Eerdmans, 2014.
 - 5 Michael Welker and Gregor Etzelmüller (eds.), Tübingen: Mohr Siebeck, 2013.
 - 6 Forthcoming in English and in Chinese, 2014.
 - 7 Since the John Templeton Foundation could not support this award beyond five years (2007–2011), a German foundation continued this fine project. It is now *The Manfred Lautenschlaeger Award for Theological Promise*.

to developing the *Research Center for International and Interdisciplinary Theology* (Forschungszentrum Internationale und Interdisziplinäre Theologie, FIIT) here in Heidelberg and to establish the *Global Network of Research Centers for Theology, Religious and Christian Studies*, in which about 45 universities from all continents are involved. Here we exchange doctoral students and postdocs for one term and create new forms of academic cooperation.

These good experiences encouraged the Heidelberg physicist Jörg Hüfner and me, together with the biologist Hermann Bujard and the assyriologist Stefan Maul, to create a discussion group among professors from the humanities and the sciences. This was not easy, but has turned out to be very rewarding. Today, the dialogue across disciplines that seem to operate very far from each other is a matter of course in this university, a university that proudly understands itself as a “comprehensive university.” The John Templeton Foundation has greatly contributed to the fact that theology and religious studies are constructive and vital conversation partners in this multidisciplinary cooperation. Therefore, we are very grateful that, together with you, we can celebrate the harvest of 25 years of your radiation, a radiation that among many places in the world has also extended to the University of Heidelberg.

John M. Templeton, Jr

Opening Address

Good afternoon.

It is an honor to follow Vice Rector Pfeiffer and Professor Welker in greeting you at the start of a conference on the Science and Religion Dialogue—a dialogue at the very heart of the work of the John Templeton Foundation. Having recently celebrated the 625th anniversary of the founding of this great university, you will understand what the year 2012 means to us who work to carry forward Sir John's vision—the vision he had for his foundation. It is the 25th anniversary of the chartering of the Templeton Foundation, as well as the 100th anniversary of my father's birth.

Sir John established the foundation that bears his name to support research seeking new insights into the truth about what he often referred to as “Ultimate Reality.” It was an endeavor that he envisioned might foster the engagement of ever more well-trained minds in many disciplines, especially scientists, philosophers, and theologians, in a quest to seek knowledge and to learn from one another.

As Germany's oldest university, Heidelberg has had a preeminent role in the training and forming of leaders in government, law, science, industry, the academy, and the church, as well as in research that embraced the challenge of drawing wisdom in these diffuse arenas. I followed my father to America's third oldest university—Yale. But it was only 160 years after its founding that Yale became, in its infancy in 1861, the first American university to confer the Ph.D. Then, with the opening of Johns Hopkins in 1876, as the first university in the United States designated as a united center of research and doctoral education, American higher education at least accelerated the process of self-transformation, which imposed the German model of a graduate faculty on top of an undergraduate college.

Before then, American students sought out German universities for their graduate studies, which greatly opened new horizons. These breakthroughs produced approximately some 10,000 U.S. citizens who enrolled in your institutions of higher learning between 1800 and 1900. Those pursuing degrees in the natural sciences were especially attracted to Heidelberg during the long 19th century period of its second flowering.

The resilience of this university after the destruction wrought by the 17th century European wars and following the disruptive behaviors in the first half of the 20th Century – especially the diverse harms of World War II, soon substantially returned to the much higher intellectual civilized aspirations. The six Noble Prizes awarded to your faculty since the mid-1950s, along with your success in both rounds of Germany's Excellence Initiative, is a testimony to your standing not only as a national, but also as an international leader in higher education.

It is, therefore, a pleasure to be here in the Great Hall of this ancient university to both celebrate the past and, most importantly, look to the future. The father of modern social science, Max Weber who both studied and taught at Heidelberg, told students in Munich toward the end of his life that the scientist's work, by its very nature, "asks to be surpassed." Such is the aspiration of the John Templeton Foundation. To draw again on Weber, it is "our fate" and "our goal." We take pride in the investments we have made to encourage cross-disciplinary dialogue on Big Questions, and we look especially to those who have engaged in conversations about foundational realities in the past to help us shape tomorrow's inquiries.

First, therefore, I express gratitude to all of you here at Heidelberg for serving as our hosts. But, second, let me say just a word about the resonance I see between the Charter of the John Templeton Foundation and the "culture of breakthrough" here at Heidelberg University.

JTF's Charter reflects many key attributes that I sense are characteristic of this ancient institution. Sir John would have recognized that a great heritage like Heidelberg's involves an attachment to eternal virtues. So let me point to one of them, which was very important to my father, that I feel certain all of us will experience over the next several days. It is an unlimited sense of "AWE". With speakers from so many disciplines come together here with the intention of learning from one another, I know I speak for my colleagues at the John Templeton Foundation when I say it is a blessing for us to be with you all.

You are exemplars of the spirit of dialogue—a dialogue that provides space for the incubation of ideas. My father, being a very practical person, saw dialogue as a springboard. Sir John believed that scientists, philosophers, and theologians, when engaged in dealing with fundamental and, often overlapping questions, may very well come to re-evaluate what they thought previously.

For Sir John, the greatest mental, moral, and spiritual framework for discovery in all matters of the intellect and the spirit was humility. In his first major excursion into such matters, Sir John's mindset was to question and think with a "Humble Approach." His classical way of describing this core attitude was: "The

more we know, the more we know we do not know. This is what gives life spice. In fact, in order to grow, we must daily become more humble and honest in admitting the paucity of our knowledge. This humble admission of ignorance is what produces progress, what keeps man searching, what makes life as we know it exciting and challenging.” As Sir John also wrote: “Humility helps us to become more receptive to others and can open wondrous doors to the realms of spirit and to research and progress in all fields of endeavor; and thus, to play a positive, productive, proactive role in the future of civilization.”

It is hard to imagine a more auspicious location and heritage than Heidelberg for such an in-depth exploration of what we have been pursuing in bits and pieces. Sir John long ago began to sense a widening spirit and mental opening to “Big Questions” among different disciplines here. He was keen to invest in the launching of Dr. Welker’s five-year major research initiative at Heidelberg. This far-reaching program, entitled, “The John Templeton Award for Theological Promise,” is, indeed, a philanthropically promising investment because it will encourage young scholars whose interests are likely to lead them to pursue questions related to “Ultimate Realities.” Such pursuits, while they may never be fully completed, clearly provide those involved in the quest a sense of meaning and direction—and to develop these things in our lives is surely part of why we are here on earth. I think that is why Dad and Dr. Welker were so excited by the title of the program, which has succeeded in its goal of identifying many of the future, global, leading researchers whose work will focus on God and spirituality.

In conclusion, I would simply add that Sir John left us with this overarching question: Might there in fact be strong evidences of Ultimate Reality – that are more fundamental than the cosmos? He asked: “If there is a phenomenal universal force, for example, in gravity, in the light spectrum, or electromagnetism. can there not also be a tremendous unknown, or non-researched potency, or force, in unlimited love?”

We at the John Templeton Foundation are united with you in a pursuit of learning. We look forward to many different opportunities to engage with you, and especially to learn from your questions – to seeing evidence of the little bright lights that your questions may turn on in the minds of your listeners as they and, indeed, our wider culture, catch a glimpse of different paths forward or have a springboard for answering the question – where do we next go?

Thank you to the university and thank you to its great heritage for the platform it has provided for our dialogue.

Stephen Post

Commemorating Sir John Templeton (1912–2012)

We are gathered here this evening, October 25, 2012, in the historic Great Hall of the University of Heidelberg, for the centennial birthday celebration of Sir John Templeton and his legacy. I believe that were he still with us, he would wish to be remembered as an innovative and bold spiritual thinker. I hope my few words help you who have come from around the world as the leading scientists, theologians and philosophers of our time to recognize more deeply the creative and somewhat prophetic mind of John Templeton.

1. Diagnosing the Condition of Arrogance

John Templeton was concerned with two forms of arrogance. The *first form is religious*, the belief that we know all there is to know about God, or that our particular tradition grasps the whole truth of divine mystery. Sir John asserted that we know less than one percent of the full truth about God and spiritual realities. He had immense respect for the scriptures of the great traditions, but was thoroughly Pauline – we see now only “through a glass darkly.” Whatever our concept of God is, he asserted, it is too small. He wrote, “Through humility we can avoid the sins of pride and intolerance and avoid especially harmful religious strife because it is unlikely any religion could know more than a tiny bit about an infinite god.”¹

The second form of arrogance is independence from God, the belief that the universe does not depend on a Ground of Being constantly sustaining the laws of nature and all that is, and that we do not depend on such an Ultimate Reality (a.k.a. “God” or “Pure Unlimited Love”) for our fullest flourishing. He wrote, “As St. Paul remarked to the Athenians, quoting a Hellenistic poet (Acts 17:28), ‘In him we live and move and have our being’.”² He wrote, “An atheist who is sure there is no God is really a pitiful person because he is too egotistical to admit his

1 *Possibilities for Over One Hundredfold More Spiritual Information* (Templeton Foundation Press, 2000), 8.

2 *Ibid.*, p. 81.

limitations and insignificance.”³ Arrogance runs deep. Like anyone who reads the papers, Sir John acknowledged the dismal side of human nature. The goal of the spiritual life as he understood it is not to pretend that this ever disappears, but rather to contain it. Like any good conservative mind he appreciated how essential flexible traditions are to achieving this goal.

Sir John once directed me by letter to use fully one third of any support he provided to study love for the investigation not of arrogant human love, but rather of “the love that made humans,” and of how we might participate intensely a Pure Unlimited Love through transformative spiritual experiences. While of course he saw hints of the divine in human love, he did not want to confuse that latter (unwise, myopic, unreliable, easily reserved into hatred, impure, and otherwise flawed) with God’s love.

2. Rx: Humility Theology

The grandson of a physician, Sir John prescribed humility theology as a medicine for religious arrogance. He wrote, “Every person’s concept of God is too small. Through humility we can begin to get into true perspective the infinity of God. This is the humble approach” (*The Humble Approach*, p. 3). Sir John knew that arrogance can bring out the very worst in people generally, and that this can be amplified in those who are absolutely certain that they know God better than anyone else; he prescribed a humility theology that would nurture co-creativity and love of neighbor.

As for the arrogance of independence from the Creator and Sustainer, he thought that an open-minded science might find the idea of an Infinite Intelligence and Divine Energy underlying all of reality to be at least as plausible as the alternative explanations, or even more so. Something does not come from nothing, and he saw the fingerprints of Infinite Intelligence in the universe. These lines from Sir John are taken from his *Riches for the Mind and Spirit*⁴:

When man becomes humble in his approach to God, then he can think and speak in this way: Billions of stars in the Milky Way are upheld in the dynamic embrace of God’s being, and He is much more. Billions and billions of stars in other galaxies are creatively sustained in God in the same way, and He is much

3 *The Humble Approach. Scientists Discover God* (Templeton Foundation Press: 1995), 45.

4 *Riches for the Mind and Spirit. John Marks Templeton’s Treasury of Words to Help, Inspire, and Live By* (Templeton Foundation Press Edition, 2006), 204.

more. Time and space and energy are all included within the power of God's presence, and He is much more. Men who dwell in three dimensions can apprehend only a very little of God's multitude of dimensions. God infinitely surpasses all the things seen and also the vastly greater abundance of things unseen by man. God is the only ultimate reality – all else is fleeting and contingent.

3. Two Spiritual Theological Roots West and East (Sir John the Edwardsian-Emersonian)

John Templeton's focus on humility theology as antidote to arrogance has roots in two great spiritual influences that converged on him in youth. First, there is Sir John the Presbyterian who, consistent with the Reformed tradition, understood sin as pride, arrogance, and self-inflation. He also affirmed with Calvin that the Creator is manifest in the visible world and its laws (Romans 1:20), and he sided explicitly with Emile Brunner on natural theology. As he looked back on his life, he wrote:

Agape love means feeling and expressing pure, unlimited love for every human being with no exception. Developing such divine ability has been a goal for me almost all of my eighty-six years on earth.⁵

These words are not the musings of an old man trying to attribute meaning to a meaningless life. In fact, as a teenager in 1927, at the age of fifteen, he became the Superintendent of the Cumberland Church Sunday School in Winchester, Tennessee. He took a special interest in hymns and biblical passages having to do with the theme of agape love. Dr. Templeton reports the story of how an old Tennessee farmer who remembered Sir John as a boy said, "That John Marks, he was born old!" meaning that he had a wisdom and purpose about him early in life. From very early on, perhaps even by age ten, John Templeton is reported to have expressed a profound sense of gratitude for the miraculous fact that God could love him and everyone, unconditionally.

Sir John's Personal Prayer of Thanksgiving was written in the 1960s as a meditation on gratitude for the love of God. It is an important marker of Sir John's core spirituality and its trajectory from youth:

Almighty God, our loving Heavenly Father, through faith and the Holy Ghost, we are totally one in unity with thee. Thou art always guiding us and inspiring us to the right

5 *Agape Love. A Tradition Found in Eight World Religions* (Templeton Foundation Press, 1999), 1.

decisions in family matters, in business matters, in health matters, and especially in spiritual matters. Dear God, we are deeply, deeply grateful for thy millions of blessings and millions of miracles that surround us each day. We are especially grateful for thy healing presence, which gives us long and useful lives in which to love thee more and more and to serve thee better and better. Dear God, help us to open our minds and hearts more fully to receive thy unlimited love and wisdom and to radiate these to thy other children on earth, especially today and all this year. Dear God we thank thee for blessing and healing each of our families and friends and for helping each of us to be better and better Christians. We thank thee for thy miraculous and continued blessing, guidance, and inspiration of our careers and daily work to serve others in business and churches and charities, so that all of these will be more and more in accord with thy wishes, O Lord, not ours. We listen and obey and are grateful.

We thank thee for our redemption and salvation and for the gift of thy Holy Ghost, by grace, which fills us to overflowing and increasingly dominates our every thought and word and deed. To thee we pray, in the name of thy beloved Son, whom we adore and seek to imitate, our Saviour and our God, Christ Jesus.

Amen.⁶

The 49-year-old John Templeton sent this prayer out in the form of a family Thanksgiving card. The reader is struck by the prayer's spiritual depth, as well as by its eloquence and sincerity. The prayer is about gratitude to a "Dear God" who can "help us to open our minds and hearts more fully to receive thy unlimited love and wisdom and to radiate these to thy other children on earth, especially today and all this year."

In Sir John's office in the Templeton Building in Lyford Cay in the Bahamas, where he lived and worked for the last forty years of his life, one observes on the wall behind his brown wooden desk a large framed page with a calligraphy-style set of passages from the New Testament, Luke 6:27–38 (The Sermon on the Plain), focusing on the love of enemies, and the need to be free of reciprocal expectations (a.k.a. "the law of Tit for Tat").

It is this Presbyterian side of Sir John that informs his skeptical realism about human nature. He felt that independent from God humans can achieve little good, and suffer much. He wrote:

How could a soul understand divine joy or be thankful for heaven if it had not previously experience earth? How could a soul comprehend the joy of surrender to God's will, if it had never witnessed the hell men make on earth by trying to rely on self-will or to rely on another frail human or on a soulless man-made government?⁷

6 *Riches*, 24–25.

7 *Humble Approach*, 93.

This realism never subsided, and he saw in “surrender to God’s will” the humble solution. He often prayed “Thy will be done.” His realism about the failures of human pride and vainglory gave rise to “humility theology” with its potential to rekindle self-awareness of our dependence on God in a theocentric universe through a progressive dialogue between perennial spiritual truths animated by science.

Second, there is Sir John the Transcendentalist. New England Transcendentalism that arrived at his Tennessee doorstep via Missouri and the Unity School of Christianity, with its booklet of affirmations, *The Daily Word*, first published in 1924. This emphasis on the power of brief affirmations cultivated through daily meditation entered Sir John’s young life through this little booklet, which came in the mail monthly addressed to his beloved mother. Briefly, Unity was co-founded by Charles (1854–1948) and Mary Caroline “Myrtle” Page (1845–1931) Fillmore in Kansas City, Missouri, in 1903. The informal beginnings of Unity go back to the 1880s when the couple, struggling with economic and health challenges, found solutions in American Transcendentalist spiritual currents of the time such as the writings of Emmanuel Swedenborg, Ralph Waldo Emerson, Theosophy, Hinduism, Quakerism, New England’s “mind healer” Phineas Quimby (1802–1866), the Bible, and Divine Science. Sir John often cited all of these Fillmore favorites. Fillmore believed that spiritually progressive individuals should welcome relationships with people of all religious persuasions, and that they should accompany creeds with simple “spiritual principles.” He recognized a phrase found in the Hindu Upanishads, a sacred text, that “What you think you become.” He was well familiar with Harvard Divinity School’s Ralph Waldo Emerson, who wrote of the Oversoul in terms of “Divine Mind” as the origin of all things. The adolescent John Templeton listened avidly to Fillmore’s radio programs as they were broadcast from Kansas City.

Sir John held that the human mind included a very small piece of Divine Mind, and that we have been given our minds so that we might love and participate in the continuing co-creativity of the Divine Mind that is in us. He, like Fillmore, emphasized the rational finite mind and the spiritual infinite mind. The rational mind provides the self-control and future-mindedness deemed a sacred responsibility, made possible in part by the use of brief spiritual affirmations freely repeated and self-inculcated into consciousness. Joy, profound creativity, and Pure Unlimited Love, however, flow from the union between the infinite spiritual aspect of the mind human and the Divine Mind, which are of the same essence. He wrote:

Yes, the eternal soul and its growth was the crucial thing: For the sake of clarity and simplicity, let us think of each person as composed of four basic components: God, soul,

mind, and body... However, for the sake of simplicity, we will consider God to be the infinite creator of the cosmos. If He is truly infinite, then nothing exists apart from Him, and all other realities are created reflections of Him. Soul signifies that divine infusion which is unique to each human being. Most major religions teach that each soul is immortal and can be educated. Mind is defined as the strategic link between soul and body. Mind is complex and miraculous but temporary. The human body is defined as a temporary physical dwelling for the mind and soul. In the light of scientific analysis all bodies, human and subhuman, are only evanescent arrangements of forces and wave patterns.⁸

He wrote:

The great question is this: How much progress can our soul make before our body becomes uninhabitable?... Our body has a physical reality, but it is only a temporary shell. Death destroys only that which is fit for destruction. The butterfly developing in the chrysalis in due time splits and abandons the dead chrysalis and flies away on wings of amazing beauty undreamed of by the chrysalis or the caterpillar.⁹

He wrote:

Maybe the earth was designed as a place of hardship because it is the best way to build a soul – the best way to teach spiritual joy versus the bodily ills. Why was it said that into every life some rain must fall? It is apparent that sometimes a great soul does not develop until that person had gone through some great tragedy. Let us humbly admit that God knows best how to build a soul.¹⁰

Needless to say, John Templeton felt the sting of loss in life, and he suffered greatly especially with the untimely death of his first wife.

This Transcendentalist Sir John is wide-ranging intellectually. For example, in the Introduction to his 2003 book *Why Are We Created?* he draws on a passage from his *The Humble Approach*, and begins: “Twenty-five centuries ago, Xenophanes and twelve centuries ago, Shankara, taught that possibly nothing exists independently of God, and that God is immeasurably greater than all of time and space, let alone the visible earth and its billions of inhabitants!”¹¹ Xenophanes of Colophon (c.570 – 475 BCE), one of the most important presocratic Greek philosopher poets, was most famous for his poetry that satirized the anthropomorphic images of the Greek gods. Xenophanes was critical of the religious views of his day because they were merely human projections – a position taken up by

8 *Humble Approach*, 103–104.

9 *Humble Approach*, 91.

10 *Ibid.*, 93.

11 *Why are We Created? Increasing Our Understanding of Humanity's Purpose on Earth* (Templeton Foundation Press, 2003), xi (cf. *Humble Approach*, 5).

Ludwig Feuerbach in relation to modern Christianity. Shankara (788–820 CE) was the Indian sage from Kalady lived only 32 years, but westerners consider him to be the greatest Hindu philosopher ever. Why? He formulated the doctrine of Advaita, which refers to the identity of the Atman (“self” or “spirit”) and the Brahman (the “Supreme” or “Ultimate Reality,” “Infinite Mind” that is the origin and support of the phenomenal universe, the “Godhead” or “Absolute,” the “Divine Ground of All Being”). In Shankara’s philosophy, we find best articulated the perennial formula that Atman = Brahman (see Aldous Huxley’s classic, *The Perennial Philosophy*). Each of our individual souls (Atman) is like a grain of sand. The whole mound of sand together comprises the Brahman, which shares bits of itself with each human being, but remains infinitely large. So the deep eternal essence of the human mind is of the same substance (in minuscule) as is the Infinite Mind. Thus, God exists in each one of us. In Sir John’s important work, *Agape Love: A Tradition Found in Eight World Religions* (1999), he includes a chapter on Hinduism that is in my view brilliant. Where does he begin? He wrote:

Hinduism speaks of the self, or soul (Atman). It also speaks of Brahman as being the ultimate principle of the universe. The fundamental religious conviction that Brahman is Atman, or that the self is ultimately inseparable from the whole, lays a firm foundation for agape in the Hindu context.¹²

Purpose in Life: As for purpose, Sir John is explicitly informed by Shankara’s notion of what the Godhead created finite beings like ourselves that share in the Divine Mind. For Shankara, the answer is expanding co-creativity. Sir John wrote, “Might a purpose of the infinite intellect be to express itself in increasing varieties of lesser intellects?” How strange of Sir John to write these words – that is, unless one understands him through the Vedic elements of Transcendentalism. He is stating here that the Infinite Mind of God flows through us all, dwells within us, and actually is constitutive of an element of our individual minds. Moreover, we are the creatures through whom Divine Mind expands its creativity. So we are driven to ask what the purpose of God is: “Were human beings created to be agents of God’s accelerating creativity? Can humans discover larger fractions of infinite intellect?” (*Why Are We Created?* p. xv) Sir John clearly thought that our minds, in their eternal element, are God’s love gifts, allowing God to extend novel creativity through our human agency. This Transcendentalist dynamic adds a whole new dimension to co-creativity as understood by such western Christian theologians such as the Catholic Karl Rahner or Mennonite Gordon Kaufman.

¹² *Agape*, 45–47.

True, this Transcendentalist Sir John does give the impression of optimism about human nature, but overall the Reformed tradition clearly holds sway, although there is some superficial tension here. Spiritual progress yes, perhaps, but what shadows lies in the hearts of men. I think of Sir John as and Edwardian-Calvinist-Emersonian, bringing together the thought worlds of the great American Calvinist Jonathan Edwards and the great American Transcendentalist Ralph Waldo Emerson in the form of a creative balance between the influences of his Cumberland Presbyterian roots and the Unity School of Christianity. There were other sources as well, but these seem to be the two essential ones.

4. Let Us Celebrate in Creativity and Pure Unlimited Love

May this centennial celebration of Sir John Templeton be filled with free and co-creative inquiry proceed with appreciation for the spiritual and theological journey of an astonishing man, a Tennessee mystic influenced by a Missouri mystic. Believe me, when you get the time, delving into Sir John's writings is a unique and exciting adventure.

May I conclude with a few final quotes Sir John, and urge us to reflect "out of the box":

God's love is given to us not because we deserve it. In fact, most likely when we need love the most is when we are most unlovable. Worthiness is not a prerequisite to receive the benefit of God's love or grace. Those who are philosophically inclined may find it helpful to understand God's unlimited love as the original and ongoing basic creative force of the universe. This love was present before the beginning, and it continues to hold all things together. Our fleeting human emotions and perceptions are in fact mere glimpses of God's perfect love.¹³

So, if there is a phenomenal universal force, for example, in gravity, in the light spectrum, can there not also be a tremendous unknown, or non-researched, potency, or force, in unlimited love?¹⁴

Could unlimited love be described as a creative, sustaining energy? When we embrace our creative energy, can we draw, from the universal Source, a tremendous spiritual energy matrix into many areas of our lives? Does a divine fountainhead of love exist in the universe in which degrees of human participation are possible?¹⁵

13 *Pure Unlimited Love. An Eternal Creative Force and Blessing Taught by All Religions* (Templeton Foundation Press, 2000), 19.

14 *Ibid.*, 35–36.

15 *Why Are We Created?*, 87.

All the world's great religions, to varying degrees, both teach and assume the priority of love in religious practice. To put it another way, whether consciously or subconsciously, the world seems to have determined that any system of beliefs that teaches or tolerates hatred or even apathy toward others does not deserve to be considered a religion in the first place.¹⁶

If God is infinite, then it follows that all other reality is dependent on Him and cannot exist apart from Him. Matter and energy may be only contingent manifestations of God. Space and time may be only manifestations of God. We should not think of matter and energy as created by God but as now utterly independent of God. That would mean that God is not "all in all" the creative Ground and Sustainer of all that is. Matter and energy may be only creaturely manifestations of the universal Creator. While God does not need the universe to be God, the universe may need to be increasingly supported and enfolded in His presence and power to be what it is. Maybe it can only exist in and through God.¹⁷

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The human ego has been the curse of religious denominations for thousands of years. In every major religion wars have been fought about differences in creed. Nations or tribes have exterminated others because they worshipped different gods or the same god as taught by different prophets. This is human ego run wild. Let us humbly admit how very small is the measure of men's minds. This realization helps to prevent religious conflicts, and obviates attacks by atheists against religion. Moreover, humility of this kind opens more minds to the idea that science supports and illuminates religion.²⁰

Should we be gentle, kind and sympathetic toward new prophets even though they bring new ideas strange to us?²¹

Maybe the more we create, the more in some ways we are like God, especially if, like God, we create out of love.²²

Let us create out of love here in Heidelberg and in so doing honor the thought and legacy of John Templeton.

16 *Agape*, 2.

17 *Humble Approach*, 21.

18 *Why Are We Created?*, 87.

19 *Pure Unlimited Love*, 19.

20 *Humble Approach*, 47–47.

21 *Possibilities*, 38.

22 *Humble Approach*, 24.

Michael Murray

Science and Religion Dialogue

Let me begin by offering my thanks to the University of Heidelberg, to Professor Michael Welker and to Vice Rector Pfeiffer for hosting us here during these few days for this special event. As you have heard from others, this is the 25th birthday of the John Templeton Foundation and in the lead up to this year we have looked for a handful of topics that we thought were truly emblematic of Sir John's life, passions and thought. In doing that we designed a few grant projects that would emphasize these in the 2012 year. As a result of this we have been able to launch projects on intellectual humility, on spiritual progress, on new frontiers and astronomy and cosmology and others including this project on the Science and Religion Dialogue. This gives us an opportunity to look back at the successes that have come in this area and also to look forward to what lies ahead.

In my brief remarks I intend to describe briefly the Foundation and its work over the past 25 years.

The Foundation was chartered in 1987 by Sir John Templeton and it has grown very rapidly in recent years. As many of you know, Sir John passed away in 2008 and since that time the funds from his estate have been moving into the Foundation endowment. As a result we have grown from an endowment of \$800 million in 2009 to \$2.3 billion in present and we will likely be at \$3 billion in early 2013. We currently have 72 employees at the foundation; for those of you who haven't been to our offices recently, you might be surprised at how many people are buzzing around there now in West Conshohocken, Pennsylvania. In addition some of you may know that Sir John founded two sister foundations that are incorporated offshore, the Templeton World Charities Foundation and the Templeton Religion Trust. The three foundations have one primary, grant-making area, and seven secondary areas and I will say something about these in a moment. The overall grant payout of the Foundation has been roughly \$700 million as of the beginning of 2012 but almost 10% of that total was distributed just in 2011. So the ramp-up to our current payout in the last year has been quite steep. And we anticipate paying out \$100 million dollars in grants in the present year. We have 432 active grants, which total 375 million dollars, so the Foundation has been a busy place. In addition our grant giving is global, including grants in 56 different countries. And as many of you know the foundation now also supports the Templeton Prize which predates the origin of

the foundation which was given out 42 times and 18 of those laureates are still with us today.

All three of the Templeton foundations focus on few key areas and I am going to tell you what those areas are because I suspect some of you might not be aware of them. The areas which are better known aside from the Science and Religion area are Character Development, and Individual Liberties and Free Enterprise. But we also have in our charter a mandate to grant funds to the area of exceptional cognitive talent, voluntary family planning, genetics and support for organizations like Unity Worldwide Ministries, which, as Stephen Post mentioned earlier, had a profound impact on Sir John's life. Those areas all taken together might seem like they are not very well connected, but in fact in the mind and thought of Sir John they were connected in that he saw all those as drivers and pillars of human progress. He believed that by supporting those topical areas, human progress could be further advanced. When we engage in grant making in those areas our aim is to fund projects that bring about that end.

But the majority of the funding that we provide is in an area that Sir John described as "Humility in Theology." 60% of the funding of the foundations goes to that area each year. And as I talk to many individuals I find that they are puzzled by what Humility in Theology is. So what really is Humility in Theology?

"Humility in Theology" is a phrase that was coined by Sir John and it really refers to two different kinds of things. First of all, it refers to a cluster of topics that fit together in a certain way given Sir John's thinking of the world. It also refers to a methodology.

Sir John's conception of theology—as you might gather from what you know from the work that we fund or from comments like you heard from Stephen Post—was quite broad; and it was driven by a distinctive conception of reality, where Spirit and Nature are intimately connected. Spirit and Nature are not distinct, as they are in the thoughts of many philosophers and theologians today, but rather God and Nature are intimately connected. Because spiritual reality and nature have this intimate, interwoven connection, science and religion are not distinct enterprises in this understanding of things. When you are doing science that is looking at the fundamental aspects of the cosmos, you are seeing the Spirit; you are seeing the Divine. And so for Sir John, theology is integrative and progressive, in the same way that science is. As we take in information from the empirical data through the scientific method, we advance not only our understanding of nature, but also our understanding of God. And discoveries in this domain yield something that he called "new spiritual information." This is another phrase you don't hear bantered around in academic halls very often, but

it's one that we use at the Templeton Foundation, to describe this end product that Sir John was passionate to pursue: "new spiritual information."

Humility in Theology has three different content domains. And these domains, I hope you will see are held together by this view of the connection between Nature and God. The three content domains are the following: first, progress oriented theological research. As you have heard, Heidelberg hosted one of the last grants that Sir John himself signed on topic of theological progress. This was a key theme for him in his philanthropy and life and thinking. And this is the portfolio within which the Science and Religion part of the foundation's work is funded.

Second, we fund research on "the Nature of Persons and Personal Well-being." This is the second facet of Humility in Theology. It involves, for example, thinking about the nature of persons: Are we physical entities? What is the relationship between mind and brain? What does human uniqueness consist in? How do persons achieve personal well-being? In the spiritual, moral and physical dimensions? Many of you know that we have a substantial portfolio on Health and Spirituality and this arises out of this emphasis within Humility in Theology.

The third area is Science that concerns Fundamental Laws, Structures and Constituents of Reality. And again, I hope that the reason for this kind of funding is transparent for you: because of the way that Sir John thought of the intimate connection between Spirit and Nature plumbing the depths of the natural is looking for roots for the Divine. So, when people ask me, "How can there be a foundation that funds quantum physics on the one hand and theological research on the other?", this is the answer. These three different dimensions of Humility in Theology are aimed at discovering ultimate spiritual reality. And this as Stephen Post said, is, for Sir John, God as unlimited love. God as unlimited love is the ultimate structure of reality that we discern through these different content domains.

In addition to the content domains I mentioned that Humility and Theology involves a methodology. Let me say a few things about that. First of all, the methodology is opposed to dogmatism or unreflective assumptions. This fits in with Sir John's emphasis on humility. We often think of humility as a moral trait. But for Sir John humility was also an intellectual trait. Intellectual humility is at the heart of Humility in Theology. Work in this area is typically interdisciplinary, which is not surprising. It's the insights from multiple disciplines coming together that help us further plumb the depths of ultimate reality and to acquire new spiritual information. And it seeks to integrate different insights from different

disciplines together. We normally think of this as insights from the sciences informing theology. In this sense, science is a font of new information that needs to be incorporated into theology, which is seen as otherwise static. But in Sir John's conception the reverse was true as well. There are insights in the domain theology that lead us to look through the lens of sciences in ways that we otherwise would not. These are thus mutually informing disciplines, such that it is not just a one-way flow of information from science to theology.

How has all of this manifested itself in the funding of the Templeton Foundation? Over the years our funding into the secondary areas has grown; in the past five years we have provided one third of our funding into these "secondary" areas: Character, Freedom and Free Enterprise and so on, with the reminder within Humility in Theology. And when you look at the Humility in Theology area the distribution over the three domains – Progress Oriented Theology, Persons and the Nature of Personal Flourishing, and Investigation into the Fundamental Structures of Nature – has shifted over time. Early on, the vast majority of funding went to the Persons and Personal Well-being area. Whereas currently about 20% goes to projects in Theology, 40% to Persons and Personal Well-being, and 40% to the Investigation into Fundamental Structures of Nature.

In addition, I mentioned that we offer grants on a global basis. Early on in the foundation's years, between 1991 and 1995, only 1% of our grants went to areas outside the US and Western Europe; in the more recent years we are at 9%. We still regard this as too small and the Foundation is actively engaged in developing projects in Russia, China, Japan, in Latin America and on the continent if Africa. And as many of you know this manifests itself in particular projects with wide-ranging character. I'll just mention a few of those: the FQX program which recently wound down a significant research program on the nature of time. FQX is currently starting a new round that is going to focus on the physics of information. We fund substantial research in the area of cognitive and evolutionary psychology of religion. Many of you are familiar with the Analytic Theology Projects--a new endeavor that seeks to integrate new insights from the philosophy of religion and theology across many disciplines. We also fund projects that try to engage the broader public with these themes. We are, for example, one of the founding benefactors of the World Science Festival that occurs every year in New York. We also fund organizations like BioLogos, which aim to engage Christians with the insights of evolutionary theory to help them better understand God's creativity.

Thus when you think of the John Templeton Foundation, you should think about many different things. You should think of it as the foundation that asks

big questions. You should think of it as the foundation that discovers new insights into the divine. You should think of it as the foundation that seeks to accelerate human progress. And you should think of it as the foundation that aims to transform human lives and culture. Thanks.

II. On the Engagement of Science and Religion

Hans Joas

The Natural History of Religion

Ladies and gentlemen,

Let me say at the outset that I am neither a natural scientist nor a theologian, but a historically oriented sociologist – and a Christian believer. For that reason I cannot competently speak about the natural sciences nor about theological problems nor about their interconnections. What I have chosen to do instead is to offer a reflection on a fundamental problem in the scientific study of religion. The problem I have in mind is whether or in which way such a scientific study of religion is necessarily or inevitably tied to secularist assumptions.

Particularly in European academic life one can often hear assertions that religious believers are not able to investigate religious matters in an unbiased way because their whole thinking is taken to be permeated with their faith and its specific dogmas for which no scientific evidence can be adduced. As a consequence, it seems that only secularists or those believers who are able completely to isolate their historical and social-scientific research from their religious convictions could be taken seriously as contributors to the scientific discourse about religion.

Others object to these assertions by pointing out that secularist assumptions are not neutral either. This seems to be all the more true given the fact that there is no secularism as such, but only varieties of secularism that are defined by their opposition to specific forms of religion. Moreover, might it not be that a certain at least imaginary access to religious phenomena is a helpful, if not a necessary precondition for the study of religious phenomena? In the last years a quotation from a letter by Max Weber that was taken up by Jürgen Habermas in a much-publicized speech has been used again and again in debates about religion. In that quotation Weber (and Habermas) speak of their lack of religious “musicality”. It is worth mentioning that one can have serious doubts about this self-description at least in the case of Max Weber; one should also not forget that in this form the quotation is truncated because Weber went on to say that he was neither anti- nor a-religious. But, more importantly, I am often wondering how we would respond to somebody who really used these words in their literal sense. If the author of a book on the history of the symphony or on Beethoven’s late string quartets would inform us in the preface that unfortunately

music is not really the area he has a sense for. Would we go on reading him at all? Would we even make the claim that those human beings that have musical talents should in principle be excluded from the study of music?

Be that as it may! I am not interested in polemics, but in the dialogue between religious believers and secularists and, even more, in the foundations for a scientific study of religion. The question, therefore, arises whether there can be common ground for believers and non-believers, and this in all the disciplines in the humanities and social sciences that deal with religion, mostly the historiography but also the psychology and sociology of religion. I will restrict myself to the first here, but perhaps I am allowed to mention that I am currently working on a book that deals with all three and their interconnections.

"The natural history of religion" is, as you all know, the title of a book by the great Scottish philosopher and historian David Hume. The book was originally published in 1757, soon reached a wide circulation and has rightly been called the true beginning of a modern social-scientific study of religion. Although Hume starts his book with the declaration that "the whole frame of nature bespeaks an intelligent author and (that) no rational enquirer can, after serious reflection, suspend his belief a moment with regard to the primary principles of genuine Theism and Religion" (134) we know today from the study of his other works and his letters that Hume was in fact deeply critical of such physicotheological proofs of God, but also afraid of the consequences an openly critical attitude towards them would have for him. Let us not pursue the question of Hume's personal religious convictions here any further. Much more important is that he introduced the idea that, at least methodologically, religion should be studied as a "natural" phenomenon. Revelation, for example, could then not be used as scientific or quasi-scientific evidence; but it could and should, of course, be the object of scientific study. Hume emphasizes the enormous variety of religions in the world and uses this fact as an argument against all attempts to derive religion "from an original instinct or primary impression of nature" (134). This statement in itself could be read in two different ways. It could mean that religion as such is a universal human phenomenon, but that all its individual forms cannot simply be derived from the one nature all human beings share. It could also mean that religion is not universal at all. When Hume adds that "some nations have been discovered, who entertained no sentiments of Religion, if travellers and historians may be credited", it becomes clear that he denies the universality of religion. He probably had in mind China, which at the time was often considered a-religious and accordingly admired by people like Voltaire who allegedly had a picture of Confucius over his desk. But historians and travellers cannot always be

trusted, and despite the efforts of the Chinese political leadership at the moment, this view that Confucianism is no religion and that China was or is a country without religion is certainly wrong. For Hume the reference to “nations” without religion clearly is mostly future-oriented. If there were such people in the past, it becomes more plausible to assume such a life without religion in the future.

In that sense his enormous methodological innovation was connected to what Charles Taylor calls the rise of the secular option. I prefer this expression over the more common term “secularization” because it makes clear that secularism is an option taken up to a very different extent in different countries, regions, or milieus. When the secular option emerges, faith remains an option as well, but the conditions of the intellectual justification of faith change. Believers no longer have to justify their faith now only with regard to other religions, but with regard to the secular option as well. In the eighteenth century and up into our times there were many attempts either to present secularization as the necessary corollary of modernization or, on the other side of the controversies, secularism as the cause of moral decline. I have serious doubts about both these assumptions, and I see our time as a new occasion for a debate about faith in ways that are free from these assumptions. (This is, at least, how I have argued in my most recent book, “Faith as an Option”).

But back to Hume and his methodological innovation. Very briefly, one could say that his “natural history” makes four substantial claims. The first is that monotheism was not the primary religion although it is, for Hume, the more valuable. “We may as reasonably imagine, that men inhabited palaces before huts and cottages, or studied geometry before agriculture; as assert that the Deity appeared to them a pure spirit, omniscient, omnipotent, and omnipresent, before he was apprehended to be a powerful, though limited being, with human passions and appetites, limbs and organs.” (136) While polytheism had often been considered a corrupted form of monotheism, Hume claims that polytheism is primary. This was, of course, intended to be a fatal blow for all attempts to declare monotheism the “natural religion” of mankind. But what is the basis of this polytheism, since reason, for Hume, cannot be its foundation? It is emotion or passion and, more specifically, “a concern with regard to the events of life, and from the incessant hopes and fears, which actuate the human mind” (139); “the anxious concern for happiness, the dread of future misery, the terror of death, the thirst of revenge, the appetite for food and other necessities” (140). In contemporary language we would speak of the experience of contingency as the psychological root of religion, and Hume’s claim that this is the basis of at least a large part of religious life has become a common assumption in the history of secularist thinking. His

third claim is that history cannot be considered to be a teleological process that leads from polytheism to monotheism (nor the other way round), but that it has to be seen as an “oscillation”, flux and reflux between the two extremes of pure monotheism and pure polytheism. Since Hume assumes that reason is the foundation of monotheism, but also that reason is weak, particularly among the lower classes, he finds it not surprising that even under the conditions of an official monotheism polytheism survives or is constantly being revitalized. Hume’s friend Edward Gibbon, the great historian of the decline and fall of the Roman empire, already applied this idea to the rise of the cult of the saints in Christianity after the fall of that empire. And, fourthly, Hume developed the thesis that polytheism is intrinsically more tolerant than monotheism. New gods can easily be integrated into a heterogeneous pantheon whereas monotheism is said to be aggressive in its tendency to expand and to suppress or destroy alternative worldviews and practices (“Assmann thesis”). In the context of Enlightenment thinking this was a rather sensational claim, because at the time even the critics of Christianity mostly defended the moral superiority of Christianity over other religions. In Hume the more reasonable religion seems to be the more dangerous, at least from the standpoint of peace.

All four claims in Hume’s book are claims that can be put to the test of empirical research. Such research has been done on a grand scale since the 18th century, and the results are rather devastating for Hume in all four cases. The simple alternative of polytheism versus monotheism was overcome in the 19th century when historians like Fustel de Coulanges demonstrated the importance of rituals and anthropologists like Robert Ranulph Marett the role of the “sacred”, a “theoplasm”, i.e. the stuff out of which religious ideas emerge. Hume’s psychology of religion has been shown (William James) to be much too narrow because it focuses exclusively on negative experiences of contingency instead of positive ones (like gratitude and ecstasy). We know today (from the path-breaking studies of Peter Brown) that the cult of the saints in Christianity originally was much more than an eruption of superstition among the lower classes and that the educated upper classes and leading thinkers of the Church played a crucial role for it. And the evidence on violent religious conflicts under polytheist conditions, on the one hand, and the role of Christianity for the history of religiously founded toleration and political freedom, on the other hand, clearly contradict Hume’s fourth claim.

But the empirical refutation of the individual hypotheses is not the most relevant point here. Of course, Hume’s empirical knowledge was rather restricted. As a librarian, he knew a lot about Greek and Roman antiquity and a little bit

about non-European civilizations, but that was clearly not sufficient for his project of a universal history of religion. Calling the Indian and the Japanese civilizations “barbaric”, as Hume did, strikes us as narrow-minded and Eurocentric, but, again, it is no wonder that an author who initiates a methodological innovation is not necessarily himself able to develop it into a full-blown and empirically based theory. The mere fact that we can empirically argue about his claims should be taken as a first indicator that there is indeed a possibility for a scientific study of religion beyond the clash of religious versus secularist convictions.

A quick glance at the reception of Hume’s book in different European countries in the second half of the 18th century offers us another, even stronger indicator. In pre-revolutionary France, Hume’s book was taken as support for an atheist materialism. Its proponents “laughed at the skepticism of Hume, preached the tenets of Atheism with the bigotry of dogmatists, and damned all believers with ridicule and contempt” (Gibbon, *Memories of my Life*, 156). In Britain Hume inspired a long tradition of positivist historiography and anthropology of religion. But the most interesting case was Germany. Several of the most ardent defenders of Christianity in Germany, critics of Enlightenment rationalism, were among those who brought Hume’s thinking to Germany, translated him, excerpted him, and used him for their purposes. The most important names here are Johann Georg Hamann, Friedrich Heinrich Jacobi and Johann Gottfried Herder. How was that possible? Was this only a misunderstanding, a consequence of the poor mastery of the English language by these Germans? I know that, due to an article by the late Oxford philosopher Isaiah Berlin (“Hume and the Sources of German Anti-Rationalism”), many people in the English-speaking world have this impression. But it is wrong. Hamann had spent considerable time in London in 1758 – when Hume’s book had just been published – and remained, like the others, fully aware of the differences between Hume’s intentions and those on the German side. But they were nevertheless enthusiastic about Hume, and this for at least three reasons. They saw in Hume’s emphasis on the role of (non-religious) “belief” in our cognitive capacities, i.e. in the insistence on an attitude that takes large parts of the world for granted when a cognitive problem has to be solved, a new way to understand religious faith. Religious faith for them should not mostly be seen as the acceptance of quasi-cognitive doctrines, but as a strong feeling of certainty in the sense of trust, of being supported and accepted by something that is stronger than us. They saw in Hume’s anti-teleological view of history the point of departure for an understanding of history that does justice to its ups and downs, declines and falls, surprising breakthroughs, ruptures, and collapses. And they, above all Herder, saw in Hume’s psychological assumptions

about the origins of religion a challenge to find an appropriate vocabulary for the literary status of religious texts, particularly the Bible. They blamed Hume for not understanding what “poetry” is, the human expression of intense experience, and applied the notion of poetry to a defense of the Biblical creation narrative. This may sound irritating today, but it has to be considered an attempt to defend the Biblical texts against scientific criticism, by pointing out that they were not meant to be paleontological science. That was, moreover, before the terms “myth” and “mythology” became available for a similar purpose. In other words, without misunderstanding or distorting Hume, they saw in his critique of Enlightenment rationalism with its facile identification of Christianity with a timeless morality and in his project of an empirically grounded universal history of religions a strong support for their own attempts to purify the Christian faith, to put it on a new basis, to develop a new understanding even of “revelation” and the Bible. In this connection, they uncovered how Hume and some of his followers in France and Britain overstated their case when they claimed that “the natural history of religion” is itself part of a new metaphysics of naturalism. The empirical study of religion in this sense does not presuppose secularist or religious assumptions; it offers a common ground instead for proponents of both.

In our time, a magisterial book like Robert Bellah’s “Religion in Human Evolution”, published in 2011 (the research of which was, I am happy to add, generously supported by the Templeton Foundation, as was the Axial Age volume edited by Bellah and myself) is a prototypical example for the empirical fruitfulness of such research – how far we have come beyond Hume – and of the possibilities for a religious faith that takes scientific innovation not as a threat, but as an inspiration for its own renewal.

Martin A. Nowak

God and Evolution

Evolution is a fundamental organizing principle of the living world. It is the one theory that permeates all of biology. Evolution can in principle explain the relationship between organisms and how biological traits arose over time. Our current understanding of evolution is incomplete. We are confronted with many open questions. I will discuss some of them in this article. I will also argue that a correct interpretation of evolution does not constitute an argument against Christian theology, which holds that God is the creator and sustainer of the universe. Science and religion are two fundamental components in the search for truth. Ignoring any one of them is an impoverished approach. Science and religion can work together to improve the quality of human life and to solve the problems that mankind is facing.

The basic idea of evolution

The basic idea of evolution is surprisingly simple. For evolution to occur we need populations of reproducing individuals. These individuals can be molecules, cells or multi-cellular organisms. During reproduction they pass on information from parent to offspring. The information is typically encoded in form of a genetic sequence. Sometimes mutations occur and the offspring ends up with a slightly modified genome. Mutation generates novel variants and thereby produces (genetic) variation. This means the population does not consist of identical individuals, but instead there are different types. If some of these types reproduce faster than others, then we observe selection: the faster reproducing (fitter) types will increase in relative abundance. They outcompete the slower reproducing types, which might face extinction after some time. Mutation and selection are the key components of any evolutionary process. Reproduction can be asexual, which means one individual produces an offspring, or sexual, which means two individuals come together to produce an offspring. During sexual reproduction there is typically a reshuffling of the genomes of the parents. We are asked to believe that this simple process of evolution, which is fundamentally driven by mutation and selection, is responsible for unfolding the tree of life that we see around us.

Time line and major steps

Astrophysicists have come to the conclusion that our universe originated 13.7 billion years ago. Our own solar system is 4.6 billion years old. Most scientists think that life originated on earth and that this happened roughly 4 billion years ago. There is also the possibility that earth was fertilized by bacterial spores that had evolved on another planet that had orbited another star. Such bacterial spores could have existed in the molecular cloud that gave rise to our solar system. In this case, the life that we see on earth today would have originated on another planet.

The earliest traces of bacterial life (procarya) on earth are about 3.5 billion years old. Higher cells (eucarya), with a nucleus, more complex genetics and organelles, were present around 1.8 billion years ago. About 600 million years ago these higher cells discovered complex multi-cellularity and gave rise to animals, fungi and plants. A few million years ago, one animal species discovered human language.

I would consider these to be the five major steps in evolution: (i) the origin of life; (ii) the origin of bacteria; (iii) the origin of higher cells; (iv) the origin of complex multi-cellularity and (v) the origin of human language. Bacteria discovered most of biochemistry, higher cells discovered unlimited genetics; complex multi-cellularity discovered intricate developmental processes and animals with a nervous system. Humans discovered language.

Human language gave rise to a new mode of evolution, which we might call cultural or linguistic evolution. The enormous speed of human discovery and invention is driven by this new mode of evolution. An idea or concept that originated in one brain can quickly spread to other brains. Prior to human language the information transfer of evolution was mostly in terms of genetic information. Now we have genetic and linguistic evolution. The latter is much faster. Presumably the collective information in human brains evolves at a much faster rate than any previous evolutionary system on earth. The world wide web further accelerates this linguistic evolutionary process.

Mutation, selection and cooperation

Mutation generates diversity, while selection acts on diversity. Selection is based on competition, but in biology we also observe cooperation. Cooperation means that one individual helps another individual. A cooperator pays a cost for another individual to receive a benefit. Cost and benefit are measured in terms of fitness, which is the rate of reproduction. Cooperation can occur among replicating molecules that form more complex organizations such as the first cell.

Cooperation can occur among cells. For example, in filaments of cyanobacteria some cells sacrifice reproduction in order to feed others with nitrogen. Multi-cellular organisms are based on cooperation among individual cells. Cancer is a breakdown of cooperation, where cells revert to their primitive program of selfish replication. Eusociality is an important phenomenon where some animals become 'workers' in order to help other animals reproduce. Human society is based on cooperation. We all require the good will and help of others. Therefore, cooperation is an important phenomenon in biology. I would argue that without cooperation there is no construction of higher levels of organization. Therefore, I propose to add cooperation as a third principle of evolution, besides mutation and selection. I like to talk of 'natural cooperation'.

The question immediately arises: why would natural selection favor cooperation? Why would it make sense for one individual to reduce its own fitness in order to augment that of a competitor? Without any further assumption it is indeed the case, that natural selection opposes cooperation. Specific mechanisms need to be in place for cooperation to be favored by selection. At present we know five such mechanisms.

(i) Direct reciprocity: there are repeated encounters between the same two individuals. I help you and you help me. (ii) Indirect reciprocity: there are repeated encounters in a group of individuals. Cooperators gain good reputation and will receive help from others. (iii) Kin selection: there is conditional behavior based on kin recognition. You help those who are close kin. (iv) Multi-level selection: competition occurs not only between individuals but also between groups. Cooperative groups might outcompete less cooperative ones. (v) Spatial selection: individuals interact in spatial situations, social networks or sets. Cooperators prevail by forming clusters. Neighbors help each other.

The recent appreciation of the importance of evolution of cooperation shifts the perspective of evolution from a purely competitive scenario to one that includes the possibility of cooperation and altruism. More than this, one can argue that cooperation is needed for constructing higher levels of organization in the biological world. Part of my ongoing research effort is to show that cooperation is essential for the origin of life, the evolution of the first cell, of multi-cellular organisms, of social insects and of humans.

Some open questions in evolution

Our current understanding of evolution is incomplete. This statement is not meant as a criticism of the approach, but rather as an impetus for further work. I will list three interesting open questions.

1. The origin of life and the very beginning of evolution

Life can be defined as that which evolves. Living systems are the product of evolution and are capable of undergoing further evolution. But how does evolution begin? Evolution requires populations of reproducing individuals? But how do we obtain individuals that have the ability to reproduce? This question concerns the transition from chemistry to biology. I am sure that a scientific explanation for this transition can be found, but it is not evolution. Evolution presupposes reproduction and therefore cannot lead to the origin of reproduction. Therefore, evolution is not a theory that explains the origin of life.

2. Why is evolution constructive?

Imagine our planet 3 billion years ago, when it was populated by bacteria. How do we get from such a world to what we have now? Which properties of the bacterial cell suggest that there is an „open ended“ evolution ahead? An evolution that would lead to higher cells, complex multi-cellularity and even to intelligent life? At present we cannot formulate such a predictive theory of evolution. We do not understand why evolution is constructive on a large time scale.

We could say if a planet of bacteria will ever discover more complicated life forms, then these life forms will have many properties in common with their bacterial ancestors. They will use DNA to store genetic information, they will use similar tools to translate DNA into RNA and proteins. But we do not know how likely it is that a planet of bacteria moves on to discover more complicated life forms, or how long this will take.

Given current biotechnology we can imagine humans producing life forms that use very different chemistry than our bacterial ancestors. We could build such life forms and send them to populate other planets and possibly start trees of evolution there. The chemical continuity with our evolutionary ancestors could have been lost by then.

3. The search space

Evolution is a search process that explores a space of possibilities. But what generates that search space? Is a theory for that space not a deeper description of biology, than a theory which just describes the search process. The outcome of the evolutionary process, its speed and probabilities very much depend on the structure of the search space.

You can say evolution discovers intelligent life, but evolution does not generate the possibility of intelligent life. What is it then that generates the possibility of intelligent life? Likewise what generates the possibility of molecules that store information, of cells that can divide, of multi-cellular organisms of human language? Ultimately the answers must come from the laws of physics and chemistry, but we do not know how to formulate such a theory right now.

God and evolution

In Christian theology, God is the creator and sustainer of the universe. According to St Augustin, God is atemporal and created the world „ex nihilo“ (out of nothing). According to St Thomas, God is the ultimate cause for everything that exists.

God has chosen to unfold his creation in time according to laws of nature. God is the creator of the laws of nature and their instantiation. Humans, created in the image of God, have begun to understand certain aspects of these laws of nature. Evolution is an organizing principle of the living world. God uses evolution to unfold life on earth. The creative power of God and the laws of evolution are not in conflict with each other. God can act through evolution as God can act through gravity. God is the ultimate cause for evolution and everything that exists. Without God there would be no evolution at all.

God uses gravity to organize the structure of the universe on a large scale. Without God there would be no gravity. Neither gravity nor evolution constitute challenges for Christian faith, which reminds us of Newton's words "Hypotheses non fingo".

A proper scientific interpretation of evolution does not lead to an argument against God. Scientific atheism is a metaphysical position, which goes beyond a purely scientific interpretation of the available scientific evidence. Science does not imply atheism, does not endorse atheism.

It is important to note that God is not only creator, but also sustainer. God not only sets the initial conditions and then watches everything unfold from a distance. Instead God's creative power and love is needed to will every moment into existence. St Augustin has also taught us that God is atemporal. In my opinion, an atemporal Creator and Sustainer lifts the entire trajectory of the world into existence. For the atemporal God, who is the creator and sustainer of the universe, the evolutionary trajectory is not unpredictable but fully known.

Further reading:

Nowak, Martin. *Evolutionary Dynamics. Exploring the Equations of Life*. Harvard University Press, 2006.

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John Polkinghorne

The Search for Truth

In a common quest for truth, the natural conversation partner for science in interaction with religion is the discipline of theology. Theology's character as intellectual reflection on human encounter with sacred reality parallels science's intellectual reflection on human encounter with physical reality. I believe that the two great enterprises of science and theology bear a cousinly relationship to each other in that they share in a search for truthful understanding that is to be achieved through the attainment of well-motivated belief.

In this truth-seeking quest, neither discipline will be able to claim that it achieves absolute certainty beyond the possibility of any further refinement or correction. Rather, its achievement will be gaining a degree of understanding which is sufficiently insightful in its explanatory character for its acceptance to be something to which it is entirely rational to commit oneself. In the case of science, this kind of judgement has been carefully analysed and defended by Michael Polanyi in his important book *Personal Knowledge*¹. Polanyi was someone whose career as a distinguished physical chemist meant that he knew science from the inside. In his account of science he said that he was seeking to understand how he could commit himself to what he believed to be true, though he knew that it might eventually prove to be false. The best we can achieve is a kind of convergent realism, making maps of domains of reality which are adequate for some, but not for every, purpose.

One needs to bear in mind that science is not as unproblematically factual as people sometimes suppose. This is because there are no significant scientific facts that are not already interpreted facts. Raw instrumental readings only gain significance when they are interpreted by a theoretical understanding of what the experimental configuration is actually capable of measuring. Thus, in science theory and experiment intertwine, as theory interprets experiments and experiments confirm or disconfirm theories. This circularity implies a degree of intellectual precariousness, though the long-term fertility of the process, often leading to the explanation and even prediction of phenomena not taken into account when a theory was conceived, strongly encourages the belief that the

1 Polanyi, Michael, *Personal Knowledge. Towards a Post-Critical Philosophy* (Routledge and Kegan Paul, 1958).

circularity is benign and not vicious, – a conclusion which supports the realist conviction, held by almost all scientists, that what they come to know is indeed a reliable guide to what is actually the case. On its part, theology has long wrestled with dialectical necessity both to believe in order to understand and to understand in order to believe. Its truth-seeking task has similarities to that of science, but its the quest is much more challenging since science engages with a physical world that we transcend and can put to the experimental test, but theology's subject is the transcendent reality of God, whose infinite nature cannot be subjected to contrived probing by human experiment. 'You shall not put the Lord your God to the test' is a fundamental fact of the spiritual life. In consequence, there is an inescapable dimension of reserve and apophatic mystery in theological discourse, as finite beings strive to think about the infinite nature of the deity, yet that does not mean that theology is simply reduced to silence.

We need to recognise that science has achieved its very great success by the modesty of its ambition. It asks essentially only one basic question: What are the processes by which events occur in the physical world? Whether there is also something going on in what is happening – that is to say, addressing questions of meaning and value and purpose – is deliberately bracketed out, but this by no means implies that these questions are not of the greatest significance. Such issues are, of course central to theology. We are perfectly familiar of the need to ask both kinds of question if we are properly to understand what is going on. To take a homely illustration: the kettle is boiling because burning gas heats the water; the kettle is boiling because I want to make a cup of tea. We do not have to choose between these two statements, for both are true and both necessary for full understanding.

Neither science nor theology can pretend to be able to answer the other's questions for it but, even if the questions are different, their answers must bear some kind of consonant connection with each other. Putting the kettle in the refrigerator is not consistent with the desire to make a cup of tea! Process and purpose must stand in a congruent relationship. Recognising these facts implies that science and theology complement each other, rather than being in conflict. For example, it is surely clear that theological discourse on creation has been significantly – and I would say, very fruitfully – influenced by the discovery that we live in a world of evolving becoming, whether one is thinking of the entire 13.7 billion year history of the universe itself, in the course of which an initial expanding ball of energy has become the home of saints and scientists, or of evolutionary biology's account of the 3.5 billion year history of terrestrial life in which an initial world of bacteria has become the home of self-conscious human

life. Religious people who are seeking to serve the God of truth should welcome the discoveries of science.

We have seen that the difference in character between science and theology does not mean that they have nothing to say to each other and, in fact there is a natural frontier region where they meet. It lies in the consideration of what one may call 'metaquestions', that is to say, questions which arise from the experience of doing science but whose character is such that the latter's self-limiting scope of enquiry implies that it is unable of itself to provide the answers. An example would be to ask why modern science is actually possible in the way that it has proved to be, probing so profoundly into the deep structure of the physical universe. We tend to take this for granted, but it is surely a fact of significance. Physicists are able to understand regimes, such as subatomic physics, which demand counterintuitive ways of thinking, quite different from the everyday modes of thought whose effectiveness may simply be assumed to have arisen from our brains having been shaped by an evolutionary necessity for survival in an everyday environment. As a prime example of counterintuitive thinking I shall later discuss the case of quantum theory. Moreover, it turns out that a powerful guide to successful discovery in fundamental physics is often provided by a quest for mathematical beauty in the equations being considered. A distinguished nuclear physicist, Eugene Wigner, once asked 'Why is mathematics so unreasonably effective?' Why does this seemingly abstract subject provide the key to unlock the deep secrets of the physical universe? What links together the reason within (our mathematical thoughts) and the reason without (the order of the universe)? Scientists are happy to exploit the remarkable opportunities provided by this wonderful rational transparency of the universe, but, simply as scientists, they are unable to offer an explanation of it. Yet, it would surely be intellectually lazy just to treat it as a happy accident. Theology offers what I believe to be a satisfying and persuasive understanding. It sees the rationally beautiful world of fundamental physics – a world shot through with signs of mind, one might say – as indeed reflecting of the Mind of its Creator. In an ancient and powerful phrase, it understands the remarkable success of science in exploring this order as one sign that we are creatures made in the image of our Creator.

A second metaquestion asks, 'Why is the universe so special?' Scientists prefer the general to the particular, so that our expectation was that the cosmos would be just a typical specimen of what a universe might be like. This has not proved to be the case. While life only appeared after ten billion years of cosmic history, the universe was pregnant with the possibility from the start. The laws of nature took exactly the very specific form necessary to allow carbon-based life to evolve.

For example, we are people of stardust, for the only place where carbon, a vital constituent of living beings, can be formed is in the interior nuclear furnaces of the stars. The process is very delicate and it requires the nuclear forces involved to lie within very narrow limits. Science treats these laws as its unexplained basis for understanding, but their 'finely-tuned' character (as one might say) seems to point beyond them and to demand some deeper explanation. Seeing fine-tuning as an expression of the creative divine will offers such an explanation. Those who recoil from this approach are driven to the rather desperate expedient of hypothesising the existence of a multiverse, a vast array of different universes of which only one, our own, is observationally accessible to us, with its finely-tuned fertility being simply a kind of lucky chance in a gigantic cosmic lottery. Actually, without further specificity, even an infinite multiverse would not be enough to guarantee one member with desirable properties. After all, there are an infinite number of even integers, but none has the property of oddness.

Much more could be said, but it is considerations of this kind which have led to a revival of natural theology, the attempt to learn something of God by the use of reason and the inspection of the world. Natural theology of this revived kind is a modest endeavour, claiming insight rather than logical demonstration – it does not talk of 'proofs' of God – and its scope is limited by the kind of general experience to which it restricts its appeal. At best, it can only lead to a rather 'thin' concept of divinity – the Great Mathematician or the Cosmic Architect – but it helps to put the question of God onto the agenda of truth-seeking rational enquiry.

Because I see science and theology as cousins under the skin in their common search for truth, I believe that there are some useful lessons that science has learnt in its quest which are also of relevance to theology. If science teaches us anything about reality it is surely that it is often surprising, so that one must be open to the possibility of having to revise what had previously been held to be self-evident. My own subject of quantum physics makes the point readily enough. No one in 1899 would have believed it possible that an entity could sometimes behave like a wave (that is, spread out and oscillating) and sometimes like a particle (a little bullet). In fact, a philosophically-minded person in 1899 would have been only too glad to 'prove' the impossibility of such oxymoronic behaviour. Yet, as we all know, that is how light has actually been found to behave. For about 25 years physicists had to live uncomfortably with this strange state of affairs, until the insights of Schroedinger, Heisenberg and Dirac led to modern quantum theory. This discovery dissolved the paradox. Its resolution lay in the discovery of what is called the 'superposition principle'. In the quantum world there are not only states with definite properties, such as

an electron being 'here' or being 'there', but also states which are unpicturable mixtures of being both 'here' and 'there', a kind of middle term undreamed of by Aristotle. In consequence, a new type of logic operates in the quantum world, quite different from the common-sense logic of everyday. Analysis showed that this fact explains wave/particle duality, with wave-like states corresponding to states with *indefinite* numbers of particles.

As a consequence of the need for this kind of counterintuitive thinking, the natural question for a scientist to ask about a proposition, whether within science or beyond it, is not 'Is it reasonable?', as if we felt we knew beforehand the shape that rationality had to take. Rather the question to ask is 'What makes you think that might be the case?' This is an open form of enquiry – no possibility is being ruled out a priori – but if a surprising proposal is made, it will have to be backed up by adequate motivating evidence.

I like to call this kind of open thinking, which seeks to move from the particulars of experience in the achievement of illuminating understanding, 'bottom-up thinking'. It contrasts with 'top-down thinking', which believes that it can start with general ideas, so clear and certain in their character that they can reliably shape our thinking about particulars. This latter kind of thought was the grand ambition of the Enlightenment, but it has not proved to be attainable.

The truth of the matter is that there is no universal rationality that fits all situations, but entities have to be thought about in the manner that conforms to their actual nature. We can think about the clear and orderly Newtonian world of macroscopic events in one way, but the cloudy and fitful world of subatomic quantum events has to be thought of in a quite different fashion. In theology, we have to seek to think about the divine nature in ways that conform to its intrinsic character. Christianity's belief in the duality of the human and the divine in Jesus Christ is a more profoundly mysterious than the wave/particle duality of light, yet it too arose from wrestling with experience rather than from metaphysical speculation. We can see the process beginning in the New Testament accounts of the life-transforming power of the risen Christ, where the writers, despite being monotheistic Jews, found that they were driven to use divine-sounding language about Jesus if they were to do justice to their experience. The process has continued in the Christological thinking of the Church down the centuries. I am entirely happy to approach my Christian beliefs in this bottom-up fashion and, in fact, I sought to do so in my Gifford Lectures.²

2 Polkinghorne, John C., *Science and Christian Belief. The Faith of a Physicist* (SPCK/Fortress, 1995/1996).

Just as there is no universal rationality, so there is no universal epistemology. Particular entities have to be known in the specific way that accords with their specific nature. Any attempt to know the quantum world with the clarity of Newtonian thinking is condemned to failure. That world can only be known in accordance with the limits of the uncertainty principle. God can only be known in a way which respects the awe and obedience appropriate to encounter with the infinite mystery of divinity.

There is one more lesson I would like to draw from the experience of being a scientist. It may seem at first sight seem surprising, but I wish to affirm the indispensability of some form of metaphysical thinking. Many scientists are suspicious, or even contemptuous, of metaphysics, asserting that they have no need of such speculative activity. However, properly understood, metaphysics is simply the search for an over-arching world view and no one can be indifferent to that. We think metaphysics as naturally and inevitably as we speak prose. The materialist who tells us that matter is the only reality and that the only questions worth asking and capable of being answered are scientific questions, has gone far beyond what an honest assessment of science's actual capacity could establish. Once again, the point at issue can be illustrated by considering quantum theory.

Quantum physics is unquestionably statistical in character. It can only calculate the relative probabilities of the different possible outcomes of an interaction, but it cannot say which particular outcome will actually occur on a particular occasion. This degree of intrinsic unpredictability might be either epistemic or ontological in origin. That is, it might arise from an unavoidable ignorance of all the detailed factors that actually determine the outcome, or it might arise from a fundamental indeterminacy in present nature itself. Interestingly, physics by itself cannot determine which of these possibilities is the correct one. Niels Bohr's Copenhagen interpretation corresponds to the ontological option. For it, the uncertainty principle is a principle of actual indeterminacy. However, David Bohm constructed an alternative interpretation of quantum unpredictability whose character is epistemological. For Bohm, the uncertainty principle is simply a principle of necessary ignorance. These two quite different interpretations yield exactly the same empirical consequences, so that the choice between them cannot be made solely on scientific grounds. The majority of physicists, of whom I am one, opt for Bohr because we think that Bohm's clever theory has an air of contrivance about it which is *metascientifically* unattractive. Even so fundamental question as the nature of physical causality cannot be settled on purely scientific grounds alone.

The question of truth is as fundamental to theology as it is to science. Otherwise, religious belief would amount to nothing more than wishful thinking. I like to consider myself as 'two-eyed', seeking to view reality with the binocular vision of both scientific and theological insight. I believe that yield understanding more satisfying than either perspective could yield on its own.

III. The Science and Theology Dialogue I: Multi-Year Research Projects

John Polkinghorne

A Contribution to the Eschatology Session

In the developing modern interaction between science and theology, the topic of eschatology has only comparatively recently become an item on the agenda¹. Nevertheless, the topic raises issues of considerable significance. The most critical question posed to theology by contemporary physical cosmology is not about the past origin of the universe in the big bang, but about the future and the universe's ultimate descent into a state of universal decay, most probably by its continuing expansion bringing about a world so cold and so dilute that carbon-based life must disappear from everywhere within it. The death of the universe on a timescale of many billions of years poses a challenge to religious belief similar to the problem of the death of human individuals on a time scale of tens of years. If both the cosmos and humanity are seemingly condemned to ultimate futility, what can we make of the theological assertion of reality being a fully meaningful creation, not only now but always? The actual fact is that every story told by science ultimately must end in futility. This sad fact is due to the second law of thermodynamics, which asserts that, without external intervention, all physical systems become more and more disorderly. The reason for this is because there are many more ways of being disorderly than orderly, so that statistically the waters of chaos inexorably rise.

However, science's 'horizontal' story of the unfolding of present process is not the only tale to be told. Theology has a 'vertical' story of the eternal faithfulness of the Creator. It asserts that, while death is indeed real, the only ultimate reality is God. This means that the issue of final destiny is not to be settled by the extrapolation of present process but by the active will of the Creator. This point was precisely that made by Jesus in his controversy with the Sadducees about whether there is a human destiny beyond death (Mark 12:18–27). He reminded them that God is the God of Abraham, Isaac and Jacob, going on to say 'The God, not of the dead, but of the living'. If the Patriarchs mattered to God once, as they for certain did, they will matter to the faithful God for ever. While there is

1 Polkinghorne, John C. and Welker, Michael (eds), *The End of the World and the Ends of God* (Trinity Press International, 2000); Polkinghorne, John C., *The God of Hope and the End of the World* (SPCK/Yale University Press, 2002); Peters, Ted, Russell, Robert, J. and Welker, Michael (eds), *Resurrection*, (W. B. Eerdmans, 2002).

no natural expectation of a destiny beyond death, either for ourselves or for the universe, of a kind that science could speak about, theologically there is every such expectation. Christians, of course, believe that this hope has been manifested and guaranteed by the resurrection of Jesus Christ within history as the sign and assurance of a destiny that awaits all of us beyond history. Such a belief is one that science, by its self-defining limitation to the exploration of present process, is powerless to speak about, either for or against. Yet, having said that, there remains a relevant issue to the discussion of which science can seek to make some contribution. The issue is simply this: can we actually make sense of the notion of a human destiny beyond death and the subsequent decay of the body, for corporeal beings like ourselves whose nature seems intrinsically to be that of physical embodiment? Once one begins to think about this issue, it soon becomes clear that if such a destiny is to become intelligible it will require the satisfaction of criteria of both continuity and discontinuity between this life and any conceivable further life beyond death.

Let us first consider the question of continuity. If God is to be everlastingly faithful to the Patriarchs, it really must be Abraham, Isaac and Jacob who live again in the Kingdom of God and not just new individuals given the old names for old times' sake. What then could be the carrier of continuity between this world and the next needed to satisfy this criterion? The traditional Christian answer has been the human soul. Often this has been conceived in a Platonic/Cartesian fashion as a spiritual component liberated at death from entrapment in the fleshly husk of the body. Yet, that kind of spirit/flesh duality has become increasingly difficult to accept today in the light of our knowledge of such matters as human evolutionary kinship with the animals and the effect of drugs and brain damage on human personality. Like many contemporaries, I see human nature as being a psychosomatic unity, with body and spirit being inseparably complementary aspects of a single, unified being (an idea that would not actually have shocked most of the writers of the Bible, whose Hebraic heritage understood human beings as being, in a celebrated phrase 'animated bodies rather than incarnated souls'). But if we take this psychosomatic view, have we then lost the concept of the soul altogether? I do not think so, but it will certainly have to be reconceived.

Whatever the soul might be, it is presumably 'the real me'. What that could be is, in fact, almost as difficult to understand within this life as it might be beyond it. What makes me, an elderly bald academic, the same person as the schoolboy with the shock of black hair in the school photograph of long ago? At first sight, it is tempting to answer by appealing to physical continuity, but that would be an

illusion. The atoms which make up our bodies are changing all the time through wear and tear, eating and drinking. We have very few atoms today which are the same as those of a few years ago and I am atomistically distinct from that school-boy. The carrier of personhood must be something much more subtle than a mere collection of physical constituents. In a phrase that can be no more than hopefully evocative, I suggest that the 'real me' is 'the almost infinitely complex information-bearing pattern carried at any one time by the atoms of the body'. If that phrase is to have any appropriate meaning, the concept of 'information' will have to be generalised immensely beyond the banalities of modern information theory in order to make it capable of embracing such aspects of human nature as memory and character. It is beyond our present capabilities to articulate this idea of the soul adequately – the notion is offered as a kind of 'thought experiment' intending to use a crude model to get some purchase on a deeply perplexing problem. One might say that what is involved is an attempt to wave our hands in a promising direction. The proposal has some kinship with Aquinas's idea of the soul as the 'form' of the body, though it offers a more dynamic picture of the soul, since the 'pattern' involved develops through the continuing deposit of life experiences.

There is also some faint kinship between this idea of the soul and a development beginning to take place in contemporary science. People are just beginning to be able to study moderately complex systems treated in their totalities rather than simply being reduced to the consideration of the properties of the individual constituents. So far, none of these systems is anything like as complicated as a single living cell, but nevertheless the systems are able to manifest holistic behaviours which are totally unforeseeable in terms of constituent properties alone. They turn out to be capable of the spontaneous generation of immensely intricate patterns of dynamic behaviour². At present complexity theory is simply at the natural history stage of the investigation of particular examples. There must be a general theory underlying all this remarkable behaviour, but the form of this theory is currently unknown. I share with many the belief that when the theory is eventually discovered it will involve some appropriate concept of physical information, likely to be as significant dynamically as energy has long proved to be.

Of course, the pattern that is me will decay after death as my corpse decomposes, so that the soul thus conceived possesses no intrinsic immortality. Yet it

2 Prigogine; Ilya and Stengers, Isabelle, *Order out of Chaos* (Heinemann, 1984); Kauffman, Stuart, *At Home in the Universe* (Oxford University Press, 1995).

is a perfectly coherent belief that the faithful God will not allow that pattern to be lost but will preserve it in the divine memory. This would not of itself comprise a human life beyond death for I believe that it is intrinsic to full humanity to be embodied in some way. We are not apprentice angels. True life after death therefore requires a further divine act of re-embodiment in some environment of God's choosing. In fact, the true Christian hope has always been expressed as resurrection and not simply as a kind of spiritual survival.

Yet there would be little point in making Abraham, Isaac and Jacob live again simply in order to die again. Hence resurrected embodiment must take place in a new form of 'matter,' endowed with such strong self-organising principles that it is not subject to the thermodynamic drift to decay which characterises the matter of this world. It is at this point that the criterion of discontinuity comes into play. I see no scientific reason to suppose that such new 'matter' is not a coherent possibility. In theological terms, the divinely induced transition from matter to 'matter' is the transformation of the world of the old creation into the world of the new creation. The physical properties of our world are those appropriate to an evolving creation existing at some distance from the veiled presence of its Creator as it is allowed to 'make itself' (as Darwin's clergyman friend, Charles Kingsley, put it). In such an evolving world the death of one generation is the necessary cost of the new life of the next. Yet God's ultimate purpose for the new creation is that it should be drawn ever closer into the unveiled life of its Creator, so that it is not a world of transience and decay and its 'matter' will have the properties that are appropriate to its redeemed status.

I believe that human beings are not only intrinsically embodied beings but also intrinsically temporal beings. Our destiny is not the timeless experience of the Beatific Vision, but an everlasting process of sanctification in which the inexhaustible riches of the divine nature are endlessly revealed in ever-increasing depth. Finite creatures cannot take in the Infinite at a glance.

This brief review of contemporary eschatological thinking necessarily involves some speculative ideas, but for the Christian it rests on the firm foundations of the faithfulness of the Creator and the Resurrection of Christ. The discussion is necessarily interdisciplinary, since it must draw on insights from science, anthropology and theology. Its pursuit will require the participation of scholars from all these disciplines. The project demands a conversation that cannot be unduly hurried, since diverse scholars must get used to unfamiliar insights from other points of view before a true synthesis can emerge. Such work can be richly rewarding. I know that Michael Welker has more to say about this.

Michael Welker

Eschatology, Anthropology, and Concepts of Law

My academic background is in the areas of theology and philosophy. I did post-doctoral work on Alfred North Whitehead¹ and thus got involved in the dialogue with natural scientists. Whitehead was a mathematician and amateur scientist and provided stimulating interdisciplinary insights. One of his basic interests was the complexity of cultural evolution. He acknowledged the fact that in modernity cultures center very much on mathematized science, and, to be sure, as a mathematician, he was in favor of this development. However, he observed that it comes with a price. He saw the danger that a culture strongly focused on mathematized sciences lowers or even distorts sensitivities for religious, ethical and aesthetic dynamics. He argued that a vibrant culture has to balance these various dimensions and strive for their mutual strengthening.

I found this perspective quite convincing. With this background in mind today, I should like to speak first about the relevance of creating different specific forms and formats in the organization of interdisciplinary research and dialogue. I will then pick up on three topics already mentioned by John Polkinghorne, topics that were successful in the interdisciplinary science and religion dialogue.

1. The relevance of specific forms and contents in the organization of research and dialogue

The *John Templeton Foundation* has in many ways been creative and innovative in supporting the science and religion discourse. It has supported a range of forms and formats of academic cooperation and interaction. I should first like to highlight my appreciation for research formats that Dr. Mary Ann Meyers has cultivated in the framework of *The Humble Approach Initiative*. These were

1 Michael Welker, *Universalität Gottes und Relativität der Welt. Theologische Kosmologie im Dialog mit dem amerikanischen Prozeßdenken nach Whitehead*, Neukirchen-Vluyn: Neukirchener Verlag, 2nd edition 1988; idem, "A.N. Whitehead's Basic Philosophical Problem: The Development of a Relativistic Cosmology," in: *Process Studies* 16 (1987), 1–25.

one-shot or two-shot events leading to a book publication. In each case a highly relevant topic was chosen, and a group of scholars with expertise in this topic was invited. Interest in the dialogue as such was not a criterion sufficient for their electability. “Are you merely interested in everything – or also in something specific?” This ironic question is attributed to Samuel Beckett. Over against this attitude, Dr. Meyers, in her projects in *The Humble Approach Initiative*, always made sure that the academic cooperation focused on a *specific topic*. The work on this topic then either supplemented previous research or stimulated the preparation of subsequent future research. Several Templeton-sponsored projects organized by Ted Peters and Robert Russell from the CTNS in Berkeley operated in a similar way. Two projects may suffice as examples: 1. *Kenotic Love*, a project organized by Mary Ann Meyers and John Polkinghorne, a preparatory consultation in the area of anthropology and love; 2. *The Resurrection*, organized by Ted Peters, Robert Russell and myself, a conference supplementing earlier work on eschatology.²

Another great strength of the Foundation is its willingness to support projects at new frontiers of cooperation and even at risky frontiers of dialogue. In the framework of the *Humble Approach Initiative*, we organized a dialogue with Greek and Russian Orthodox theologians and scientists³ on the work of the Spirit in creation and new creation. We also had a dialogue with the first generation of Pentecostal theologians interested in academic discourse and in the engagement between science and theology.⁴ This was innovative but not easy because we could not rely on established models and exemplary experiences, recognized publications and proven styles of thought. In the same vein, greatly supported by Dr. Paul Wason and his team, we initiated a project entitled *Law and Love: The Science and Theology Dialogue in China and the West*.⁵

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- 2 John Polkinghorne (ed.), *The Work of Love: Creation as Kenosis*, Grand Rapids and London: Eerdmans and SPCK, 2001, 127–136; Ted Peters / Robert Russell / Michael Welker (eds.), *Resurrection: Theological and Scientific Assessments*, Grand Rapids: Eerdmans, 2002.
 - 3 Michael Welker (ed.), *The Spirit in Creation and New Creation: Science and Theology in Western and Orthodox Realms*, Grand Rapids u. Cambridge/UK: Eerdmans, 2012 (Russian translation by Sergii Bortnyk, Moscow: St. Tikhon Orthodox University Press, 2013).
 - 4 Michael Welker (ed.), *The Work of the Spirit: Pneumatology and Pentecostalism*, Grand Rapids: Eerdmans, 2006.
 - 5 Michael Welker et al. (ed.), forthcoming 2014 in English and Chinese.

2. Three topics that proved successful in the dialogue between science and theology

In terms of topics, three areas within my expertise have been particularly successful as foci of engagement between science and theology respectively science and religion.

a. Eschatology

John Polkinghorne and I organized a multi-year research project at the CTI in Princeton that resulted in a very successful publication titled *The End of the World and the Ends of God: Science and Theology on Eschatology*.⁶ A crucial point of insight was that the spiritual eschatological realities have to stand *in continuity as well as in discontinuity with our real experiences*. Eschatological realities are not fantasies. This is quite obvious in the biblical symbol systems that always emphasize both aspects, the discontinuity and the continuity of earthly and eschatological realities. “New creation, new heaven and new earth” – i.e., discontinuity; but then: “New creation, new heaven and new earth” – continuity. “Flesh and blood will *not* inherit the reign of God” – discontinuity; “We believe in the resurrection of the body” – continuity. This constellation, we found, leads to fascinating processes of discovery, processes that are not mere invention. In describing these processes of discovery, we developed clear concepts and strategies of *truth-seeking communities*, in both the sciences and theology.

The contents of these processes of discovery and the search for truth are not at all simple issues. For religions deal with gigantic problems and not, as is often believed, with just cozy private experiences. Think of the historical backgrounds and the developmental logics of the biblical canon. Here, religious experience and religious thought always unfold under the pressure of a global power: Egypt,

6 John Polkinghorne and Michael Welker (eds.), Harrisburg: Trinity, 2000; second printing 2000 (Korean translation by Joon Ho Shin, Seoul: The Christian Literature Society of Korea, 2002; Chinese translation by Wang Tao, *Logos and Pneuma Translation Series 16*, Hong Kong: Institute of Sino-Christian Studies, 2010). The gain of methodological insights was reflected in a consultation documented in “Opening Windows Unto Reality” (Polkinghorne) and “Springing Cultural Traps: The Science-and-Theology Discourse on Eschatology and the Common Good” (Welker), in: *Theology Today* 58 (2001), 165–176; and in John Polkinghorne and Michael Welker, *Faith in the Living God: A Dialogue*, London and Philadelphia: SPCK and Fortress, 2001 (German translation 2005; Chinese translation 2006).

Assur, Babel, the Persians, the Greeks and the Romans. The global power, in its overwhelming presence, puts the traditional religious, legal and moral norms under extreme stress: "Our traditions and institutions, as we see and have experienced them so far, do not help us in this situation!" Then there is a search for new insight, followed by the discovery that spiritual powers, soft, emergent powers, seemingly frail, like wisdom and love, the coming reign of God, and the spiritual body of the resurrection, are revealed as creative and saving realities. To be sure, they are complicated realities, but realities that can be explored in truth-seeking communities. One of the central notions we are still wrestling with is the notion of the "spiritual body." The ancient cultures were well aware that our bodies are loaded with and shaped by mind and spirit. They also conceived of the reverse impact, e.g., spiritual realities shaped by bodily realities. In this context, it is crucial to acknowledge the complicated interference of natural, social, cultural and religious dynamics and processes.

b. Anthropology

The second most important area of research in the science and theology discourse, already mentioned by John Polkinghorne, was and still is the area of *anthropology*. The John Templeton Foundation generously supported our projects and agreed to fund more than one or two meetings so that we could develop a fruitful multidimensional approach toward the human person. The fact is that in order to have an impact on each other and potentially change the participants' ways of thinking, more than one or two conferences are needed. In projects that we conducted at the CTI in Princeton, and with Professor William Schweiker at the University of Chicago, supported by the Lilly Foundation, we had had good experiences with sequences of four or five meetings in the course of several years. For the first meeting, we invited short and often programmatic papers of only three to five pages. These first meetings of competent scholars from various disciplines and different countries always generated at least mild enthusiasm and great anticipation. For the second meeting, we asked half of the participants to elaborate their contributions, and the others were asked to prepare responses.

As a rule, these second meetings became what I have termed "Tower of Babel meetings." The participants had to go through the experience of clashes of rationalities, methods and procedures of research. Quite often we heard the phrase: "I do not belong to this group! I cannot contribute to further progress." The confusion and even despair generated threatened the continuation of the projects, but that was only one part of the danger. The other part was the danger

of “great proposals of dominant minds,” e.g., “If we all thought as I suggest we do ...;” “If you all followed these ideas, these methods, then we could succeed in ...” If as organizer of the project one does not want to lose a number of the bright and subtle minds, one has, against such proposals, to look for the small bridges among some of the contributions. In this phase, the balancing of complexity and the search for coherence is crucial.

The third meeting then not only brought the elaboration of the second half of the contributions and the responses of the rest of the group. (At this stage, we sometimes included additional contributions on topics, methods and strategies of research left out earlier.) The third meeting as a rule brings a significant rise in progress with regard to interweaving, consistency and coherence. The fourth meeting sees a continued growth and gain in profile. It also serves to prepare the book publication. In some cases, a fifth meeting was needed for this preparation.

In the case of anthropology, we wanted to question dualistic anthropologies or anthropologies based on dualities such as “mind and body,” “spirit and body,” “brain and spirit,” etc. We wanted to overcome the mentalist approaches that dominated the 1960s and -70s, and often just focused on “consciousness and self-consciousness;” we also wanted to overcome more recent naturalistic and scientific anthropologies that were just fixated on the brain or the genome. The question was how the body can be included in anthropological explorations without then dropping into naturalism and reductionistic scientific approaches. Soon it became clear that the appeal to the “complexity of the human person” over against a dualism was not helpful. A philosopher warned us that such an approach was a bottomless pit: “We do not know how to rank about twenty current concepts of the human person!”

With the help of biblical scholars and a new appreciation for Pauline anthropology, we explored the interesting spectrum of *flesh – body – heart – soul – conscience – reason – spirit* and developed a multidimensional anthropology, an approach that allowed the different disciplines and fields to bring in and connect their specific insights.⁷ We were able to work with a new spreadsheet in anthropology, a spreadsheet that enabled us to differentiate flesh and body, to explore the complexities of the heart and the complexities of conscience, to differentiate and fruitfully relate spirit and reason, and to offer inspirations in the current wrestling with questions of embodied cognition, memory theories and evolutionary anthropology.

7 Cf. Michael Welker (ed.), *The Depth of the Human Person: A Multidisciplinary Approach*, Grand Rapids: Eerdmans, 2014.

c. Concepts of Law in the Sciences, Legal Studies and Theology

The third area of research that proved successful in the interdisciplinary dialogue was “*Concepts of Law in the Sciences, Legal Studies and Theology*.”⁸ This was the most complicated dialogue so far, because we had to bring the different rationalities and modes of thought of scholars of law and the history of law into the orbit we had earlier established in projects between the science and religion respectively the science and theology groups. The encounter among these different fields, however, enabled us to gain deep and subtle insights into the character of the laws of nature and into commonalities and differences in the approaches in chemistry, biology and physics. We were able to explore complicated relations between laws of nature and natural law traditions. We asked, “What can the laws of nature teach us about moral laws?” “How should we deal with tensions between a deep and growing moral skepticism in some parts of the world and continued trust in the natural law and in morals based on it in other religious and cultural traditions?” In a famous dialogue with Jürgen Habermas some years ago, Joseph Cardinal Ratzinger maintained that the “instrument of natural law has become blunt.” We made several preparatory steps to replace this “blunt instrument” by our insights gained in the science and theology dialogue, enriched by those of legal scholarship.

8 Michael Welker and Gregor Etzelmüller (eds.), Tübingen: Mohr Siebeck, 2013.

Denis R. Alexander

The Faraday Institute for Science and Religion – the First Seven Years

The Faraday Institute for Science and Religion started its activities in January 2006 based at St. Edmund's College, a graduate College of the University of Cambridge. The University comprises 31 colleges in all, each of which is completely interdisciplinary. A Cambridge college therefore provides a natural location for an enterprise which aims to bridge the discourses of many different academic disciplines.

Funding for the initial research and dissemination projects of the Institute was generously provided in the form of a 30-month grant from the John Templeton Foundation, together with matching funds. The generation of matching funds, together with other grants and income from a wide range of more than fifteen different trusts and donors, including the Templeton World Charity Foundation, then secured the work of the Institute to the present day. 'Friends of the Faraday' provide an invaluable support and donor group. Faraday Associates are those in the academic community, ranging from PhD students to Vice-Chancellors, who help provide an important linkage between the Institute and various academic disciplines.

The purpose of this chapter is to illustrate the way in which an Institute of science and religion can flourish within the framework of a historic university such as Cambridge. There are of course many different ways in which an Institute of this kind might exist within a university; the present chapter describes one particular model which may hopefully spark ideas for others.

The Faraday Institute is an integral part of St. Edmund's College and has no separate legal existence outside of the College which is regulated by its Governing Body, consisting of the Fellows of the College. The Fellows were kind enough to vote, in 2005, that the Institute become part of the College, established by its own separate College ordinance. The Institute receives no funding from the College, but instead pays the College for its valued practical support, including office rental, personnel, IT and financial services. Overall responsibility for the running of the Institute is in the hands of the Master and Fellows of the College.

From its beginning, the ethos of the Institute has been created by scientists, but in such a way that is open to all other disciplines, so that staff over the first seven years have been recruited from a very wide range of disciplinary backgrounds in

both the sciences and the humanities. The scientific ethos was nurtured by the Principal Investigator on the initial funding grant, Dr. Denis Alexander, who has spent the past forty years in the biological research community, and who served as Director from 2006–2012, and by the co-Investigator and Associate Director, Prof. Bob White FRS, Professor of Geophysics in the University, who subsequently took over as Director in October 2012. Regular weekly staff meetings at which participants share news of their current activities, lunch-time discussion groups on specialised topics, and regular internal research presentations, all ensure that staff are well engaged with the projects of others.

The Faraday Institute also has a Christian ethos, given that it is located in a College that started life (in 1896) as a place in which Catholics could find a home within the University. Although it retains some of its Catholic heritage, the College has since become, like all Cambridge colleges, a seat of research and learning for those from any faith or none, and this is likewise reflected in The Faraday Institute activities. The Institute is ecumenical in stance and its activities are open to all, of any faith or none.

A distinguished Advisory Board¹ which meets on an annual basis has been invaluable in providing advice and support for the work of the Institute. For the first six years the Board was chaired by Sir Brian Heap FRS, previous Master of St. Edmund's College and Vice-President of the Royal Society. The next Chair was then Prof. Hill Gaston, Professor of Rheumatology in the University of Cambridge and a Fellow of St. Edmund's College.

Since its founding, the Institute has gained a wide international profile, partly as a result of its dissemination activities. All talks have been filmed and then posted on web-sites in ways described in more detail below. This alone has multiplied worldwide audiences many-fold. But it is academic research and publishing which is the core activity of the Institute. This chapter will therefore first provide some examples of the core research activities of the Institute, then some examples of activities that have both strong academic and dissemination emphases, and then finally some examples of projects that are focused purely on dissemination and the public understanding of science and religion. Of course, no purely dissemination project is without academic underpinnings, and no academic project is without dissemination, but the Institute has always sought to incorporate a broad spectrum of projects within its portfolio. No attempt is made here to give anything like a complete report on the Institute's projects – these are examples, ranging from the traditional 'tried and tested' approaches of academia to some

1 The members are listed at www.faraday-institute.org.

more innovative initiatives. More detailed monthly reports are published at www.faraday-institute.org and may be accessed by use of the 'archive' option.

The Uses and Abuses of Biology

Ideas often start with small seeds and the seed-sowing process in this case began at the Templeton Foundation Advisory Board meeting held in Vienna in May 2006. At that meeting there was a discussion concerning the various ways in which biological discourse can be used for non-biological ends, be they in politics, sociology, economics or religion, and the circuitous routes whereby such uses often impinge upon science-religion discourse.

A Faraday Writers' Workshop for a group of high-profile academics, mostly historians, was subsequently held in Cambridge in 2007 in which pre-circulated papers were discussed over a three-day period. This in turn led to a 13-chapter multi-authored book entitled *Biology and Ideology – From Descartes to Dawkins* (edited by Denis Alexander and Ronald Numbers) published by Chicago University Press in 2010, which has since become an established recommended book in university courses on the history and philosophy of ideas. The book includes, for example, a chapter by Peter Harrison showing how the first systematic investigations of the natural world in the early modern period attracted prestige by their support for natural theology and for the moral order; a chapter by Shirley Roe discussing the ways in which biological ideas connecting life and matter played a central role in the materialistic arguments of the French Philosophes, which in turn were employed in the subversion of the social order; a chapter by Sujit Sivasundaram showing how concepts of race before Darwin were based on contemporary biological understandings of anatomy and physiology, and how in turn the racial construction of societies defined new programs of biological investigation, lending itself conveniently to the requirements of colonial subjugation; and a chapter by Alister McGrath highlighting the ways in which the 'new atheists' have made a concerted effort to invest evolutionary biology with an atheistic agenda.

Biology and Ideology focused mainly on historical themes, but our aim in this project was never to stop with history, but rather to extend the research to more contemporary questions. With this in mind a grant was obtained from the Templeton World Charity Foundation to run a sub-grants and essay prize programme entitled the *Uses and Abuses of Biology*² with the aim of resourcing

2 www.uabgrants.org

academics interested in investigating contemporary non-scientific uses and abuses of biological thought (beneficial, benign or negative) in the domains of philosophy, the social sciences, the media, religion and politics, with an emphasis on collaborative and cross-disciplinary work. In 2012 a total of 18 grants were awarded on this theme to different institutions in four countries funding 38 different researchers and with a total value of around £1.3m. The overall grant also funds two workshops, one for the grantees to discuss their results and one more for dissemination purposes. In parallel two annual prize essay competitions for writers aged 30 or less were organised with the aim of raising interest and bringing new investigators into this research field.

Natural Theology and the Legacy of Karl Barth

The contemporary relevance of natural theology has been a long-term interest of the Institute since its inception. To what extent do the physical properties of the universe point towards the work of a creator? What is the relevance of anthropic fine-tuning? And do competing cosmological theories carry any theological implications? However, natural theology has had a bad press in the theological world since Karl Barth's famous attack in the early part of the twentieth century. A research project within the Institute to re-examine Barth's critique and the reaction to it in various ways by a number of prominent theologians in the Protestant tradition has been pursued by former astrophysicist, the Revd Dr Rodney Holder, Course Director from 1 January 2006 – 31 January 2013. The theologians studied included, besides Barth, Dietrich Bonhoeffer, Wolfhart Pannenberg, Thomas Torrance and Alister McGrath. The aim was to examine whether in principle natural theology is a right pursuit for Christian theology, and to see how it might be possible to uphold the centrality of God's revelation in Christ (Barth's concern) while at the same time employing reason and scientific evidence in the justification of religious belief. This project resulted in the publication of *The Heavens Declare: Natural Theology and the Legacy of Karl Barth*.³

3 *The Heavens Declare: Natural Theology and the Legacy of Karl Barth* (Templeton Foundation Press, 2012).

Georges Lemaître Anniversary Conference and Book Project

The year 2011 saw the 80th anniversary of the seminal paper of Georges Lemaître's theory of the origin of the universe in the 'primeval atom', now referred to as 'Big Bang' cosmology. Given that Lemaître was a Catholic priest, there is an immediate science-religion interest, and of course the Big Bang is a topic of direct relevance to the theme of natural theology. The Faraday Institute therefore sponsored a significant anniversary conference based around this event in which cosmologists, physicists and theologians came together at Sidney Sussex College, Cambridge, to mark the remarkable achievements of this Belgian Catholic priest and alumnus of St. Edmund's College. By a happy coincidence, the award of that year's Templeton Prize to Lord Martin Rees FRS, then President of the Royal Society, had been announced just the day before the start of the conference, and it was therefore in a spirit of celebration that Lord Rees gave the opening address of the conference. In fact there were no less than five Templeton Prize laureates amongst the speakers and the President of the John Templeton Foundation, John Templeton Jnr, with his wife Pina, were special guests at the opening dinner.

In 2012 the proceedings of the conference were published by the Royal Astronomical Society-Springer [Rodney Holder and Simon Mitton, eds.] in the Astrophysics and Space Science Library series under the title *Georges Lemaître: Life, Science and Legacy*. Following a foreword by Lord Rees and an introductory chapter by the editors, the fourteen chapters of the book tell in detail the story of Lemaître the priest and his early expanding universe and primeval atom solutions to the equations of Einstein's general theory of relativity applied to the universe as a whole (Dominique Lambert, Helge Kragh). There are chapters which deal with theological issues, including one contrasting the science and religion of Lemaître with Fred Hoyle (Rodney Holder), another which deals with a dispute between Lemaître and Pope Pius XII (George Coyne), and another on Aquinas and contemporary cosmology (William Carroll). One chapter looks at the issue of priority in the formulation of "Hubble's law" (David Block). Lemaître's legacy is dealt with in chapters which look at the quantum universe (Michael Heller), non-homogeneous cosmological models (William R. Stoeger), and the debate about multiverses (Don Page, George Ellis). The book is rounded off with two more philosophical chapters embracing discussion of the link between macro-physics and microphysics, the role of mind, cosmology and meta-cosmology, and the anthropic principle (Bernard Carr), and whether cosmological fine-tuning is

really explicable on the basis of a multiverse as is often claimed (Robin Collins). There is a final chapter of theological reflections (by John Polkinghorne).

Let Newton Be!

In 2009 the University of Cambridge celebrated the 800th anniversary of its founding and members of the university were encouraged to contribute appropriate ideas to mark such a venerable birthday. What better way than to sponsor the writing and production of a new play about Isaac Newton, one of Cambridge's most iconic scientists? The playwright Craig Baxter had previously written a play called *Re:Design*, produced by the Menagerie Theatre Company, based on the verbatim correspondence between Charles Darwin and the American botanist, Asa Gray, of Harvard. In 2007 The Faraday Institute hosted a production of *Re:Design* at St. Edmund's College and it was this that sparked off the idea of asking Craig Baxter to write a new play on Newton, based on his verbatim writings and those of his contemporaries.

With generous support from the Cambridge University Press and the John Templeton Foundation, the play was written by Craig Baxter over the following two years, based on his review of a huge collection of relevant documents. Ably produced by Patrick Morris, *Let Newton Be!* saw its opening performance by the Menagerie Theatre Company on 20th October, 2009, at Trinity College, Newton's old College at Cambridge. Newton was the second holder of the Lucasian Chair of Mathematics at Cambridge, so it was fitting that the opening gala performance was introduced by the seventeenth holder of that Chair, Professor Stephen Hawking. The title of the play, *Let Newton Be!*, was derived from some famous lines by the poet Alexander Pope, originally intended for Newton's tomb:

Nature and Nature's Laws lay hid in Night.
God said, Let Newton be! and All was Light.

Since 2009 the play has seen many more performances in Cambridge and has been on tour in both the UK and North America, attracting some very positive reviews in *Nature*, *Science*, *New Scientist* and the *Times Higher Education*. As the review in the journal *Science* commented: "Can theater be a platform for science? In the hands of Baxter, Morris, and Menagerie Theatre – yes. Spectacularly yes.... This is Newton fully in three dimensions." The play brings the big questions to new audiences that might not normally consider the broader philosophical and religious implications of science, in this case as seen through the eyes of a mathematical genius and passionate theist.

How might the enduring impact of *Let Newton Be!* be extended? The President of the John Templeton Foundation was the one who asked this question and also gave the answer: by publishing a book centred around the play together with a DVD providing a professionally filmed version of the play. Edited by Denis Alexander and with a Preface by Stephen Hawking, the proposed book was duly published by The Faraday Institute in 2013. The Isaac Newton Guide Book contains the first publication of the text of *Let Newton Be!* together with a DVD of the film in the sleeve in the back cover. In addition there is an introduction by the playwright describing the extensive background research and the concepts that helped to bring to life on stage such a challenging and complex character. Eight specially commissioned essays for the Guide Book by experts in the field help to fill out the richness of Newton's contributions to both science and religion. The book's lavish collection of illustrations represents one of the most extensive series of Newtonian memorabilia yet in print.

The 2009 Darwin Centenary Celebrated in Turkey

The year 2009 was a busy year for The Faraday Institute, not least because of the double anniversary for Charles Darwin – the 200th anniversary of his birth and the 150th anniversary of the publication of *On the Origin of Species*. Apart from an increased level of lectures and panel discussions on Darwinian themes during that year, a special event was a conference held in Istanbul entitled 'Celebrating Darwin', a high-level two-day Symposium attended by 50 top Turkish biologists from more than 25 universities across Turkey, as well as Ph.D. students, educationalists, foreign speakers and special guests. In addition, on the final evening of the Symposium, a major public event attended by over 400 people and widely reported in Turkish media was held in the ball-room of a well-known Istanbul hotel. The main aim of these events was to open up a 'third way' in Turkish thinking, and more generally in the Muslim World, to show that Darwinian evolution can be incorporated within religious world-views, rather than necessarily being linked to atheism and materialism.

Feedback from symposium participants confirms that this aim was met; many reported being surprised about the history of Darwinism and challenged to think strategically about how to advance evolution education in Turkey. Several speakers in particular were very effective in supporting the stated aim: Prof. John Hedley Brooke (until recently Oxford University) provided a lucid account of Darwin's nuanced position regarding evolution and religion at both the symposium and the public event; Prof. Sükrü Hanioglu (Chair of Dept of Near East

Studies, Princeton University) presented the illuminating history of how materialistic Darwinism took root in Turkey a century before the translation of *On the Origin of Species* into Turkish in 1971; Prof. Francisco Ayala (University of California) offered a critique of Intelligent Design and overview of the historical development and current frontiers of evolutionary theory; Prof. Asli Tolun from Bogaziçi University spoke about the impact of evolution on the genetic diversity of the Turkish people, relevant to both medicine and the tracing of migratory pathways; and Prof. Simon Conway Morris FRS of Cambridge University showed how evolution repeatedly leads to similar biological forms and that the evolution of intelligent creatures like ourselves is not unexpected.

The public event also featured a panel discussion on the big questions in evolution, the first performance of *Re:Design* in Turkey (the dramatisation of the Darwin-Gray correspondence, mentioned above, performed by the Menagerie Theatre Company), complete with a translation into Turkish of the text of the play, given to each student who attended, and The British Council's 'Darwin Now' exhibit. In addition Turkish national television (TRT) filmed a discussion of Darwin's theory of evolution for a TV show presented by Mithat Bereket, a well-known TV presenter in Turkey, in which an international panel of four biologists and one journalist took 'hard' questions from the audience about the fossil record, the evolution of humans, and the relationship between science and religion. The only regret was that the televised debate was never shown on Turkish television but was censored along the way, apparently at a rather high level. Unfortunately there is not yet sufficient freedom of ideas in Turkey for the evidence for Darwinian evolution to be openly discussed on public television.

Despite the censorship of the main panel discussion on television, print media reporting of the event was perfectly free, and the seventeen journalists who attended the public event generated several favourable full-page articles and interviews in major Turkish newspapers and Turkish Newsweek. Additionally, about 100 scientific and 'third-way' texts were sold at the bookstall during the symposium and public event. The availability of the script of *Re:Design* in Turkish has led to performances of the play in Turkish universities and many of the lectures given at the Symposium are being prepared for publication in Turkish.

The Faraday Papers

One of the concerns of The Faraday Institute since its inception has been to provide academically solid and yet accessible materials that might engage scientists, journalists and educationalists, not to speak of the general public at large, in the

fascinating world of science-religion discourse. As one way of achieving this aim we have published eighteen Faraday Papers written by commissioned experts in the field introducing many of the key topics in the science-religion field. Only 4000 words long, these succinct summaries are produced in a standardised format and are available for free down-load from the Faraday web-site [www.faraday-institute.org]. In addition 5000 copies of each Paper are printed in English, with 90,000 Papers in print so far, and many of the Papers have been translated into twelve different languages, also available for free down-load from the Faraday web-site. Packs of the complete collection of Papers are sold off the book-stalls that are always present at Faraday events. In practice nearly all the translations have been carried out by international delegates who have attended Faraday Courses, or by people in various parts of the world who have down-loaded Papers from our web-site, and who see the benefits of generating versions in their own language. Two volumes of Faraday Papers have also been published in Madrid in Spanish with English in one column and Spanish in the other column.

Test of Faith

Church communities and student groups often lack accessible materials that will help them to engage in a positive way with ideas of science and faith. To help meet this need a Faraday Staff member, Dr Ruth Bancewicz, has pioneered the production of a professionally made film that introduces a broad audience to the main issues. From the beginning we felt that the best communicators for a general audience would be those who themselves had no formal background in the subject, but with a strong track-record of making TV quality films. With this in mind a film production company called Contrapositive were commissioned to make the film with Mark Brickman as writer and director and John Ford as producer. The film is divided into three 30 minute segments: 'Beyond Reason?' (covering the relationship between science and religion, and cosmology); 'An Accident in the Making?' (on creation, evolution and the environment); and 'Is there anybody there?' (introducing questions of the brain, freewill and ethics). Interviews with top scientists are mingled with creative images and metaphors with the aim of generating thought and discussion rather than merely telling people 'the answers'. The Test of Faith documentary picked up a number of awards after its release, including Winner of silver in the category Best Documentary in the 2009⁴ International Visual Communications Association (IVCA)

4 <http://www.ivca.org/news/2009/ivca-awards-2009--winners-announced.html>

Awards; a 2009 Redemptive Storyteller Award (USA); and Highly Commended in the 2009 IVCA Clarion Awards⁵, Feature Film Category.

From the beginning of the project it was felt that the impact and usefulness of the film would be greatly amplified if it was accompanied by materials that would stimulate and inform discussion. With this in mind Dr Bancewicz and her assistant James Crocker wrote discussion booklets and a leader's manual to sell as part of the Test of Faith package, together with a book entitled *Spiritual Journeys With Scientists* in which top scientists and theologians from different parts of the world explain how they relate their science to their faith. In further development work the Test of Faith materials have been adapted for use in youth groups, secondary schools, church services, and for home schooling.

A key aspect of the whole project has been the development of a web-site at www.testoffaith.com which features many resources, including a trailer of the film, hundreds of useful film clips only a few minutes long that can be downloaded for use in talks and sermons, articles and briefing sheets, and information about how to purchase and use the materials. The Test of Faith materials continue to be publicized through special events held in many parts of the UK and North America, including panel discussions, concerts in schools, and church meetings. The materials have been published in other countries in different languages also, including China, Brazil, Spain and France.

The Faraday Courses

One of the main aims of The Faraday Institute is to engage scientists in the science-religion dialogue on the grounds that they often have little time in the midst of a busy research life to take part in activities outside of their focused disciplinary work. With this in mind we have organized since the beginning an extensive programme of week-end courses in Cambridge, together with one week summer courses, open to any undergraduate or graduate of any university in the world, of any faith or none. Thousands of delegates coming from dozens of different countries have now benefitted from these courses, which range from general introductory overviews to more specialized courses with titles such as 'God and Biology' or 'God and Physics'. Some courses are focused on particular professional groups, such as teachers or church leaders. One course is entitled 'Science, Religion and Atheism' in which theist and atheist speakers are paired to give lectures on the same topic with the aim of finding out whether academic

5 <http://www.ivca.org/award-schemes/clarion-awards.html>

science-religion discourse is in fact different when addressed by people coming from different worldviews.

The initial aim was to hold courses only in Cambridge. However, it was not long before delegates from other countries began to say that “We enjoyed this course so much that we would like to have one in our own country”. Our response has always been the same: “As long as you organize it and most of the speakers are from your own country”. Our aim in this context has simply been to act as a catalyst, helping with an initial course with the expectation that any future courses in a particular area will be organized and financed by local enterprise and initiative. In this way courses have been held in countries such as China, India, Australia, New Zealand, Russia, Ireland, Mexico and Guatemala, with many other countries in the pipeline. On occasion attendance at a single course in Cambridge can be the spark that initiates a delegate’s action to organize a course in their own country. In fact this is how the first Faraday course in Guatemala happened. In 2012 an enthusiastic delegate from Panama, just completing his graduate studies in theology at a seminary in Guatemala City, attended the summer course in Cambridge. Within less than a year he was able to organize a Faraday Course in his seminary in 2013 attended by around 50 people from many parts of Latin America at which the lectures were shared between several Faraday speakers together with local speakers.

One significant feature of Faraday Courses is the very wide array of international speakers that come from all over the world to share their expertise at the courses in Cambridge. A Summer Course, for example, will typically have around 17 different speakers each one an expert in his or her field. The days are full: two full one-hour lectures morning and afternoon, each followed by 30 minutes of question and discussion, and then a panel discussion every evening featuring all the day’s speakers with written questions collected in a box over the course of the day. An unexpected but welcome spin-off has been the linking up of international speakers in the science-religion field who had never previously met, leading to quite a community of course speakers who keep in touch on other projects. Likewise delegates from different countries often form lasting friendships and/or discover other delegates present from their own country whom they had never met before, thereby helping to form an informal international ‘Faraday alumni community’ of those engaged in the science-religion field.

Faraday Public Lectures

Lectures and seminars are the core routine activities of any academic research enterprise. However, even before the Institute was established, we have had the

conviction that a public lecture can be of far greater benefit if linked to a post-lecture discussion by a smaller group. It was with this in mind that we and others in Cambridge initially collaborated in order to obtain a small grant from the John Templeton Foundation in 2001 to fund a series of termly public lectures in the University on science and religion. Indeed it was this small grant with its single activity that then led on to the much larger grant that we obtained in 2005 to launch the new Faraday Institute in 2006.

What is now called the Faraday Public Lecture series is simple but effective. The one-hour Public Lecture, held in one of the Cambridge Colleges and given by a high profile speaker, is followed by a time for questions and discussion and then a reception for all participants at which there is an extensive bookstall. Around eighteen invited guests are then given a special dinner at St. Edmund's College. Once the coffee is served, there is a one-hour recorded round-table discussion between guests and speaker when the topic of the day can be addressed in somewhat greater depth. The recording is then transcribed and sent to all participants for editing before posting on the web-site.

Topics and speakers of particular interest have been provided with larger venues, drawing crowds of 500 or more on several occasions. And although we do not organize debates, as we find that these can too easily turn into point-scoring exercises rather than being genuinely educational, we do organize the occasional public discussion as part of the Faraday Public Lecture series. For example, one such event attended by 1400 people involved the then Archbishop of Canterbury, Rowan Williams, in discussion with the well-known Professor of English Literature, Terry Eagleton, on the topic 'Responses to the New Atheism'.

Faraday Institute Dissemination and External Communications

Many academic research institutes can operate in an 'academic bubble' in which the only real engagement is with other academics in closely related fields. We determined from the beginning of our activities that we would have a strongly outward-looking stance with respect to external communication and the dissemination of our research outputs and activities in the international context.

For example, we have always filmed all our lectures and seminars and posted them on the Faraday web-site⁶, which is part of the St. Edmund's College web-site, in both audio and film formats. In 2011 Cambridge University approached

6 www.faraday-institute.org

The Faraday Institute with a request to post all our outputs on the University's Video and Audio web-site⁷, which we were very happy to do, and during the first two years of full operation, the 350 or so academic Faraday lectures and discussions posted there have drawn more than 0.75 million down-loads representing 38TB of information. A useful feature of this web-site is that it shows how many people to date have down-loaded each individual talk; one-third of talks are down-loaded via iTunes. It is intriguing to note which topics attract the largest number of down-loads and clearly the subject of the brain and free-will scores highly in this regard. At the time of writing The Faraday Institute collection is the 9th most watched out of the 106 colleges, departments and institutes that post their video collections on this university web-page. The top viewing country is the USA followed by the UK with the Netherlands in third place and China not far behind.

Faraday Research Seminars, which take place every two weeks during term-time, have become a well-established feature of the Institute's activities, typically attended by 60–100 people. It is interesting to note that a rather specialized academic seminar which may draw 60 people on the day, once posted on-line may be down-loaded by more than 10,000 people within the following year or so, thereby greatly multiplying the impact of the event.

The Faraday External Communications Officer plays a key role in ensuring that the outputs of the Institute are disseminated as widely as possible through the press, radio, television, You-Tube, Facebook, Twitter and other social media. A Faraday app ensures that smart-phone users have access to the main Faraday web-site materials. A newsfeed to which anyone can subscribe on-line is circulated every day consisting of a list of the current top four or so current media stories relevant to the field of science and religion. Regular Press Releases help in placing articles in the press, journalists are on occasion invited to the Faraday Public lecture dinner-discussions, and Faraday staff members write on-line articles for The Guardian, the Huffington Post etc.

One significant avenue for dissemination and enduring impact can be when The Faraday Institute provides inspiration and encouragement for similar research institutes to be established in other parts of the world. An example of this has been the founding of the Graeme Clark Institute⁸ in Adelaide, Australia, in 2011. The institute was named after the distinguished Australian surgeon,

7 www.sms.cam.ac.uk/institution/FARADAY

8 <http://www.taboradelaide.edu.au/home/root/aboutus/graeme-clark-research-institute>.

Dr Graeme Clark, 2010 recipient of the prestigious Lister Medal, who spoke at the launching ceremony. Professor Clark pioneered the multi-channel cochlear implant for severe-to profound deafness which has helped hundreds of thousands of people round the world to hear for the first time. The founding director is Dr Graham Buxton whose visit to The Faraday Institute played a key role in establishing the Graeme Clark Institute and in securing a grant for their initial projects from The John Templeton Foundation. As part of the launching events in 2011, The Faraday Institute was pleased to collaborate in a well-attended course on science and religion held at The Science Exchange, a science communication centre in the heart of Adelaide's bustling commercial area.

Conclusions

The Faraday Institute continues to flourish partly due to its location within a Cambridge College, which provides a natural home for inter-disciplinary activities of this kind. All Cambridge Colleges are completely mixed communities as far as the subjects being taught and studied by their members are concerned. Finding similar multi-disciplinary locations is one of the challenges for those seeking to establish similar research institutes or centers on science and religion in other parts of the world. If such institutes are attached to a particular faculty or department specializing in one particular branch of academic study, then it is inevitable that the institute will become associated with that particular branch. In some cases this may help in providing focus for the work of the institute, but to encourage a genuinely open dialogue between different disciplines, there are some advantages in locating the institute in an environment where such discourse is the norm rather than the exception.

The Faraday Institute retains its vigour because it has no endowment and is therefore entirely dependent upon its research community to write new short-term grant proposals to fund new projects and to maintain its activities. There is no scope for resting upon its laurels. Like a plant which flourishes as long as it is well-watered and keeps actively drawing up its nutrition from the soil, so the Institute will continue to make valuable contributions to the wider field of science and religion so long as it continues to come up with creative ideas, research projects and goals that are worthy of fresh funding.

Friederike Nüssel, Robin Lovin

Theological Inquiry and the Science and Religion Dialogue

Theology is by its nature a comprehensive inquiry. Theo-logia – the teaching on God – involves not only cosmological, anthropological, psychological, and social aspects, but also political and economic dimensions. However the inquiry proceeds, the aim is that nothing that is real and important in the field of human experience should be omitted or left unexplained. Since it convened its first group of scholars in 1978, the Center of Theological Inquiry [CTI] has been committed to that kind of comprehensive understanding crosses traditional disciplinary boundaries. The science and religion dialogue has been part of these theological inquiries from the beginning, and it has a particular importance at CTI today. In this essay, we will briefly review the problems of interdisciplinary thinking in theology and explain how the science and religion dialogue is contributing to a comprehensive, interdisciplinary approach to theology today.

The historical challenge

In modern times, however, the comprehensive approach to theology has been challenged both within the discipline and in relation to other methods of inquiry. The impulse to understand all things in relation to God that we find in the theology of Augustine or Thomas Aquinas gives way to a variety of more specialized disciplines. Humanism, the Reformation and the Enlightenment not only led to a multiplication of academic questions and research areas, but also to a differentiation and multiplication of academic disciplines and widening gap between the sciences and the humanities. Each discipline develops its own methods as well as its own questions, insulating itself from other investigators who might like to challenge its conclusions, but who lack the methodological warrants to do it. As a result, we find in the 19th and 20th centuries not only the development of many new academic disciplines, but also a strong emancipation process in which each new discipline defends its distinctive approach and academic character.

Theology also got involved in this process, though perhaps rather late in its history. After eagerly adopting 19th century developments in history, philology, archaeology, and the emerging social sciences, theologians in the 20th century reasserted the distinctive nature of theological understanding, which could for

them no longer be reduced to or evaluated in terms of other modes of human experience. Theologians know that for the formation of modern theology the movement of “dialectical theology” and especially Karl Barth and his students were of great influence in defending purely theological standards for theology in its encounter with other disciplines.¹ For some decades the Barth school and the “Wort-Gottes-Theologie” discouraged theology from actively supporting and participating in interdisciplinary discourse. While disciplinary specialization in the universities is now giving way to new forms of interdisciplinary inquiry, theologians sometimes retain what is precisely a theological, rather than purely methodological, commitment to the foundational nature of their truth claims.

Whatever may be said for the theological warrants for this disciplinary exclusivism, in a time of growing interdisciplinary exploration, it can only result in the isolation of theology in the academy. Secularization and the decline of church participation leave many unaware of religious ideas and traditions. Especially recently, the “new atheism” offers its own interpretation of theological claims to this secular public.² In this context, theology has a growing responsibility to articulate and defend Christian faith on an intellectual level in the academy. This is especially true in the dialogue between religion and science.

Patterns of interaction

In the 19th century reaction to Darwin’s revolutionary insights, three different claims came to dominate discussions of religion and science:³

- the claim of an antithesis or contradiction between science and religion as two different and incompatible approaches to understand the world;
- the claim to integrate scientific findings into theological explanation and description;
- the claim that science and religion offer distinct explanations which do not interfere.

1 For Barth’s own interpretation of these academic developments, see Barth, Karl, *Die Protestantische Theologie im 19. Jahrhundert* (Evangelischer Verlag, 1947).

2 Hitchens, Christopher, *God is Not Great: How Religion Poisons Everything* (12/Warner Books, 2007).

3 Cf. Beutel, Albrecht, “Evolutionbiologie als Herausforderung des Christentums,” in Herms, Eilert (ed.), *Leben. Verständnis. Wissenschaft. Technik* (Gütersloher Verlag-Haus, 2005), 96–119; see also Barbour, Ian, *Religion and Science: Historical and Contemporary Issues* (Harper San Francisco, 1997), 77–105.

Given the history of sharply drawn disciplinary boundaries, it is not surprising that subsequent interactions followed these same stereotypical patterns. The question, however, is whether these different approaches result from a thorough reflection of scientific explanations and their impact on theological claims, or whether they merely result from theological assertions about the nature of religious language and the status of theological propositions in relation to non-theological accounts. Likewise, scientific claims and scientific methods are often formulated in ways that are supposed to be without metaphysical content and, therefore, without theological implications. The easiest way to manage the dialogue between science and religion is to see them as distinct explanations that cause no problems because they cannot conflict. The evolutionary biologist Stephen Jay Gould coined the term “non-overlapping magisteria” to describe these independent, conceptually distinct systems of ideas in science and religion.⁴

Science, however, aims at a comprehensive account of the world, no less than theology does. A variety of scientific methods and disciplines may be required, but the aim of modern science, taken together, is like the aim of classical theology: Nothing that is real and important in the field of human experience should be omitted or left unexplained. As Robert Bellah remarked at a recent Templeton Centenary event in Philadelphia, Gould was half right. There are distinct “magisteria,” but they do overlap. Given the objectives of science and theology, it is hard to see how it could be otherwise.

We must therefore move beyond the abstract disciplinary boundaries to determine the relation between science and theology in a dialogue on concrete, specific topics. Does science provide information that is important to theology? Does theology shape our understanding of human experience in ways that are relevant to scientific inquiry? What theology can learn from science and what science can learn from theology cannot be decided before and apart from a conversation on concrete questions.

The Center of Theological Inquiry

Such conversations require both an institutional and an intellectual context. Sustained dialogue requires a place where representatives of different disciplines can come together. It also requires leadership to maintain a record of these conversations, share insights with a wider audience, and make plans for future discussions

4 Gould, Stephen J., *Rocks of Ages: Science and Religion in the Fullness of Life* (Ballantine Books, 1999), 49–67.

that will build cumulatively on what has been accomplished. The Center of Theological Inquiry seeks be that institutional context.

CTI is an independent study center located in Princeton, New Jersey, with important ties to Princeton Theological Seminary, to Princeton University, and also to life and work of Sir John Templeton. Sir John was one of our founding trustees, and he provided the twelve townhouses in which our resident scholars live in memory of his mother, Vella Handley Templeton. He also shared the vision of James McCord, who was then president of Princeton Theological Seminary, that there should be a place where theologians could push the boundaries of their discipline, and where they could do this in open discussion with scholars in other fields.

To continue that vision shared by McCord, Templeton, and others in the 1970s, CTI has now begun a new approach to our research programs that will be focused on assembling each year a team of 10 to 12 resident scholars who will work on a common topic. They will spend full time, most of them for a full academic year, advancing their own research and working together to define the questions that they and others will be pursuing in the future. Not all of these topics will be about religion and science, but precisely because that is probably the most important, the most developed, and the most contentious part of interdisciplinary studies in theology, that is where we have begun in 2012–13, with a year-long interdisciplinary inquiry on Evolution and Human Nature. In 2013–14, we will turn our attention to the psychology and science of religious experience and its relationship to moral identity, and in 2014–15 to larger social questions of law and religious freedom.

The inquiry on Evolution and Human Nature is just now getting underway, but we are already learning some important things about interdisciplinary conversations. What a residential project does first is give people time to listen. After decades of tightly focused disciplinary specialization, this is an important consideration. While interdisciplinary inquiries are no longer intellectually suspect, specialists in all fields still tend to regard them as a distraction from the “real” work that advances careers, builds reputations, and secures grant money.

Theologians and scientists tend at first to approach each other as if the dialogue were a matter of answering one or two specific but persistent questions. Theologians think they’re going to be asked about the origins of consciousness, or of altruism, or of the idea of God. Scientists think they’ll have to explain how there can be complexity without design, or why people sometimes engage in moral behavior that is costly to themselves or their groups. The unstated thought,

perhaps, is that if we can answer those questions satisfactorily, we can quickly get back to real theology and real science.

As scientists and theologians begin to understand the areas of overlap between the distinct comprehensive accounts of the world they offer, the underlying question that emerges is whether an account that is comprehensive also has to be exclusive. As theology and science put questions to each other—sometimes superficial questions that arise out of a brief acquaintance—each begins also to put deeper questions to itself about the scope of the explanations it offers and the kind of space those explanations leave for other explanations. The accounts of human nature offered by theology may or may not lend themselves to explanation in terms of the mechanisms of biological and cultural evolution. The universality of evolutionary explanations may be tested by the variety to be found within and between religious traditions. In any case, the questions that emerge from an ongoing dialogue are concrete, specific, and calculated to provoke further questions.

We could evade those questions by a kind of reductionist science or by a kind of narrative theology that prides itself on its incomprehensibility to those who do not share its story and its virtues, but those who think of their work in those terms would have little reason to spend a year in Princeton listening to what another discipline has to say. What makes the inquiry on evolution and human nature possible is that there are people who are fully committed to naturalistic explanations and others who are fully committed to theological explanations who understand that it is precisely that commitment that demands full attention to other kinds of comprehensive explanations. A commitment to science or to theology cannot be vindicated by a methodological decision that renders the big questions meaningless at the outset.

CTI is, of course, primarily a center of theological inquiry, and its institutional commitment to the science and religion dialogue says something important about the future of theology. We expect, too, that the opportunities for dialogue that CTI makes possible will also have an impact on evolutionary biology, neuroscience, sociology, psychology, and the other disciplines that participate in the dialogue in Princeton. As the barriers of scope and method that have been erected between disciplines since the Enlightenment begin to be dismantled, theology will demonstrate that it brings added value to interdisciplinary conversations and research, both for theology and for other disciplines. This can only be done through practical engagement and good examples that provide new and better answers to questions which scientists and theologians both are asking.

Ted Peters

Science and Redemption: The Future of Creation

At the Center for Theology and the Natural Sciences (CTNS) in Berkeley, California, we look for both consonance and dissonance between scientific claims and theological claims. My colleague and friend, Robert John Russell, has on repeated occasions demonstrated the consonance between Big Bang cosmology and the biblical account of creation; and he has shown the dissonance between the biblical prophecy of a new creation and physical cosmology.¹ On the one hand, what natural science tells us about the origin of the universe seems consonant with Christian and Jewish theologies of creation, even creation out of nothing, *creatio ex nihilo*. On the other hand, scientific prognostications of the future of the universe which ends in either a freeze or fry scenario – either a collapse to a hot center or an everlasting expansion into frozen equilibrium – flatly contradict the New Testament promise of a renewal of all things in the new creation. We must take on board both consonance and dissonance when pressing our agenda: creative mutual interaction between science and theology, or CMI for short.

In what follows we will give our attention to the dissonance: the future of creation. The dissonance in this case is not due to what Ian Barbour calls the “Independence” model of the relationship between science and religion,² or due to what I call the “Two Language” model.³ The dissonance regarding the future of the universe is not due to a model, according to which science and theology speak different languages or go about their work independently. Rather, the dissonance is the result of different sources of knowledge. Scientific cosmology prognosticates about the future based upon its observations of the history of nature thus far and speculations of what to expect based upon known natural

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- 1 Russell, Robert J., *Cosmology from Alpha to Omega: The Creative Mutual Interaction of Theology and Science* (Fortress Press, 2008) and *Time in Eternity: Pannenberg, Physics, and Eschatology in Creative Mutual Interaction* (University of Notre Dame Press, 2012).
 - 2 Barbour, Ian G., *Religion and Science: Historical and Contemporary Issues* (Harper San Francisco, 1997), 84–89.
 - 3 Peters, Ted, “Science and Theology: Toward Consonance,” in *Science and Theology: The New Consonance*, ed. Peters, Ted (Harper San Francisco/Westview, 1998), 17.

processes. Theological cosmology, in contrast, relies upon a divine promise, namely, the promise that God plans a transformation and renewal of all that has hitherto existed. This is the difference.

The theologian may call upon the scientist for an expanded understanding of natural processes, to be sure. Yet, this will not suffice for theological knowledge. At the basis of theological speculation is the historical event of Jesus' Easter resurrection and the accompanying New Testament promise that this is but a foretaste of a future for all of reality.⁴ From the point of view of the theologian, scientific explanations obtain for the universe as we know it today, for the present creation; but the ultimate future of creation will include a redemptive power which is not included in scientific prognostications.

In the tradition of Augustine and Anselm, we think of theology as faith seeking understanding. The picture of the universe painted by science aids in the expanded understanding theology seeks. But, the point of departure for the theologian is faith and faith's foundation in special revelation.

At CTNS we frequently employ the image of the bridge to depict our understanding of the relationship between science and theology. Typically, the traffic goes one way: from science toward religious reflection. Might the traffic go the other way as well: from theological reflection toward science? When the traffic goes both directions, we have CMI, creative mutual interaction. In what follows, I'd like to follow the traffic from theology in the direction toward science. I'd like to precipitate interaction, but certainly not a head on collision.

How might the theologian expand our understanding of the divine promise for a new creation in light of the picture of physical reality painted by the physical sciences? I will try to answer this question in a series of theses. One theme will become quickly evident, namely, my own conflation of creation with redemption. The promise of new creation takes priority over the present creation, in my interpretation; and I would like to explore what this could mean in the context of the existing worldview so influenced by scientific assumptions and methods.

4 "On the basis of the biblical witnesses to the resurrection [theologians can] go a long way with the conditions of certainty and rationality set by the exact sciences." Welker, Michael, "Resurrection and Eternal Life: The Canonic Memory of the Resurrected Christ, His Reality, and His Glory," in *The End of the World and the Ends of God: Science and Theology on Eschatology*, ed. by Polkinghorne John and Welker, Michael (Trinity Press International, 2000), 281.

Retroactive Ontology

Because this is a report on CTNS research and publication over time, I must begin with a rather decisive assumption. I work with an assumption that for many seems counter-intuitive. Yet, I hope as the paragraphs whiz by, you the reader will see the coherence that this assumption yields. Here it is: the power of being works retroactively from the future, from God's creative and redemptive future.⁵

The New Testament promise is this: all things will be transformed at point omega (to borrow a term from Teilhard de Chardin). If this is our expectation, then just what is the ontological status of all things right now? Whatever things are, they will not remain as they are. Nothing remains the same. Nothing avoids undergoing change. This is empirically observable. We have long discerned that change involves deterioration, dissolution, death, and dissipation. Change may also incorporate temporary advancements in creativity, to be sure; but creativity will peak and then decline as well. So, process and change and even decline is a given. What can we expect to be the effect of omega?

Perhaps we can say that nothing in our present reality has attained its final state. Nothing has attained its final definition. Everything is subject to routine process and modification; and everything is subject to total redefinition at the coming of omega, God's eschatological transformation. Omega, then, becomes that which determines reality, that which defines who we are and what all things are.

Because God is gracious, according to the Christian claim, omega will be different from ordinary change. Ordinary change is associated with disease, death, and disappearance; and in the case of evolutionary biology, extinction. Our gracious God promises healing, redemption, and renewal. We can expect omega to provide transformation, salvation, and eternal definition. The meaning of our existence and self-understanding today is contingent on our transformation in the future. Our final future will retroactively transform who we are today. It will determine who we had been as we anticipated who we would become.

I would like to call this line of thinking retroactive ontology. The fundamental insight is that our being is determined by, and defined by, our future. The transformed reality promised by God is the ground for all other reality that anticipates it. One important implication is this: creation is contingent on transformation.

5 For a fuller exposition of these theses, see my previous work: Peters, Ted, *Anticipating Omega: Science, Faith, and Our Ultimate Future* (Vandenhoeck & Ruprecht, 2006).

The meaning and even being of the past is contingent on its future. God's omega redefines—actually defines—all that has gone before. Who we are now is dependent on who we will be at omega.

In order to explicate this constructive proposal and draw out some of its implications, I would like to set forth a series of theses. In the explication, I will at points refer to understandings of the natural world as changing. Nature is malleable. Nature has a history; and it has a future. What we can see in nature is contingency; what we cannot see without looking through theological lenses is that the decisive contingency is God's promised action at omega. Connecting scientific perception with theological vision will be part of faith seeking understanding.

Thesis 1. God creates from the future, not the past.

This thesis – “God creates from the future, not from the past” – may seem to fly in the face of common sense. As we look around at the objects in the room, we recognize that each one either grew or was manufactured. Should we investigate, we could find out where and when in time each item came into existence. Before that time, there was no such thing. Even the plants in the room came from seeds. Similarly, each one of us was born once. Before our birth, we did not exist. So, common sense would place the creation of things in the past. What we see daily is the result of past creativity.

In common parlance, when we think of the cause and effect nexus of finite events, we place the cause in the past and the effect in the present. What exists in the present is the result of past causes, it appears. When we think of the creation of the world, then, we look to the past. We look to the arche, to the beginning, to the point of origin. We look backwards to alpha. What we find back at alpha we call genesis. Common sense places creation at genesis.

Is such common sense exhaustively explanatory? I don't think so. Let us look once again, a bit more closely. Just what does it mean to be, to have existence? Can we exist without a future? No. Without a future, we are not. If someone takes away our future, we drop from existence into non-existence. This is what death is, the loss of our future.

Our first thesis has two corollaries, the first of which is this: To be is to have a future. If this is the case, then the way God gives being is to give a future. Each moment, God gives the cosmos the next moment. God is moment by moment giving to all of reality its future. Without this future-giving on the part of God, all of reality would freeze up and cease. ^{NRS} Romans 4:17b God “gives life to the dead and calls into existence the things that do not exist.”

The second corollary is this: the first thing God did for the cosmos was to give it a future. Back at the beginning, God called the universe from nothing into something by bestowing a future that set reality on the course of historical becoming. By creation, we refer to God's gracious gift of futurity. And moment by moment with unceasing faithfulness God continues to bestow a future.

In this moment by moment future-giving God bestows a future in two ways: by calling the world into existence plus, curiously, by allowing it to drop back into non-existence. Not only does God provide physical reality with its existence, that very existence is characterized by openness, contingency, and even freedom. This means that God's future-giving is both positive and negative. It is positive in that God is the ground of being, the one who protects what is now from ceasing to be. God's work is also negative [negating of the past], in that by giving a new future God releases the present from the grip of the past. Contrary to common sense, past causes do not hold the present moment in the grip of exhaustive determinism. The present moment is open to change, open to what is new. This is because God liberates the present from the oppression of the past. New things can happen because God prevents the past from overpowering the present.

In this way God's future-giving is what makes both contingency and freedom possible. The course of natural events is subject to contingency—that is, events in nature are not exhaustively predictable. Despite the determinism of the laws of nature, natural history does not operate like a machine. New and unpredictable events happen. Then, when we turn to the course of human events, we take a giant step beyond contingency. Human actions are not predictable because they are freely determined. The human reality adds a subjective self that envisions the array of potentials and then makes a conscious decision to actualize some and not others. The openness of the future is the condition that makes freedom possible.

Thesis 2. The concept of creation out of nothing (creatio ex nihilo) should be combined with continuous creation (creatio continua).

Although the opening verse of Genesis does not state unequivocally that God creates the material world out of nothing, this has become an indispensable assertion in Christian theology. *Creatio ex nihilo* is a conceptual explication of what theologians believe the biblical symbols are telling us. The point of this thesis is that *creatio continua* is an appropriate complement to *creatio ex nihilo*.

“God is continuously creating,” wrote Arthur Peacocke. “God is *semper* Creator...the scientific perspective obliges us to take more seriously and concretely than hitherto in theology the notion of the immanence of God as Creator – that God is the Immanent Creator creating in and through the processes of the natural order.”⁶

The act of drawing the world from nonbeing into being is not limited to a once-for-all event in the past. God is doing it right now. Without God’s vigilant activity as what we call the primary cause, the world would immediately cease to exist and we would never know the difference. Moment by moment in a continuous temporal flow, God is drawing the world into being and protecting it from falling into nonbeing; and this accounts for what previous theologians thought to be God’s sustaining or preserving work. Rather than preserving a creation already complete, I view God’s creative work as ongoing; it is yet to become complete in the eschatological future. Right now, we creatures are on the way to becoming who we will be. So also is the entire creation still under construction, so to speak, yet to be completed and yet to be judged “very good.”

Thesis 3. God’s creative action within nature and within history is derivative from the divine act of redeeming and creating the whole of the cosmos.

When some theologians employ the term creation, they limit creation to a single act that happened just once a long time ago. In contrast, I think of creation as a single event incorporating the whole history of the cosmos, including but not limited to human history. Although we mistakenly think of God’s creation as a once-upon-a-time event in the past, we unknowingly experience God’s creative work as a constant durative process. Each moment of our lives God is drawing our personal reality out of the nonbeing of the past into the actual existence of the present moment, while maintaining a destiny for us, an as-yet-unrealized purpose which will become realized only in the consummate future.

This concept of creation requires a holistic model of reality. Included in the holistic model is the notion of downward causation. Whereas in upward causation the parts alter one another and the whole; in downward causation the whole

6 Peacocke, Arthur, *Theology for a Scientific Age* (Fortress Press, 1993) 105, Peacocke’s italics.

alters the parts by incorporating their participation in the dynamics of the whole. "Top down causality...must imply that the nexus of bottom-up causality is not drawn so tight as to exclude room for the influence of the whole upon the parts," writes John Polkinghorne.⁷ With this in mind, can we conceive of the creation as itself a whole, perhaps a whole of wholes plus parts? Can we think of God acting on the whole of creation and, thereby, reorienting and redefining all of the parts within? And if we add time to this holistic vision, can we predict the emergence of a future whole of wholes which will retroactively determine the place of all the parts?

Might holism apply on a cosmic scale in a way that makes scientific sense? At present, we cannot easily consider the entire cosmos as a single whole with downward causation. In various locations within the cosmos dynamic changes are taking place, super novas and similar change events that initially have little or no relation to what is happening in very distant regions of the same cosmos. Because light travels at a finite speed, and because the universe is so vast and galaxies are flying away from one another, the ripple effect of events in one galaxy simply cannot catch up to escaping galaxies in order to have an impact. What we mean by the word 'universe' might be a totality; but it does not look like a single whole. Must we resign ourselves to dissonance here?

Perhaps the concept of time can help us at this point. If we go backwards in time, say 13.82 billion years, we return to what appears to be a minute singularity.⁸ All things were but just one thing prior to the Big Bang. Although physicists disagree as to whether we can refer to the initial reality at the onset of the Big Bang as a singularity in the sense of an inert unit, we can say that all physical reality belonged together in a single inertial frame of reference. Only when the post-Big Bang expansion carried the developing universe beyond the threshold where all its light shared a common inertial frame did we lose the causal glue that holds the parts of the material world together.

What about the future? Physical cosmologists can only project on the basis of present observation that the universe will continue to expand for the foreseeable future. On the one hand, the second law of thermodynamics and its partner,

7 Polkinghorne, John, *Science and Theology: An Introduction* (SPCK/Fortress, 1998), 88–89.

8 On March 21, 2013 the Planck space telescope team released the highest precision map yet of the cosmic microwave background, revealing that the universe is a little older than previous estimates: from 13.7 to 13.82 billion years. Peplow, Mark, "Planck snaps infant universe." *Nature* 495:7442 (28 March 2013): 417–418, 417.

the law of entropy, would suggest that as time passes and the universe expands further, it will die out. As we move from hot to cold, from concentrated energy to dissipated energy, like an old car the universe will run out of gas and just stop at a state of equilibrium. Particles will be so spread out and so cold that they simply will lose a causal relationship to one another. On the other hand, the observation that distant galaxies seem to be accelerating rather than slowing down leads to counter speculations. Might there be some sort of vacuum energy that accounts for this increase? Might this mean that entropy will not apply? In sum, based upon present observations, the future of our cosmos is barely understood or predictable. Still the theologian needs to pose the question: do all things including all galaxies constitute a single whole? Or does their wholeness exist only in the mind of God? And, if the latter, at what point will God's thought become physical reality?

Perhaps dissonance rather than consonance between the scientific vision of the far future and the eschatological vision is unavoidable. The winding down to a state of equilibrium due to entropy or other such scenarios that forecast the demise of physical reality do not dovetail conceptually with the biblical symbols of God's ultimate future. ^{NRS} Isaiah 11:6 "The wolf shall live with the lamb, the leopard shall lie down with the kid, the calf and the lion and the fatling together, and a little child shall lead them." Or, ^{NRS} Revelation 21:23 "And the city has no need of sun or moon to shine on it, for the glory of God is its light, and its lamp is the Lamb." Such biblical symbols of the new creation bespeak harmony, of a full integration of the divine life with cosmic life. They draw a holistic picture in which the contentious forces within the present creation are reconciled. Such salvation must apply to all things if it is to apply to one thing. If God be the creator of all that is, then nothing would be left out of this eschatological vision. For this to come to pass, God would have to act in such a way that few if any past events have set the precedent. The Easter resurrection of Jesus Christ just might be the only precedent.

Thesis 4. God is the primary cause of nature's secondary causes.

I affirm as does virtually the entire Christian tradition that the God of Israel is the creator of all that is. In classical and especially medieval theology, God is identified as the primary cause of the world's existence; and the sequence of activities within the world are linked by secondary causes. From Aristotle on we have presumed that a secondary cause (*causa secunda*) precipitates a change or

an effect in preexisting matter. It took God as the primary cause (*causa prima*) to bring matter into existence in the first place.⁹

My own variant on designating God with the task of primary causation avoids dating the divine work of creation at a single moment in the past, say 13.82 billion years ago at the moment of the Big Bang. Rather, God's exercise of primary causation continues. It is exercised moment by moment or, better, as a ceaseless durative relation between creator and what is becoming created. The relations between creatures characterized by secondary causation is subject to scientific study. In our modern context, only the philosopher or the theologian can point in the direction of God as primary cause.

In classical theism, God's power is absolute. Yet, once the plan of creation is set in motion, God places absolute power in abeyance and ordains power to creatures to maintain the preordained plan of creation. God invests creatures with their own natural powers. Hence the medieval distinction (*potentia dei absoluta et ordinata*) between the absolute power of God and the power God ordains be exercised by the world's creatures.

The distinction between primary and secondary causation is an abstraction from the concrete flow of physical and extra-physical becoming. Primary causation is not absent when secondary is in effect; rather, they constitute two dimensions of a single reality. This permits a noninterventionist theory of divine action. God does not intervene in the sequence of secondary causes, because God's primary causation is always coincident with whatever is happening within the world. This does not preclude divine action at the secondary level; rather, it simply depicts God's ordinary relation to the world as that of primary cause while making no commitment to extraordinary interventions such as miracles.

Through the eyes of science what we see is the sequence of secondary causes. We do not see miracles, nor do we see primary causation. Science is free to limit itself to secular explanations for natural phenomena. Science provides theories of explanation within the self-imposed parameters of secondary relationships.

9 Russell, Robert J. does not rely upon the distinction between primary and secondary causality as I do here. Rather, as an incompatibilist, he prefers to see divine action as ubiquitously present in the physical world at the quantum level; therefore, he does not need to employ the concept of secondary causation.

Thesis 5. Our human nature is not yet fully created; we are still becoming.

The human race in its entirety and each human person as an individual does not arrive complete as the result of God's primary creative action. Our creation is not something past. It is present. We are not done yet. We are not yet what God the creator intends for us to be. We are still baking, so to speak; we still need to emerge from the oven in our final form.

The human reality is a becoming reality. On a planetary scale, the human race is evolving and changing physically and culturally. On an individual scale, we are not born as mature adults. We grow and change and mature and deteriorate and die. At what point do we become human? Or, does our humanity include our entire evolutionary history and personal history? Does humanity require a biography? If so, then we are not yet there. We await a fullness yet to come.

Built into the definition of the human reality is life, eternal life. This is the way it was in the opening chapters of Genesis when the divine image was ascribed to the human race. When Jesus Christ—whom the New Testament describes as the true image of God, the *εικον του Θεου* or *imago dei*—rose from the dead on Easter, this introduced resurrection into the definition of what a human being is. ^{NRS} 1 Corinthians 15:22 “for as all die in Adam, so all will be made alive in Christ.” We will not become who God intends us to be until we ourselves share in the resurrection at omega. Once raised, we will look back over our biographies and over the evolutionary biography of the entire human race and understand who we are in our totality. Who we are will be defined by the length and breadth of our relationship with our Creator God.

As we examine the human condition as we find it now, we are examining a slice of human history and only a slice of the human reality. We can incorporate some of our past—both our prehistoric and historic past—but we cannot except in only the most vague way incorporate our future destiny. We must define our human reality as best we can by including some speculation about our ultimate future.

Thesis 6. Our human reality is in continuity with the surrounding natural world, including suffering and sin.

DNA is DNA is DNA. The four chemicals—ACGT – that make up DNA are the same in all life forms on planet earth. Whether with chimpanzees, Chihuahuas, chickens, Chinooks, or chickpeas, we human beings share a pattern of genetic

activity. Just as Genesis 2:7 says we are formed from the soil, Adamah, and therefore are made up of our planet's material, we can also say that what makes us live is in continuity with what makes anything alive in our world. And if Darwin's theory of evolution holds, we will have to conclude that all living things share a single biological history, perhaps even a single biological origin.

The relational model for understanding the human condition warrants adherence. The relational model cedes ontological priority to the relationship and subordinate status to the relation's terms. What we know as human individualism finds its place within the more comprehensive network of relationships. The human soul, for example, is not an isolated metaphysical monad, but rather a cipher that locates the dimension of the human reality that overlaps with the presence of God in a person's life. God has a relationship with each of us individually, to be sure; yet, even this relationship is tied to the network of connections with the rest of reality. Our resurrection, to cite a second example, is tied to the advent of the new creation, the eschatological renewal of the entire created order.

When it comes to understanding the shadow side of human existence—evil, frustration, suffering, sin, and death—we need to look first at the continuity between the human race and other forms of life, even pre-animate matter. We need to look at nonhuman life forms to compare our experience of suffering with that of other animals. We need to ask whether our evolutionary history has disposed human beings for violent and destructive behavior, and whether even sinful behavior might be commonplace in the wild kingdom. We might even want to ask if preanimate physical matter operates according to principles that make possible the rivalry for resources and the conflict between life forms that leads to the predator and prey relationship. The theological concept of the fallenness of nature needs to be explored in light of a relationalist model for apprehending the interconnectedness of the living and nonliving domains.

Thesis 7. We need to think epigenetically, not archonically.

We need to elect one of two options when thinking about matters of definition or essence: archonic or epigenetic forms of thinking. The archonic path takes us back to the origin, to the beginning. I elect this term because its Greek root, ἀρχή, has a relevant double meaning. It means both beginning and governance. In the word archaeology it means origin, for example; and in monarchy or hierarchy it means governance.

The word *arche* betrays a structural propensity in human thinking, namely, we associate the definition or essence of something with its origin. The rule or governing principle is coincident with the way something begins. The nature of things is established at origin, so whatever comes subsequently is a betrayal or deviation from a thing's original nature. Analysis takes the form of seeking origins, because in an origin we believe we find the essence. What this leads to is the concept of revolution—to revolve—as a return to an original essence by means of clearing away unwanted accruals.

Myth provides the paradigm of archonic thinking. Here is my working definition: a myth is a story about how the gods created the world in the beginning, in *illo tempore* or the time before there was any time, which explains why things are the way they are today. Whether providing etiologies for the cosmos or one's nation or name or disease or whatever, the myth reveals a thing's essential nature by telling us a story of its origin. We may tell very few myths in the modern world, but the archonic path is still followed. Physical cosmologists still look back to the Big Bang in hopes of devising a Grand Unified Theory (GUT). Medical researchers still look for the ontogenesis of maladies. Archonic thinking is common to both myth and science.

The other path is epigenesis. If we take this word apart, we can see that 'genesis,' reminding us of 'generate,' refers to bringing something into existence for the first time. It is no accident that the First Book of Moses or the Torah is called "Genesis." If we prefix it with 'epi,' the Greek preposition for 'upon' or 'after,' we get a compound word that suggests ongoing or repeated genesis. Epigenesis is the process by which new things continue to emerge. The way the world begins is not the way it remains. It changes. New things appear. New things do not need to bow in allegiance to what preceded them, nor is their essence reduced to the nature of their predecessors. The reality of new developments is not suspect because they were not present at the point of origin.

Perhaps I should interject a disclaimer. My term, epigenesis, should be distinguished from its use in genetics research or the sociobiology of E. O. Wilson. Among geneticists, epigenetics refers to intra-cellular or inter-cellular processes which influence gene expression such as methylation. Or, "epigenetics can be defined as a set of modifications to our genetic material that change the ways genes are switched on or off, but which don't alter the genes themselves."¹⁰ A completely unrelated use of the term can be found in the theorizing of entymologist and social commentator, Edward O. Wilson. With the term epigenetic rules, Wilson

10 Carey, Ness, *The Epigenetics Revolution* (Icon Books, 2011), 7.

intends to say that “human nature is not the genes underlying it.... Human nature is the inherited regularities of mental development common to our species. They are the epigenetic rules.”¹¹ This notion is scientifically vague and seems unconnected to any empirical research. However, my point here is merely that my use of epigenetic thinking should be distinguished from these two other uses. My own use is derived from that of biologist and philosopher, J.C. Smuts, according to whom “evolution is not merely a process of change...it is creative.”¹²

What does epigenetic thinking imply for theology? To be sure, much of the Bible follows the archonic path. The book of Genesis is rife with etiological narratives, stories about the origin of virtually every aspect of daily life for Israelites in ancient Canaan. The origin of Israel is given in the story of Abraham’s call; and the name ‘Israel’ is given in the story of Jacob. Yet, this is not all. The God of Israel makes promises to do new things; and this God fulfills these promises. The people of Israel live between promise and fulfillment. God is not stuck in the past. God’s future relationship to the covenant people is not determined by what happened at origin. ^{NRS} Isaiah 43:19 “I am about to do a new thing; now it springs forth, do you not perceive it?” We will miss perceiving God’s new things if our eyes look only toward the past and not toward the future.

The lens of epigenesis helps us perceive the dynamism of every day existence as well as view with credibility the divine promise for an eschatological consummation where God will become all in all. New things happen every day, both in natural history and human history. The eschatological transformation is continuous with daily newness, even though the breadth of the eschatological transformation is total. Only by liberating our thought processes from reliance upon archonic ontologies can we come to appreciate the Christian gospel that anticipates omega.

Conclusion

In the tradition of Thomas Aquinas, I believe the task of theology is to explain all things real in relation to their creator, God. “In sacred science all things are treated of under the aspect of God, either because they are God Himself, or because

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- 11 Wilson, Edward O., *The Social Conquest of Earth* (W.W. Norton&Company, 2012), 194–195. See: Peters, Ted, “E.O. Wilson’s Conquest of Earth,” *Theology and Science* 11:2 (May 2013), 86–105.
 - 12 Smuts, Jan C., *Holism and Evolution* (Macmillan, 1926, and N&S Press, 1987), 89. See: Peters, Ted, *God-The World’s Future* (Fortress Press, rev. ed., 2000), 18–19.

they are ordered to God (sub ratione Dei) as their beginning and end.”¹³ Nothing smaller than the cosmos with its past and its future can encompass what we mean by God’s creation.

Theological reflection on what we have learned about physical reality through science leads to both consonance and dissonance. The theory of the Big Bang with its concomitant notion of natural history over time is roughly consonant with what the religions of the book see as divine creation. However, scientific prognostications regarding the far future of the cosmos seem dissonant with biblical promises of a new creation, promises of an eschatological salvation. I have sought here to develop a theological ontology that draws both creation and new creation into a single conceptual scheme, a conceptual scheme intended to enhance consonance and reduce dissonance. The elimination of dissonance between naturalistic and theological visions of the future cannot be easily erased, of course. This is because of their respective methodologies; because the different disciplines rely upon different sources of knowledge for their points of departure. The truth or falsity of the Christian claim that a new creation is coming has the status of a hypothesis, subject to confirmation or disconfirmation by what happens in the future.

13 Thomas Aquinas, *Summa Theologica*, I:1:Q.7.

Robert John Russell

Scientific Cosmology and the Theologies of Creation and Redemption¹

We live in a tremendously exciting time. More and more scientists, philosophers, ethicists, and theologians are contributing to the goal of placing science and faith in a dynamic relation of mutual, creative interaction. I hope to suggest, in this short essay, how this is possible. I will choose three of the dozens of topics to be found in the interaction, topics that highlight the way physics and cosmology, my fields of scientific speciality, interact with Christian theologies of creation and redemption. In each case I will assess the past accomplishments regarding each topic and then point to opportunities for future research in theology and science. I intend this as an expression of my gratitude to the John Templeton Foundation which has been instrumental in funding the growing research in theology and science on the celebration of the Foundation's 25th anniversary, and to the University of Heidelberg for its vital role in this research.

Cosmology and Creation *ex nihilo*

My first topic is the relation between scientific cosmology and the Christian doctrine of creation *ex nihilo*. After assessing past accomplishments I turn briefly to directions for future research.

A. Assessing the past

According to standard Big Bang cosmology, the universe began some 13.8 billion years ago with an “absolute singularity” denoted as the beginning of time: $t = 0$. There can be no direct observational evidence for this claim, of course, because of the cosmic microwave background (CMB). The CMB is now a weak, almost uniform, glow of light at approximately 2.7 degrees Kelvin and coming from all directions in the sky. It is a remnant of the extraordinarily intense hydrogen

1 This essay is based on a lecture given at the University of Heidelberg, Germany, during the international conference: “Science and Religion Dialogue, Past and Future,” Oct. 25–28, 2012.

plasma and radiation in the very early universe at roughly 380,000 years since $t=0$, a period long before the formation of galaxies, stars and planets.

Theoretical evidence, however, for $t=0$ comes from the singularity theorems developed by George Ellis, Robert Geroch, Stephen Hawking, and Roger Penrose in the 1960s. According to these theorems, if general relativity is the correct theory of gravity (and it is still considered to be so as long as we look beyond the atomic level where quantum mechanics is involved), and if the mass-energy-stress of the universe obeys some simple equations then the singularity theorems predict the existence of $t=0$. It then follows that physics at $t=0$ breaks down as the radius of the universe goes to zero and the cosmic temperature and density go to infinity. Within this model we must use physics to describe what “happened before” $t=0$. But, in this case, since the physics breaks down at $t=0$ and we cannot project back before this event scientifically, it is reasonable to interpret $t=0$ from the perspectives of philosophy and theology. And so to our first question: “Is $t=0$ relevant to creation theology?” In a previous essay I suggested that there have been three types of response to this question².

i. $t=0$ as directly relevant to theology. The first is that $t=0$ is directly relevant to theology, and this response comes in two starkly different forms. Many voices have greeted $t=0$ as offering more or less direct support for belief in God the Creator. Two examples will suffice for our purposes of illustrating the position. On November 22, 1951, while addressing the opening meeting of the Pontifical Academy of Sciences, Pope Pius XII reflected on the apparent absolute beginning of the universe, and it is worth considering an extended quotation from his philosophically balanced and nuanced comments:

(44) It is undeniable that when a mind enlightened and enriched with modern scientific knowledge weighs this (“insoluble enigma”) calmly ... it perceives and recognizes the work of creative omnipotence, whose power, set in motion by the mighty “Fiat” pronounced billions of years ago by the Creating Spirit, spread out over the universe, calling into existence with a gesture of generous love matter bursting with energy... (45) It is quite true that the facts established up to the present time are not an absolute proof of creation in time, as are the proofs drawn from metaphysics and Revelation in what concerns simple creation or those founded on Revelation if there be question of creation in time. The pertinent facts of the natural sciences, to which We have referred, are awaiting still further research and confirmation, and the theories founded on them are in need of further development and proof before they can provide a sure foundation for arguments which, of themselves, are outside the proper sphere of the natural sciences. (46) This

2 Russell, Robert J., *Cosmology from Alpha to Omega: The creative mutual interaction between theology and science* (Fortress Press, 2008), Ch. 3.

notwithstanding, it is worthy of note that modern scholars in these fields regard the idea of the creation of the universe as entirely compatible with their scientific conceptions and that they are even led spontaneously to this conclusion by their scientific research.³

More apologetic positions have also been taken and directed towards a popular audience. For example, physicist and evangelist Dr. Hugh Ross, President of *Reasons to Believe*,⁴ has written about the Big Bang:

If the universe arose out of a big bang, it must have had a beginning. If it had a beginning, it must have a beginner... The cause of the universe is functionally equivalent to the God of the Bible, a Being beyond the matter, energy, space, and time of the cosmos.⁵

Other scholars have also seen $t=0$ as offering evidence for God's existence, but they have then sought to challenge Big Bang cosmology because of their commitment to atheism. Fred Hoyle is probably the most prominent such voice. In 1949 Hoyle, along with fellow scientists Thomas Gold and Hermann Bondi, accepted the fact that the universe is expanding but they sought to disconnect the expansion with $t=0$. Instead they proposed a new theory of gravity consistent with Einstein's special relativity, but one in which the universe has been expanding forever, increasing its radius exponentially in time. In this "steady state" cosmology, matter is spontaneously created, thus keeping the density of matter constant. Hoyle saw the rejection of an absolute beginning of the universe through the steady state cosmology as a direct challenge to those who used $t=0$ as evidence for God and thus a vindication of his allegiance to atheism. The steady state cosmology, however, was generally abandoned in the 1960s as increasing evidence emerged in support of the Big Bang model, particularly the CMB radiation.

ii. $t=0$ as entirely irrelevant to theology. A number of scholars have defended the view that $t=0$ is of little if any direct relevance to theology. Wary of the detriment of distracting the conversation about cosmology's significance for Christian thought to a far-off and debatable beginning to the universe, they prefer to emphasize the crucial significance of the dynamic, relational and open character of the universe. What counts about the discoveries of the 20th century cosmology is not so much whether the universe had a beginning but that the universe is one precisely "fine-tuned" for life, and one in which life is most likely in abundance

3 "The Proofs for the Existence of God in the Light of Modern Natural Science," available in English at: <http://www.papalencyclicals.net/Pius12/P12EXIST.HTM>.

4 <http://www.reasons.org/about/who-we-are/hugh-ross>.

5 Ross, Hugh, *The Creator and the Cosmos: How the Greatest Scientific Discoveries of the Century Reveal God* (Navpress, 1995), 14, 61.

throughout the riot of galaxies in the cosmos. Again one example will serve to illuminate this position nicely.

For Arthur Peacocke, science in general, including contemporary physics, cosmology and evolutionary biology, plays a crucial role in his constructive theology. Nevertheless the problem of $t=0$ finds marginal significance at most. This seems to stem from the fact that Peacocke makes a stark distinction between I call “ontological and historical origination.” The former refers to the sheer existence of the universe in its utter contingency and dependence on God as such. The latter refers to an historical beginning to all things. Thus the former is relatively indifferent to the purported discovery of a cosmic beginning, $t=0$, while the latter is quite naturally embodied in the concept of a cosmic $t=0$.

One sees this distinction clearly in Peacocke’s 1978 Bampton Lectures, *Creation and the World of Science*.⁶ Here Peacocke explores at length the historical and contemporary discussion surrounding the doctrine of creation as both *ex nihilo* and *creatio continua*, and the important relation of science to the doctrine. Use of what I am calling the ontological/historical distinction pervades Peacocke’s discussion of *ex nihilo*:

The principal stress in the Judeo-Christian doctrine of creation ... is on the dependence and contingency of all entities, and events, other than God himself: it is about a perennial relationship between God and the world and not about the beginning of the Earth, or the whole universe at a point in time.... Time, in modern relativistic physics ... has to be regarded as owing its existence to God... It is this ‘owing its existence to God’ which is the essential core of the idea of creation.⁷

The results of science are simply not germane to the core of that doctrine.

Scientific cosmology...cannot, in principle, be doing anything which can contradict such a concept of creation. From our radio-telescopes ... we may, or may not, be able to infer that there was a point (the ‘hot big bang’) in space-time when the universe, as we can observe it, began, and, perhaps, what happened on the other side of that critical point. But, whatever we eventually do infer, the central characteristic core of the doctrine of creation would not be affected, since that concerns the relationship of all the created order, including time itself, to their Creator.⁸

6 Peacocke, Arthur R., *Creation and the World of Science: The Bampton Lectures*, 1978 (Clarendon Press, 1979).

7 Ibid., p. 78.

8 Ibid., p. 79.

iii. $t=0$ as indirectly relevant to theology:

The “golden mean” between the two preceding positions is that science is indirectly relevant to theology: it is neither of direct importance nor of minimal unimportance. Here science can be seen as providing a kind of confirmation for what theology already affirms on other grounds (e.g., scripture, tradition, etc.), but certainly not proof of its truth nor a source of its content nor confirmation in any compelling sense. I like to use the metaphor of a court of law, where the defendant is being tried and her lawyer introduces a crucial “character witness.” The witness cannot speak conclusively in support of the defendant’s innocence as he wasn’t present at the event in question, but he can testify to the fact that in his opinion the defendant is incapable of such a charge because of her character, one well known to him. Similarly I see $t=0$ as a token of a universe whose character is that of “beloved creature” of the immensely generous Creator. This is exactly the type of universe that God would have created if God wanted life to evolve on some, perhaps many, worlds. I believe in creation primarily because of scripture, tradition, and experience, but I find confirming support from the physical character of the cosmos as having an absolute temporal beginning and being fine-tuned for life, even if we have no direct empirical evidence of such a beginning or for such fine-tuning. Again this is in keeping with the analogy with the court witness not having been present at the event in question.

A now-widespread term for this sort of relation between theological and scientific statements is “consonance.” Its origins go back to a highly original article by historian of science Ernan McMullin published in Arthur Peacocke’s 1981 anthology, “The Sciences and Theology in the 20th Century.”⁹ Here McMullin introduced the idea of “consonance” between theology and science in the specific context of the relation between Big Bang cosmology and the doctrine of creation *ex nihilo*. McMullin was cautious, and rightly so in my opinion, about viewing the relation too tightly, where $t=0$ might be seen as supporting or even proving the doctrine of creation, as well as the converse, viewing cosmology as irrelevant to theology. Instead McMullin offered the term “consonance” to characterize the relationship in a more nuanced way. He called for a “coherence of world-view” to which all forms of human knowing can contribute, including science and theology—but a world-view that, as he put it in a tantalizing phrase, would involve a “constant slight shift.”

9 McMullin, Ernan, “How Should Cosmology Relate to Theology?” in Peacocke, Arthur R. (ed.), *The Sciences and Theology in the Twentieth Century* (University of Notre Dame Press, 1981), 17–57.

I was to explore McMullin's phrase as I developed the idea of consonance in relation to what I began to refer to as "dissonance." The exploration began with the tantalizing fact that for the first time ever we had a scientific cosmology which viewed the universe as expanding in time and time as having an absolute beginning denoted " $t=0$ ". Clearly $t=0$ seemed to be remarkably coherent with our theological tradition which radically distinguishes creation, as finite, from God as infinite and understands creation as existing contingently—the gift of God who exists necessarily. The problem was that Big Bang cosmology also seemed to point to features about our universe that are actually infinite: the flat and open models depict the universe as infinite in size and as expanding forever in the future. Surely, then, if the finite past of our universe is consonant with the doctrine of creation, the infinities in size and future of the flat and open Big Bang models undercuts consonance. It seemed paramount to me that this fact be acknowledged and dealt with if we are to "play the game fairly." To signal this problem I referred to it as "dissonance."

One virtue in acknowledging such dissonance is that it actually leads to new directions for further research in the theology and science conversation about cosmology, ones which might lead to an even deeper consonance—as we will see in looking to future research below. Moreover by recognizing that elements of consonant or of dissonant can change in time, we can build change directly into the relation between science and theology, making the relation itself fluid and dynamic. Finally, and perhaps most importantly, this approach avoids two extremes: on the one hand identifying the core meaning of the theological doctrine too closely to science and hence being overly vulnerable to scientific change, yet on the other hand so insulating theology as a whole from science that no substantive relation exists. In working this way, we can make contact with science, not with the intent of proving a theological claim but of looking for a modest form of confirmation or disconfirmation that can vary in creative ways as theories change and can lead to further insights.¹⁰

B. Future directions for research

A clear and crucial question for the conversation between theology and scientific cosmology is this: When cosmology changes will cosmology and creation theology

10 A decade later McMullin's idea of consonance was extended by Ted Peters in several crucial publications. See for example Peters, Ted, *Cosmos as Creation: Theology and Science in Consonance* (Abingdon Press, 1989) and *Ibid.*, *Theology and Science: The New Consonance* (Westview Press, 1999).

still be consonant or will their elements of dissonance grow? I take this to be an open-ended research question. The key is to be in a flexible and dynamic conversation that accepts change as healthy and anticipates new insights from the changes in the existing relationships. I will focus briefly on two of these changes here.

1. These changes in cosmology starting with the birth of inflationary Big Bang cosmology. In 1980 Alan Guth proposed that the very early universe expanded at an enormous exponential rate, increasing its volume of a factor of 10^{78} between the time 10^{-36} to 10^{-32} seconds after $t=0$. The rate of expansion then slowed radically, leading to the kind of expansion rates we see today. Inflation offers answers to several technical problems in standard Big Bang cosmology: the visible universe is basically flat because of the initial radical increase in its size; the visible universe is “fine-tuned” for life because inflation created a huge number of domains in the universe and the fundamental constants vary from domain to domain; and major inhomogeneities such as galaxies arise from the rapid magnification of tiny inhomogeneities in the very early universe. However in these inflationary models the question of the existence of $t=0$ remains largely unanswered since most inflationary models do not satisfy the conditions required for the singularity theorems mentioned above. This means that while the fine-tuning argument in cosmology may not be of further importance to philosophical and theological writers the absolute beginning of time, $t=0$, remains an open question: is it one which science can address or is it legitimate for philosophy and theology to speculate about its wider meaning?

2. More recently, string theory has been proposed as a way to reconcile the differences between two fundamental theories in physics: general relativity and quantum mechanics.¹¹ The key is to replace the pointlike particles of standard physics with one-dimensional strings (think connected loops). These strings vibrate at different frequencies, and in this way account for many of the different properties of the so-called elementary particles. As it has developed over the past two decades, string theory now widens into superstring theory and its prediction that there exist a multitude, perhaps an infinity, of actual universes, the string theory multiverse. In models like this our visible universe becomes part of not only an inflationary Big Bang cosmology but a larger and potentially infinitely old scene of universes coming into being and ceasing from being. How would speculation about the beginning of our universe, the $t=0$ question, reverberate into these new and perhaps infinitely grander cosmologies than Big Bang theorists ever imagines? My recommendation is that those of us engaged in this

11 See http://en.wikipedia.org/wiki/String_theory.

dynamic and ever-changing interdisciplinary field of cosmology and theology welcome these new cosmologies and continue the conversation about what they portend for ongoing constructive Christian theology.

Cosmology and Creation: *creatio continua*, evolution, and NIODA

A. Assessing the past accomplishments

The key question here is “does God act in the natural world—specifically in the evolution of species?”¹² A variety of scholars who represent the ecumenical movement called “theistic evolution” say “yes!” Theistic evolution combines two distinct but inter-related themes within the Christian creation tradition: *creatio ex nihilo* and *creatio continua*. God both creates the universe out of nothing and sustains it in existence moment by moment. Now in light of evolutionary biology the concept of divine creation receives a dynamic, unrepeatable character. The voices for theistic evolution include Ian Barbour, Teilhard de Chardin, Denis Edwards, George Ellis, Owen Gingerich, Niels Gregersen, Philip Hefner, Martinez Hewlitt, Wentzel van Huyssteen, Elizebeth Johnson, Nancey Murphy, Jürgen Moltmann, Nancey Murphy, Wolfhart Pannenberg, Arthur Peacocke, Ted Peters, Pope John Paul II, Thomas Tracy, Karl Rahner, Jeffrey Schloss, Tom Tracy, and many more.¹³

12 Some fundamentalist voices say “no”, because they reject the scientific theory of the evolution of life. Atheist voices say “no”, because they reject the idea of God as such. Still others try to steer a middle road by arguing that evolutionary biology can explain “microevolution” (change within species) but not “macroevolution” (change of species) but that it needs to be supplanted by a theistic argument within science for an Intelligent Designer Agent (ID). I dismiss the ID argument in trying to interject a theological explanation into laboratory and theoretical biology, and I sharply distinguish this move from the standard move of introducing the discoveries of science into the sphere of Christian theology.

I accept methodological naturalism, as a way to explain as much as we can about nature using strictly natural causes, and metaphysical naturalism, as an ontological claim that all that exists and has causal efficacy is nature captured by the lens of the natural sciences. I strongly reject the claim of ID scholars that methodological naturalism leads (inevitably?) to metaphysical naturalism / atheism.

13 For a very helpful survey of many of the positions taken within theistic evolution see Martinez Hewlitt and Peters, Ted, *Evolution from Creation to New Creation* (Abingdon Press, 2003).

The challenge to *creatio continua* comes from a causally closed world: Does God act, not only to create and sustain the world, but also to make a difference in the processes of evolution? And if God does act in this way, does this depict God as intervening in these processes and violating the very regularities which life depends on and which science discovers? As Nancey Murphy as eloquently written, the problem of divine action issues into a “forced option” between conservatives and liberals in both Catholic and Protestant communities.¹⁴ Conservatives accept an interventionist/miraculous view of God’s real, objective action in nature while liberals opt for a non-interventionist account at the cost of making talk of divine action merely a subjective interpretation of ordinary events.

As a way out of this dilemma I have proposed that in a causally-open, indeterministic world we can combine the best of conservative and liberal views: God really acts in the processes of nature but without intervening and violating them. I call this account “non-interventionist objective divine action” or NIODA. In essence, if natural processes at some level of complexity are genuinely indeterministic, God can act in, with and through them to bring about new events without miraculously intervening in nature. (This view in no way challenges belief in miracles as such which I happen to share, but it does allow for a new category of divine action which can apply throughout nature without requiring such divine action to be miraculous.) Now the challenge amounts to finding areas in nature in which natural processes are indeterministic (or to put it more carefully, in which we can interpret the scientific theories that describe these processes philosophically in terms of indeterminism).

The most likely candidate, as far as I can tell though we are about to embark in a new assessment of diverse areas in science for other such areas, is quantum mechanics (QM). QM is crucial to the intelligibility of divine action in light of science since one of its of many plausible interpretations, namely that of Werner Heisenberg, is that quantum processes are not only statistical but fundamentally indeterministic. Since the production of genetic mutations in the context of evolutionary biology is governed to a large extent by quantum mechanics (the making or breaking of a covalent bond, for example), and since genetic mutations play a very significant role in biological evolution, we can deliver on the promises

14 Murphy, Nancy, *Beyond Liberalism and Fundamentalism: How Modern and Post-modern Philosophy Set the Theological Agenda* (Rockwell Lecture) and *Ibid.*, *Anglo-American Postmodernity: Philosophical Perspectives on Science, Religion and Ethics* (Westview Press, 1997).

of theistic evolution in a new and robust way.¹⁵ Essays published in the final decade of the twentieth century reflected and developed this approach to theistic evolution.

B. The future: Research frontier questions

Several questions arise from the preceding discussion. I would like to focus on one of the most promising of them.

Can we move beyond the sub-atomic realm of quantum mechanics and explore additional scientific areas concerning the everyday, macroscopic world or the universe as a whole which support indeterminism?¹⁶ Recently CTNS received a grant from Calvin College to explore this very issue¹⁷. These areas include:

- the macroscopic expression of quantum entanglement (in which once bound quantum particles, when separated over enormous distances, continue to show simultaneous correlations in their properties)
- subtle propensities (tendencies) in apparently random processes in physics and biology
- dynamic self-organization in large-scale physical systems (such as terrestrial meteorology and the rings of Saturn)
- the emergence of new properties and processes in complex biological systems which can causally effect the functioning of some properties and processes at lower levels in these system (strong emergence) and the effect of the system as a whole on its underlying parts (top-down/whole-part causality).
- the capacity for autopoiesis (self-regulation in complex, thermodynamically open systems such as the biological cell)

15 For a detailed discussion of NIODA, a detailed response to many critiques, and a assesement of the views of Barbour, Peacocke and Polkinghorne on divine action, see Russell, *Cosmology from Alpha to Omega* (Fortress Press, 2008), Chs. 4–6.

16 Some critics have read me as claiming that indeterminism, and thus NIODA-type divine action, only happens at the quantum level. Instead I have frequently written that I believe that God acts at every level to achieve God's purposes; the quantum level, however, is the only one I know that allows me to make this claim within the scholarly methodology of theology and science. It is potentially important to the mind-brain problem in so far as the firing of individual neurons is in part a quantum event.

17 "Scientific And Theological Understandings of Randomness in Nature" (SATURN) is a program of CTNS funded in part by a grant from Calvin College through their "Randomness and Divine Providence" program. The Calvin program is supported by a grant from the John Templeton Foundation.

- the universe as understood in terms of quantum cosmology (a quantum-mechanical approach to cosmology) and superstring theory / multiverse cosmology (in which our universe is part of a vast collection of possible universes referred to as the “multiverse”).

If these areas lead to the possibility that nature is largely indeterministic and that indeterminism is not entirely restricted to the area of quantum mechanics, we might conclude that God acts without intervention in many, perhaps *all*, levels of nature.

Cosmology and Redemption: The challenge to New Creation Eschatology by Scientific Cosmology

A. Assessing past accomplishments

Following the lead of many New Testament scholars and Christian theologians I start the task of constructive eschatology by basing it, by analogy, on the bodily resurrection of Jesus. His resurrection was neither a resuscitation as happened to Lazarus (John 11:1) or a Gnostic flight of a disembodied soul. Instead every aspect of the human person, Jesus of Nazareth, was transformed into the Risen Lord. The significance, then, of the empty tomb is that matter matters: the resurrection of Jesus includes his bodily, physical material dimension — his *sarx* — and not just his personality as remembered by the disciples.¹⁸ And transformation here means that there are elements of continuity between the historical Jesus of Nazareth and the transcendent, Risen Lord, as well as elements of discontinuity. Both of these elements are found subtly entangled in the New Testament appearances traditions. One of the hardest tasks for theology is to find ways, admittedly very partial and tentative, of speaking about these two types of elements.

If an eschatology of New Creation is modeled on the bodily resurrection of Jesus, this entails a transformation of the entire Creation and not just of humanity or even of the earth's ecosphere. All that is now — the universe — will be changed into the New Heavens and New Earth in the eschatological future. As with the resurrection of Jesus, there will be elements of continuity and elements of discontinuity. But with the topic being the transformation of the universe an even harder task for theology is to find ways, admittedly again very partial and tentative, of speaking about these now universal elements.

18 To put the point briefly, I am siding with Barth and N. T. Wright over Bultmann and the Jesus Seminar.

Still I believe that the most serious challenge which comes from science, given the intimate theological relation between the resurrection of Jesus and the general resurrection. The general resurrection in the future is an event which was taken for granted by first century pharisees such as Paul. We see this relation clearly in the famous passage in 1 Corinthians 15: 12–20 where Paul writes:

Now if Christ is preached that He has been raised from the dead, how do some among you say that there is no resurrection of the dead? But if there is no resurrection of the dead, then Christ is not risen. And if Christ is not risen, then our preaching is empty and your faith is also empty. Yes, and we are found false witnesses of God, because we have testified of God that He raised up Christ, whom He did not raise up—if in fact the dead do not rise. For if the dead do not rise, then Christ is not risen. And if Christ is not risen, your faith is futile; you are still in your sins!

Here we can see with stark clarity how direct and profound is the challenge from scientific cosmology. If the predictions about the future of the universe made by Big Bang cosmology really describe the future of the universe, then it is one in which the universe will expand forever, endlessly cooling towards absolute zero. All material structures from galaxies to atoms will vanish, leaving behind only black holes, a plasma of fundamental particles and radiation. It goes without saying that if this cosmic future truly comes to pass there will be no general resurrection. If this is so, then, as Paul insists Christ, is not risen and our faith is indeed futile. Have we finally reached an unanswerable conflict between theology and science?

Beginning in 2000 I came to focus increasing attention on how we might meet this challenge. The first step was the realization that the challenge is not actually from science but from a *philosophical assumption* we bring to science: the predictions of well-established scientific theories must occur. But this assumption, in turn, relies on a deeper philosophical assumption, namely that the regularities which science describes are dictated by the laws of nature taken as prescriptive. Prescriptive laws, if they are correct, will govern what comes to pass in nature, period.

Instead we may chose to assume that the laws of nature are descriptions of causal regularities within nature herself, not prescriptions which nature must obey. The final step is to assume that these descriptive regularities are the continuing gift of God. If so, then if God choses to act in a new way, nature's future will not be what science predicts. In this way we have diverted the challenge from one seemingly between science and theology to one between philosophy and theology. If God *did* act in a new way at Easter and if God promises to continue to do so to create the New Creation from the present world, then the cosmic 'freeze'

predicted by Big Bang cosmology *will simply not happen*. With this new assumption in place, the conversation between science and theology can continue fruitfully without the shadow of conflict hanging over the discussion.

B. Future Directions

How do we continue the dialogue between Christian eschatology and science? How do we make an eschatology of universal transformation intelligible in light of science?

In my view the best option is offered by a combination of the writings of Wolfhart Pannenberg and John Polkinghorne. From the latter we gain a crucial insight: if there are some continuities between the present world and the New Creation, then science, in its study of this world, may offer vital clues to the elements of such continuity, especially if we have some instinct for what's going to be involved in the New Creation. From the former I take the insight that a properly revised doctrine of God's eternity in light of physics might well lead to new questions to be put to science, and thus indirectly to new research programs in science. These insights, in turn, underscore the value of an interactive conversation between science and theology. They might also lead to additional insights about the nature of the New Creation given these scientific pointers to the elements of continuity between the present world and the new world. I have recently developed these ideas in detail in my book, *Time in Eternity: Pannenberg, Physics and Eschatology in Creative Mutual Interaction*.¹⁹

Conclusions

Progress has been made in the past on research in theology and science, yet much work remains. May the future bear new creative insights, address continuing challenges, and gain wider vistas about God's creating and redeeming purposes in light of science. I hope that the three themes of this essay reflect both the excellence of the past accomplishments and the agenda for future progress in theology and science.

19 Russell, Robert R., *Time in Eternity: Pannenberg, Physics, and Eschatology in Creative Mutual Interaction* (University of Notre Dame Press, 2012).

IV. The Science and Theology Dialogue II: Multicontextual Dimensions

Cyril Hovorun

The Dialogue between Science and Religion in Russia

I would like to begin my paper with an affirmation that there *is* a dialogue between science and religion in Russia. However, it evolves differently from the same dialogues in the west. The differences are conditioned by the contexts of these dialogues. The Russian context is remarkably different from the western one. It is post-soviet and post-atheist. Soviet atheism was a special sort of atheism. It was extremal, much anti-, namely anti-religious, and as such, quasi-religious. It was called 'militant'. At the same time, it was also declared 'scientific'. It became a full embodiment of the Soviet phenomenon of science being turned into an instrument of propaganda.

Birth of the 'scientific atheism' was 'blessed' in 1954 with the decision of the Central Committee of the Communist Party of the USSR called 'About significant failures in the scientific-atheistic propaganda and measures of improving it'. In 1958, the Department of propaganda and agitation of the Central Committee produced a classified report where it recommended along other measures of atheistic propaganda the following:

'The Ministry of the Highest education of the USSR and Faculties of Philosophy of Universities should secure training of philosophers with profound knowledge of atheism, who would be able to propagate efficiently scientific atheism. Relevant changes should be introduced to the educational plans and programs of the Faculties of Philosophy.'¹

Soon after this report was produced, the Central Committee of the Communist Party issued a document, also classified, where it urged all the party and state organisations in the Soviet Union to implement the recommendations of the above document. As a follow up of this party imperative, in 1959, a course of 'Basics of the scientific atheism' was introduced as a part of obligatory curriculum in the highest educational institutions of the Soviet Union.

In 1964, an 'Institute of scientific atheism' was established. It became a part of the Academy of Social Sciences, which in turn was an institution of the Central

1 РГАНИ. Ф. 4. Оп. 16. Д. 554. Л. 5–13. Подлинник. Published on the site of the Russian Association of Scholars in Religion: <http://www.rusoir.ru/03print/02/239/> [accessed Aug 15, 2012].

Committee of the Communist Party. The Department for ideology of the Central Committee managed the activities of the newly established Institute. Among its responsibilities was coordination of the atheist studies in all academic and educational institutions of the Soviet Union. The Institute developed massive publishing activities. For instance, it published a periodical 'Questions of scientific atheism'. 39 volumes in sum have been published, each approximately 20 thousand copies.² The policy of forceful infiltration of the 'scientific atheism' to all the branches of the Soviet Academia shaped a specific approach to the relationship between science and religion among those who went through the system of the higher education during the Soviet period. This approach affected not only those in humanities or social sciences, but also in science. This approach was built on the 'scientific materialism' similar to the Positivism of the 19th century.

Not only Positivism was imported from the 19th century as a precondition of radical divorce between science and religion in the Soviet Academia. There were other pre-Soviet situations that helped the Communist Party to polarise theology and science. Among those situations was a separation of theological education from University. Theology was never a full part of the University in the Russian Empire. From the very beginning of the Russian University, it was decided that theology should function separately from it. Theology was confined to its own *locus*, the theological academies. They constituted a self-sufficient system. Although this system was fully recognised and sponsored by the state, it was not allowed to be a part of the University. After the Bolshevik revolution 1917, this separation helped the Soviet regime to get rid of theology in the educational system altogether.

All these factors became a serious obstacle for revival of theology after the fall of the Soviet regime. Still, theology struggles to achieve two important things: 1) to be recognised as a proper academic discipline, and 2) to be re-introduced to the educational system in Russia. Although there is no much success in achieving these goals, some steps were made forward in the dialogue between science and theology. There are, first, official contacts between the Church and the Russian Academia. The Synodal Biblical and Theological Committee of the Russian Orthodox Church bears official responsibilities for the dialogue. Apart of facilitating occasional meetings between theologians and scientists, it maintains a dialogue with the Institute of Philosophy of the Russian Academy of Science.

2 Report by Zuev, Yury. Published on the website of the Russian Association of Scholars in Religion: <http://www.rusoir.ru/2009.php?action=view&id=486> [accessed Aug 15, 2012].

Partially the Commission on theology of the recently established 'Interconciliar Board' of the Russian Orthodox Church undertook a task of dialoguing with science. This institution has been commissioned to produce an official document of the Church regarding the dialogue with science. The document is still in the process of preparation. There are also many unofficial interactions between the Church and the world of science in Russia. Some of them happen in a natural way, as there is a good number of converts from science to theology. Moreover, majority of the most prominent theologians in the Russian Orthodox Church are former physicists, mathematicians, chemists *etc.* Their massive conversion caused a situation that *science* constitutes now a basic thinking framework for theology, not philosophy or proper academic theology, like in the West. It is possible to affirm that theologians and scientists in Russia speak a more common language than their colleagues in the West. They do not have as many platforms to talk to each other, however, as their western colleagues have a sort of platform for interactions between science and religion constitute parishes, which have been established at the Universities. This is a trend of the recent years to plant ecclesial communities in the academic environment. Some of them are quite successful and really facilitating the cooperation between the two realms. An example of such success is St. Tatiana's church at the Lomonosov State University in Moscow. Its rector is himself a graduate of the Classical department of the University. The church functions as an effective bridge between the University and the Church. St. Tatiana, however, is an example of a re-established community, which existed before the revolution as a Moscow University church. There are also examples of communities, which have been established in the places where they never existed. An example of such community is the one recently established at the 'National Research Nuclear University', formerly known as 'Moscow Institute of Engineering and Physics'.

A usual paradigm of how ecclesial communities at the Universities function is the following. They are normally established with the support of the rectors of institutions who believe that a parish at the University will fill a lacuna in moral formation of their students. However, they normally do not believe that theology is something to be taken seriously. There are also some protests against establishing such communities from the side of students.

Observers are now speaking of 'anticlerical reactions' to the active return of the Church to the public square in Russia. Voices of rebuking are heard also from the academic environment. The loudest among them was a so-called 'letter of academicians'. This was an open address to the President of Russia Mr Putin titled 'Policy of the Russian Orthodox Church: consolidation or collapse of the

country?³³ Ten members of the Russian Academy of Science signed the letter. Remarkably, among them were just two biologists and one medical doctor. The rest seven were physicists, including Noble Prize winners, Zhores Alfeyorov and Vitaliy Ginzburg.

The authors of the letter express their anxiety about an 'increasing clericalisation' of the Russian society and about active penetration of the Church to all spheres of the social life. They accentuated their major concern as follows: 'We cannot remain indifferent about attempts to doubt the scientific Knowledge ... and to substitute knowledge accumulated by science, with faith.' Thus, they consider science as essentially incompatible with religion. The main point of this incompatibility, in their view, is the materialistic nature of science. They state: 'All achievements of the modern science are based on the materialistic outlook on the world. There is nothing else in the modern science.' Thus, the Russian academicians declare themselves to be materialists. All true scientists are also materialists, in their belief. One can easily see in this appeal the rudiments of the Communist approach to the science, when there can be either religion or science, never together. No wonder therefore, that Zhores Alfeyorov, for instance, is a member of the Russian Parliament from the Communist Party of the Russian Federation.

There are also increasing protests against the 'clericalisation' of Academia among those who do not share Communist ideology and who even consider him- or herself to be religious. These protests reflect the discussions about the role of the Church in the modern Russian society and relations of the Church with the political establishment. Many in Russia disagree with the tendency of a too close rapprochement between the Church and the state. This tendency casts shadow on the dialogue between science and theology.

The ten academicians raised in their letter another important issue. This is an issue of legalisation of theology in the academic system of Russia. The academicians objected to it because they believe that science is based on the materialistic philosophy. There are many figures in the Russian Academia who do not share materialism confessed by the ten academicians. Yet, they do not believe that theology is an academic discipline and can be treated equally with other disciplines. They can be very positive about religion and even build churches on the campuses of their universities, but they want theology to stand outside of the doors of the university auditoria.

3 Published in the 'Novaya gazeta' on July 22, 2007: <http://old.novayagazeta.ru/data/2007/kentavr03/00.html> [accessed Aug 15, 2012].

Theology experiences resistance on all educational levels in Russia. Until recently, elementary religious education was not allowed to the secondary school. Only a couple of years ago it started to be introduced to the schools as an optional subject called 'Basics of the Orthodox culture.' On the University level, the Church for many years fought for theology to be introduced to the curriculum. Only in 2010 the educational standards for Bachelor and Master programs were accepted by the state, though theology constitutes only approximately half in these programs. A serious problem remains the recognition of dissertations in theology. In the Russian educational system, there is an institution, which has an ultimate responsibility for defences of dissertations. It is called 'Highest Attestation Commission'. It functions on the basis of the Ministry of Education and Science and stands above the universities. The Commission should approve all dissertations defended in any recognised educational institution of Russia. For this, a dissertation should correspond to one of the specialisations accepted by the Commission. Theology is not on the list of the Commission, and the Church for approximately twenty years struggles for theology to be included to this list. So far, the struggle was unsuccessful. Students are unable to submit their theses in theology at the institutions accredited by the state. This also remains a serious obstacle in the dialogue between theology and science.

To conclude, the dialogue between theology and science in Russia goes on under conditions of post-secularity. This post-secularity is specifically Russian. It combines elements of the communist ideology of the past, primitive positivism in understanding of the nature of science, complexities of the Church-state relations *etc.* The post-secular character of relations between theology and science in Russia, I think, is eloquently reflected in the words of the academician Sergey Kapitsa written in response to the letter of ten academicians. Religion, for Kapitsa, is generally useful in 'answering the question: how a human should behave in the society.' However, he continues, 'science in relation to religion is a next step in cognition of the world. It is a passage from the mythical or mythic-poetical description of the world to its scientific description.'⁴ Sergey Kapitsa's position expressed many scientists in modern Russia in their attitude to religion. This attitude is positive and welcoming. However, it is not sufficient yet for a serious and equal dialogue.

4 Published in the Religious supplement to the *Nezavisimaya gazeta* on Aug 1, 2007: http://religion.ng.ru/events/2007-08-01/3_monastry.html [accessed Aug 15, 2012].

Niels Henrik Gregersen

The Role of Thought Experiments in Science and Religion¹

How little we know, how eager to *explore*
(freely after Sir John Templeton)

The role of metaphors and models has rightly been emphasized in the science-religion discussions of the past. Already in *Myth, Models, and Paradigms: A Comparative Study of Science and Religion*, Ian Barbour refers to models as “imaginative tools” for ordering experience, and describes the use of theoretical models in science as relying on “an imagined mechanism or process, postulated by *analogy* with familiar mechanisms or processes and used to construct a *theory* to correlate a set of *observations*.”² Barbour hereby intended to show that there is a creative role for models in science for explaining empirical features of reality, similar to the way in which metaphors provide an imaginative basis for understanding religious experience. The distinctive feature of scientific models, however, is to pave the way for experimental observations. “The *model* thus leads to a *theory*, and the theory accounts for patterns in experimental *observations*.”³ Who would not like to see science proceed in this clear order!

Often enough, however, it is not easy to find empirical validation. Think of speculative areas of the very big (such as the hypothesis of extraterrestrial life, not to speak of multiverses), or of the very small (such as the nature of sub-atomic reality). In the absence of crucial experiments, thought experiments may play an important role. The nature and function of thought models, however, has only been dealt with in passing in science-religion discussions of the past, for example when discussing some of the famous scientific thought experiments, such as Schrödinger’s Cat penned up in a steel chamber, or the Einstein-Podolsky-Rosen

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- 1 This paper was first given for the conference “The Science and religion Dialogue: Past and Future,” organized by the John Templeton Foundation and University of Heidelberg, October 27, 2012; later presented at The Faraday Institute, Cambridge University, February 19, 2013, and at the University of Uppsala, May 21, 2013.
 - 2 Barbour, Ian, *Myth, Models, and Paradigms: A Comparative Study of Science and Religion*. (Harper Row, 1974), 30.
 - 3 Ibid., 31.

thought experiment, also from 1935, and eventually transformed into an real world experiment by Alain Aspect in 1983.

Since the 1990's, however, much work has been done on thought experiments within philosophy of science. Questions asked here are the following:

- What is the *nature* of thought experiments – are they just a subset of logical-deductive arguments dressed up in visual forms, or are they mental exercises that offer new information of reality not otherwise acquirable?
- What is the *value* of thought experiments – are they nothing but speculations unless they can be transformed into real world experiments, or do they have a cognitive value of their own? And, finally,
- What are the *distinctive forms* of thought experiments – some having a heuristic purpose, others having a destructive purpose, while still other having a constructive purpose.

In what follows I am indebted to discussions in leading journals of philosophy of science since the 1990's, as well as also to the work of the German-Canadian philosopher-theologian Yiftach Fehige.⁴ My purpose is show how thought experiments, by invoking imaginary counterfactuals in disciplined thinking, play an explorative function both in religion, philosophy, and science. While thought experiments use common sense observations as background knowledge, quite a few of them also question all too safe quotidian assumptions about what is ultimately real. In this sense, thought experiments are not just idle speculation, but doorways into deeper understandings of reality.

A Phenomenology of Thought Experiments

Thought experiments take place in the laboratory of mind, as indeed most of our reasoning does. If one enters into a book store, only very few books aim to describe or explain facts. Most books are fiction. But also cookbooks do not describe the food that we actually eat, but offer recipes for the food that we *might* produce. Even works in history and biography cannot avoid invoking counterfactuals when understanding historical processes.⁵ What, for example, would

4 Brown, James R., and Fehige, Yiftach, "Thought Experiments." *Stanford Encyclopedia of Philosophy* (2010); Fehige, Yiftach, "Quantum Physics and Theology: John Polkinghorne on thought Experiments," *Zygon: Journal of Religion & Science* 47:2 (2012), 256–288.

5 de May, Tim and Weber, Erik, "Explanation and Thought Experiment in History," *History and Theory* 42 (2003), 28–38.

have happened to post-WW II Europe, had not Churchill been required by the American President Roosevelt to move his army from North Italy northwest towards France rather than northeast towards Slovakia and the Czech Republic, as Churchill so eagerly wanted? No doubt the post-war fate of these countries would have been different. Evidently, such thought experiments cannot be turned into a real world experiments. The historian of WW II will have to evaluate such counterfactuals in order to be able to pick out the crucial historical events that explain why things went *this* way rather than *other* ways. Moreover, dealing with thought experiments is inescapable also for criticizing existing theories and opening up new explanatory perspectives, also in the case where thought experiments (TEs) cannot be put to test in real world experiments (RWEs).

Here is a list of what I see as recurring features of TEs:

- TEs take place in the laboratory of mind (in contrast to RWEs).
- TEs are highly economic with respect to clarifying the problem under consideration (like models in science, but unlike fiction)
- TEs combine visual imagination and a narrative plot (like stories)
- TEs invoke common sense intuitions while using conditional types of reasoning: Given xx, what happens if yy... (like theories)
- TEs, however, have no clear distinction between *explanans* and *explanandum*. They *show* by examples rather *explain* general facts (unlike theories).
- Yet TEs do have specific argumentative targets (unlike fancy and fiction).

How can a TE have an argumentative target, without offering a theory about something? My answer is that TEs, in themselves, explore their own internal world of logic (for example, a cat is penned into a chamber, the conditions of which are dependent on singular quantum events). A TE *shows* before it *argues*. In so far as the set-up of a TE is imaginary, a TE is hypothetical (*imagine* that x or y is the case). However, despite the illuminative character of imaginary situation, a TE is *neither* a hypothesis, *nor* a scientific theory, even though it can be transformed into such (cf. the Alain Aspect-experiment). Why, then, is a TE something more than a compressed or economically informed piece of fiction? Because it has an implicit *argumentative target* beyond its own imaginative space. A TE wants to *say* more than its shows, for it is somehow “telling” for reality as such. Without being a theory at distance to reality, the imaginary world rather exemplifies a piece of reality (the TE itself) in order to *illuminate* the wider reality (its argumentative target). This, in principle, can be done in three distinctive (but often combined) ways:

- TEs may *explicate* implicit knowledge
- TEs may explore *new perspectives* on known areas of reality, or
- TEs may explore *unknown realms* of reality, or even *new contingent facts*.

Thought Experiments in Sapiential Discourse

Let me begin by reminding of two thought experiments from classic religion and wisdom tradition – one from the Jesus tradition, and one from the Chinese Daoist tradition of Zhuangzi.

Once Jesus was compelling his followers to pray to God (“knock, and the door will be opened for you”) based on the following TE:

Is there anyone among you who, if your child asks for* a fish, will give a snake instead of a fish? Or if the child asks for an egg, will give a scorpion? If you then, who are evil, know how to give good gifts to your children, how much more will the heavenly Father give the Holy Spirit* to those who ask him! (Luke 11: 12–13).

Jesus is here backing up his encouragement to pray without reservations by invoking common sense knowledge about what fathers use to do. While the argumentative target is the practice of prayer, the thought experiment itself is about human fathers. From here the inductive move from the minor to the major starts out. Provided that even self-absorbed human parents want to help their children, “how much more” will not the heavenly Father listen to human prayers? This latter argumentative move only works if the listeners or readers share the intuition of an analogy between human fathers and the divine father. In order to reach its argumentative target, the thought experiment is thus based on a wider set of assumptions, not included in the thought experiment itself. Something similar, we shall see, also pertains to philosophical and scientific thought experiments.

Thought experiments, however, can also be entertained by offering a *change of perspective* on reality, as in the following story told about the Daoist philosopher Zhuangzi in Book 17 of his *Writings*.

Zhuangzi and Huizi were walking on the dam over the river Hao, when Zhuangzi said, “Look at the ease of the play of the fishes – that is their enjoyment.” Huizi responded: “You are not a fish, how do you know about what constitutes the enjoyment of fishes?” Yet Zhuangzi replied: “You are not I. How do you know that I do know what constitutes the enjoyment of fishes?”... “Well I know about their enjoyment from our enjoying ourselves together over the river of Hao”.⁶

6 Legge, James, trans., *The Texts of Taoism. Part I* (Dover Publications, 1962 (1891)), 390–391.

Here there is no explicit thought experiment but only an implicit one. What Zhuangzi does, first, is to contravene Huizi's common sense assumption of a separation between humans and other creatures by making a *reductio ad absurdum*. If a separation between individuals is to be conceived as basic, then human beings cannot understand one another, either. This is the destructive part of argument. Then follows, second, the constructive argument that it is from the inter-human experience of enjoyment that we have access to understand the enjoyments of the fishes in the river. Also this argument builds on the wider metaphysical assumption that inner bonds exist beneath the perspectival shifts between individual organisms. Dao is at work in everything, especially in play.

Philosophical thought experiments

Also in contemporary philosophy we find thought experiments of different sorts. Some have to do with revealing the implicit intuitions we have about what is valuable about our lives. Harvard philosopher Robert Nozick has developed a TE on *The Experience Machine*. Imagine a situation in which a future neuropsychologist could set up a machine with electrodes stimulating our brain just in the right proportions so that we would always feel a full satisfaction of our innermost desires – be they the desires of sexual pleasures, the feeling of strong and reciprocal attachment to other beings, or the making of great scientific discoveries. In the experience machine we would experience all according to our inner wishes. Yet two limitations are built into the machine. First, all our experiences would be purely subjective without contact with the real world; there would actually be no beloved, no two-way relations to the world, no real discoveries. Second (and I here amend Nozick's thought experiment), you could not come back to ordinary life as you were before, since the electrodes would destroy the natural operations of your brain. Provided this situation, Nozick asks, "Would you plug in?"

The purpose of this thought experiment is to show the untenability of the widespread hedonistic view that all that matters in life is well-being. So far the thought experiment is destructive, or critical. But the overall purpose of the thought experiment is constructive – or explorative as I would call it. Nozick's point is that in addition to the feeling of well-being and doing well we also want to do *something real*, and that we also want to be *somebody*, a person responsible for relating to the ever changing situations of life. "Plugging into the machine is a kind of suicide", as Nozick observes, though a pleasant one in kind. Sinking down into the virtual world of the experience machine would not allow us to encounter other real-world beings. But we actually want to live our own lives, not

a predesigned life. “Perhaps what we desire is to live (an active verb) ourselves, in contact with reality”.⁷

Does Nozick’s *Experience Machine* give us new information about reality? Well, not about contingent physical features of nature, but certainly about a dimension of reality inescapably linked to human existence. Many philosophical thought experiments aim to *explicate dimensions of reality without which the world would not be as it actually is*. TEs contravene the taken-for-grantedness of common sense perceptions of reality, while uncovering underlying aspects of ordinary existence. The TE is critical in order to be revealing.

The “testing” of the thought experiment concerns what we cannot take away from existence without denying crucial aspects of existence. This also goes for other famous thought experiments in contemporary philosophy. Think of John Searle’s *The Chinese Room*. Here an English speaker is locked in a room full of boxes of Chinese symbols (like a data base) together with an English book of instructions for manipulating the symbols (like a computer program). The man in the room would be able to respond “correctly” to outside inquiries, while not himself understanding the questions in Chinese handed over to him (the input), or the Chinese answers that he was able to provide by following strictly the rules in English manual.

The question, “Would the English-speaking person understand anything?” is intrinsic to the TE itself. Yet its argumentative target lies beyond itself. The target of Searle’s argument was the strong AI-proposal in vogue at that time in the community of cognitive scientists:

The point of the argument is this: if the man in the room does not understand Chinese on the basis of implementing the appropriate program for understanding Chinese then neither does any other digital computer solely on that basis because no computer, qua computer, has anything the man does not have.⁸

However, also here the critical role of the thought experiment serves the positive point of showing that the semantics (the meaning and reference of language use) cannot be reduced to the syntactics (the rules of grammar). Take semantics away, and you take away an essential dimension of human understanding – which in turn also has causal effects in the real world.

My third example is Frank Jackson’s (1982) thought experiment about *Mary’s Room*. A future brilliant neurophysiologist Mary possesses all physical

7 Nozick, Robert, *Anarchy, State and Utopia* (Blackwell, 1995), 42–45.

8 Searle, John, ‘The Chinese Room’, *The MIT Encyclopedia of the Cognitive Sciences* (1999).

information needed for knowing what is going on when we see colors of all shades. She herself, however, is bound to sit behind a black and white television monitor. Now the question is, What will happen if Mary is given a color television monitor? Jackson's argumentative target is that that she would actually learn something new, namely the *qualia* of the distinct colors:

It seems just obvious that she will learn something about the world and our visual experience of it. But then is it inescapable that her previous knowledge was incomplete. But she had *all* the physical information. *Ergo* there is more to have than that, and Physicalism is false.⁹

In conclusion, our three philosophers do not elaborate thought experiments that are designed to bring forward theoretical hypotheses about contingent physical features of our universe. They rather uncover aspects of reality that cannot be thought away from reality without making reality into something less than it actually is. Remove the world of actively self-engaged persons (Nozick), remove the world of semantic meaning of language (Searle), or remove the world of colors (Jackson), and the world would be different. There would be no human agents engaged with reality, no communication and understanding, no painters and exhibition halls.

Scientific Thought Experiments

Scientific thought experiments presuppose a good deal of background information, too. But if so, how can they reveal anything new about reality? Thomas A. Kuhn formulates the conundrum as follows,

Granting that every successful thought experiment embodies in its design some prior information about the world, that information is not itself at issue in the experiment... How, then, relying exclusively on familiar data, can a thought experiment lead us to new knowledge or to a new understanding of nature?¹⁰

Here philosophers of science disagree. John D. Norton takes a purely empiricist position by viewing thought experiments as nothing but pre-conceived dressed-up arguments. TEs are arguments in disguise – either examples of an inductive reasoning (arguing from the concrete case of imagination to the general case)

9 Jackson, Frank, "Epiphenomenal Qualia." *Philosophical Quarterly* 32:127 (1982), 127–136, 130.

10 Kuhn, Thomas S., "A Function for Thought Experiments." Reprinted in *Ibid.*, *The Essential Tension. Selected Studies in Scientific Tradition and Change* (University of Chicago Press, 1977), 240–65, 241.

or as a purely deductive reasoning, based on prior assumptions of reality tacitly smuggled into the TE:

All thought experiments can be reconstructed as arguments based on tacit or implicit assumptions. Belief in the outcome-conclusion of the thought experiment is justified only insofar as the reconstructed argument can justify the conclusion.¹¹

The problem for this view is that thought experiments can be interpreted differently. Since people are actually arguing about the conclusions of thought experiment, it cannot be the case that thought experiments are nothing but dressed-up arguments. One example is the famous argument about the clock-in-the box, which Albert Einstein figured up at the 1930 Solvay Conference in order to disprove the uncertainty principle as a fundamental, or “complete”, principle in the quantum world. Slip out one photon after the other from the box, controlled by the clock inside the box, then the box as a whole would have slowly yet gradually to lose weight. Initially Niels Bohr had no answer. Reportedly he was depressed and seemingly defeated, until he came back the next day, elatedly arguing that the uncertainty principle would apply also to the fundamental limits to the accuracy of the measurement of photon emissions.¹² One thought experiment, two diverging interpretative arguments!

The question therefore stands, How come that TEs can be cognitively fertile? James R. Brown here stands at the other end of the spectrum, arguing for the view that some TEs indeed do function as telescopes into unknown domains of reality. Brown distinguishes between different forms of thought experiments, some destructive (such as “Schrödinger’s cat”), some constructive (such as the thought experiment of “Maxwell’s demon”, aiming to show the in principle possibility of heat being passed from colder to warmer bodies). Yet Brown also argues for what he dubs “Platonic thought experiments”, which are simultaneously destructive and constructive while relating to general laws of nature, discoverable through thought experiments. A candidate in case is the Einstein-Podolsky-Rosen dilemma which at once aims to show the absurdity of Niels Bohr’s view, and the existence of local hidden variables.¹³ The case also shows,

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- 11 Norton, John D., “Are Thought Experiments Just What You Thought?” *Canadian Journal of Philosophy* 26 (1996), 333–366, 339.
 - 12 Bishop, Michael, “Why Thought Experiments are Not Arguments.” *Philosophy of Science* 66 (1999), 534–41, 535–538.
 - 13 Brown, James R., “Thought Experiments: A Platonic Account”. In *Thought Experiments in Science and Philosophy*, eds. Horowitz, Tamara and Massey, Gerald (Rowman & Littlefield, 1991), 119–128, 124–125.

however, that such thought experiments are neither fallible nor innate, but are of a more conjectural nature,¹⁴ which is why I think that the term “Platonic” is not quite appropriate. What is Platonic, however, is the assumption that laws of nature pre-exist their discovery, but may nonetheless be intimated by human reasoning.

In my view it is important to be aware of the many forms that thought experiments can take in scientific inquiry. Some thought experiments can indeed be tested in crucial physical experiments, such as Galileo’s notable Thought experiment in his *Discorsi from 1638* about two bodies – one light and one heavy – falling down.¹⁵ According to the inherited Aristotelian view, the lighter body would slow down the heavier one when combined, so that the heavy body on its own would fall faster than the two bodies combined ($H > H+L$). In his crucial experiment from the top of the Tower of Pisa, Galileo could show that this is not case. The heavy body and the lighter body and the two combined bodies fall down at the same speed ($H = L = H+L$). The mental imagination of the TE here directly feeds the physical experiment.

This is far from always the case, however. Thought experiments may also achieve their aims apart from physical experiments, contemplating various imagined scenarios each with their own *if-then* logics. The different interpretations of the aforementioned clock-in-the box experiment shows this.

Tamar Szabo Gendler:

I will suggest, in the case of imaginary scenarios that evoke certain sorts of quasi-sensory intuitions, their contemplation may bring us to new beliefs about contingent features of the natural world that are produced not inferentially [as Norton would have it] but quasi-observationally [without claiming to have intuitive access to a Platonic realm of *abstracta*, as Brown would have it]¹⁶.

Gendler mentions quite a few examples from the field of experimental psychology, showing how the human repertoires of emotional response is based on imaginary as well as real situations, due to what Antonio Damasio calls “somatic markers” that elicit particular set of responses. Here the set-up of the psychological experiments needed the conceptual devices of thought experiments. Something similar also applies to disciplines such as economy, where imaginations

14 Ibid., 127.

15 Galilei, Galileo, *Discourse on Two New Sciences*, trans. S. Drake. (University of Wisconsin Press 1974), 66–67.

16 Gendler, Tamar S., “Thought Experiments Rethought—and Reperceived” *Philosophy of Science* 71 (2004), 1152–1163, 1154.

about the perceived interests of buyers and sellers inform not only the theorizing of economists but also the actual economic choices in the market.

Some might argue that such soft thought experimenting only applies to the social sciences but not to physics. However, one would not be able to speak of multiverse theories unless a good deal of practising cosmologist were willing to entertain even very grand scale thought experiments about unobservable universes. In *Our Cosmic Habitat* from 2001 Martin Rees asks the question, “Do unobservable universes exist?” While admitting that no quick answer is forthcoming he concludes: “The question cannot be settled by direct observation, but relevant empirical evidence *can* be sought, which could lead to an answer”¹⁷. At further scrutiny it seems, however, that what Rees actually shows is that there is definitely (only) a theoretical possibility for the search for empirical evidence that *could* be sought, evidence which then *could* lead to an answer. Rees shows, first, that there are always technological limits for telescopes; second, that are limits provided by the speed-of-light horizon that we cannot, according to our best theories, overcome; and third that many galaxies within our universe are unobservable in principle – that is, unless the expansion of the universe turns out to be decelerating rather than accelerating. We are obviously here dealing with a grand-scale scientific TE for which it is not likely that evidence can ever be found in our cosmic epoch. Nonetheless, multiverse theories are part of current physical sciences, fundable both by public research agencies and private foundations.

Theological thought experiments

Let me here bring in my compatriot Søren Kierkegaard as a theologian-philosopher who has used thought experiments extensively also in his theological work. In *Philosophical Fragments* from 1844, Kierkegaard’s pseudonym John Climacus explores what he calls “A project of thought”¹⁸, in which he depicts the distinction between a “teacher” such as Socrates (who wants us to discover the truth in ourselves) and a “saviour” (who gives us truth and love). This is then followed up by a second chapter named “The God as Teacher and Saviour: An Essay of the Imagination”¹⁹ in which Climacus imagines the conditions under which love

17 Rees, Martin, *Our Cosmic Habitat* (Princeton University Press, 2001), 166.

18 Kierkegaard, Søren, *Philosophical Fragments, or A Fragment of Philosophy Johannes by Climacus*, trans. Swenson, David F. and Hong, Howard V. (Princeton University Press, 1962), 11–27.

19 *Ibid.*, 28–45.

between unequals can be exercised. "Suppose then a king who loved a humble maiden."²⁰ The King would know that love cannot be won by might and power. A courtly applause of the depth of his kingly love would not liberate the maiden but rather bind her to obligations of gratitude. The King saw that she might have "been happier had she remained in her obscurity, loved by an equal, content in her humble cottage; but confident in her love, and cheerful early and late."²¹ Similarly with God's love to humanity. Since a union of love

could not be brought about by an elevation it must be attempted by a descent.... In order that the union may be brought about, the God must therefore become the equal of such a one, and so he will appear in the likeness of the humblest. But the humblest is one who must serve others, and the God will therefore appear in the form of a *servant*.²²

This is no doubt an apologetic TE which aims to explore the logic of incarnation as based on the logic of love known from human conditions. Even for Kierkegaard, incarnation is more than a paradox, since it's required by the nature of divine self-giving love. Penetrating as it is, this TE falls within John D. Norton's view of TEs as dressed-up analogical arguments. The question is whether we can find other examples of theological thought experiments that would rather be like James Brown's telescopic exploration of unknown terrains.

One such example is theological discussions of the possibility of extraterrestrial intelligence (ETI). We are here not dealing with counterfactuals but rather about possible scenarios. Science itself is concerned with the possibility of ETI, as can be seen from established science journals such as *International Journal of Astrobiology*, published by Cambridge University Press. In the same vein, theology and the human sciences may elaborate TEs about the different possible scenarios:

1. Imagine we were alone? What a rare planet we would inhabit!
2. Imagine we were not alone, but other intelligent civilizations are less developed than we are? What a rare species we would be!
3. But now imagine that we were not alone, but other intelligent civilizations are more progressed than we! Here new scenarios would show up:
 - 3.1 Imagine they were more intelligent than us, but also evil (as in the 1996 science fiction movie, *Independence Day*)? This would seriously challenge the assumptions of a secular humanism that presupposes that intelligent "brights" can make us into the better persons.

20 Ibid., 32.

21 Ibid., 33

22 Ibid., 39

- 3.2 Imagine they were less intelligent yet more virtuous than we (as in the 2009 science fiction movie, *Avatar*)? In this case, our understanding of the central place of humanity in the cosmos would be seriously challenged.
- 3.3 Imagine, finally, that they were both more intelligent and truth-seeking than we are, and also more virtuous and beauty-oriented than we, *but have no sense of religion*. My assumption is that this scenario would be serious challenge to those forms of religion (like my own) that see the religious sense as intrinsically linked up with the meaning of truth-seeking, of moral sense, and of beauty. Indeed, on this scenario religion may easily be seen as nothing but an idle ornamentation of otherwise rational, moral and aesthetic values (or, alternatively, that humans are elected to be cosmic missionaries).

Any ETI-scenario, scientific or theological, is inevitably speculative. Yet explorative TEs of this kind are nonetheless of cognitive value, insofar as they explore the logic of the different situations that humanists as well as religionists would be placed in, given this or that future scenario, predicted by scientific theory. Outstanding theologians of the last generations, such as John Hick and Wolfhart Pannenberg, spoke of the possibility of an “eschatological verification”. However, according to the TEs described above, *philosophical as well as theological anthropologies would be empirically testable within a this-worldly and limited time-horizon*, although empirically validated views about ETIs are not likely to be available in the nearest future.

In the meantime, however, the above mentioned TEs serve the more mundane but not less important task of exploring the *attitudes* and *beliefs* that philosophers and theologians take to their own species, and their own humanistic and religious commitment, already within the present time horizon. We are here coming full circle back to the observation of Tamar Gendler²³ that imaginary scenarios in fact may evoke some “quasi-sensory intuitions” that eventually will bring us to “new beliefs” of contingent features of the natural world, even if only in conjectural modes of reasoning.

23 Gendler, “Thought Experiments Rethought—and Reperceived”, 1154.

J. Wentzel van Huyssteen

A Postfoundationalist Approach to Theology and Science

Introduction: The Task of Public Theology

I have always, first in my earliest work on methodology, then later in my work on epistemology, rationality and hermeneutics, and finally in my more recent work in theology, science, and theological anthropology, seen my own work as fundamentally defined by its interdisciplinary nature: a theology on a journey, if you will, to find its public voice. In this sense I have argued quite specifically for a *public theology*: a theology that can and should claim the right to a democratic presence in the interdisciplinary, political and cross-contextual conversation that constitutes our public discourse, including the discourse in the secular academy.¹ In this form of public inquiry I see the church, or rather specifically, contextualized churches, as the natural context, but not the only context for theological inquiry.²

More specifically, I have argued that our interdisciplinary reflection and the specialized forms of knowing it presupposes in reasoning strategies like theology and the sciences, differ from other ways of knowing and every day knowing only in degree and emphasis. All our knowing is grounded in embodied, interpreted experience and is accountable to many layers of interpreted experience, and the adequacy of this accountability is subject to rational justification as justification through interpersonal expertise. These problem solving judgments apply to both theology and the sciences as we use the same kinds of interpretative and evaluative procedures to, broadly, understand nature, humans, and the social historical, and religious aspects of our lives. And in this fact is found the deepest epistemological and hermeneutical reasons why theology by its very nature should be seen as public theology.

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- 1 Brown, Delwin, "Public Theology, Academic Theology: Wentzel van Huyssteen and the Nature of Theological Rationality," *American Journal of Theology and Philosophy* Vol. 22, No. 1 (2001), 88–101, 88–89.
 - 2 van Huyssteen, J. Wentzel, "What Makes Us Human? The Interdisciplinary Challenge to Theological Anthropology and Christology," *Toronto Journal of Theology* Vol. 26, No. 2 (2010), 143–160.

As a way of facilitating this kind of cross-disciplinary dialogue I have argued for a *postfoundationalist* approach to interdisciplinary dialogue, which implies three important moves for theological reflection. *First*, as theologians we should acknowledge the radical contextuality of all our intellectual work, the epistemically crucial role of interpreted experience, and the way that disciplinary traditions shape the values that inform our reflection about God and what we believe to be God's presence in the world. *Second*, a postfoundationalist notion of rationality should open our eyes to an epistemic obligation that points beyond the boundaries of our own discipline, our local communities, groups, or cultures, toward plausible forms of interdisciplinary dialogue.³ Against this background I have argued for distinct and important differences between reasoning strategies used by theologians and scientists. I have also, argued, however, that some important shared rational resources may actually be identified for these very different cognitive domains of our mental lives.⁴ *Thirdly*, it is precisely these shared rational resources that enable interdisciplinary dialogue, and are expressed most clearly by the notion of *transversal rationality*. In the dialogue between theology and other disciplines, transversal reasoning promotes different, non-hierarchical but equally legitimate ways of viewing specific topics, problems, traditions, or disciplines, and creates the kind of space where different voices need not always be in contradiction, or in danger of assimilating one another, but are in fact dynamically interactive with one another. This notion of transversality thus provides a philosophical window to our wider world of communication through thought and action,⁵ and challenges us to construct bridge theories between disciplines, while respecting the disciplinary integrity of reasoning strategies as different as theology and the sciences. In this way an interdisciplinary approach, carefully thought through, can help us to identify these shared resources in different modes of knowledge so as to reach beyond the boundaries of our own traditional disciplines in cross-contextual, cross-disciplinary conversation. It can also enable us, as will become clear, to identify possible shared conceptual problems as we negotiate the porous boundaries of our different disciplines.

3 cf. van Huyssteen, J. Wentzel, *The Shaping of Rationality: Toward Interdisciplinarity in Theology and Science* (Eerdmans, 1999).

4 van Huyssteen, J. Wentzel, *Alone in the World? Human Uniqueness in Science and Theology* (Eerdmans, 2006).

5 Schrag, Calvin, *The Resources of Rationality: A Response to the Postmodern Challenge* (Indiana University Press, 1992), 148ff; and Welsch, Wolfgang, *Vernunft: Die Zeitgenössische Vernunftkritik und das Konzept der transversalen Vernunft* (Suhrkamp Taschenbuch, 1996), 764ff.

1. Evolutionary Epistemology

In this first section I would like to show why transversal reasoning finds a natural home in postfoundationalism, and then why postfoundationalism is necessarily embedded in evolutionary epistemology. This will reveal, if one reverses this reasoning, why evolutionary epistemology creates a natural space for postfoundationalism, and why the performative praxis of inderdisciplinary, postfoundationalist reflection is found in transversal reasoning.

If we take the evolution of human cognition seriously, we quickly realize that even theological reflection is radically shaped by the enduring influence of its own traditions, and therefore by its social, historical, and cultural embeddedness. However, this would imply that theology, and theological reflection and knowledge, is not only shaped by cultural evolution, but is also definitively shaped by the deeper biological roots of human rationality. This is precisely the point made by evolutionary epistemology: like all living beings we humans have resulted from evolutionary processes and consequently, our mental capacities are constrained and shaped by the mechanisms of biological evolution.

On this view, all evolutionary epistemologists agree that the theory of evolution in essence is a theory of knowledge precisely because the process of evolution is the principal provider of the organization of all living things and their adaptations. Evolution thus turns out to be about much more than the 'origin of species' and is revealed as a much richer process that has shaped the way our minds work, and how we know the world. As such, evolutionary epistemology highlights both the deeply embodied and the fallibilist nature of all human knowledge, and explains that there are advances and growth in human knowledge, but that this 'progress' is not necessarily an increase in the accuracy of depiction, or an increase in the certainty of what we know. This view is strengthened by the conviction that human cognition is a crucial bridge between biology and culture, between biological evolution and cultural evolution.

On this view, all evolutionary epistemologists are 'hypothetical realists' as far as biological evolution is concerned. Our biology suggests that our rational powers of abstraction and our ability to know the world through distinct expectations and interpretation are the result of natural selection. The hypothetical realist approach of evolutionary epistemology thus implies that our embodied cognitive apparatus is adaptive, and that our knowledge of the world around us consists of proposals made to this environment. On this evolutionary epistemological view knowledge is thus revealed as an interactive relationship between an embodied knower and something/someone that is known. Moreover, I would argue that here cognition/knowledge is revealed as a complex interactive process

of expectation, interpretation, and explanation. This is why at a cultural and philosophical level, evolutionary epistemologists would want to reveal extreme forms of nonfoundationalism or antirealism as *epistemic narcissism*, because they would have us believe that knowledge is not a relation between a knower and what is known, but a narcissistic, inward reflection disconnected from those aspects of the world we are claiming knowledge of.⁶

From a philosophy of science perspective scholars often, and correctly I would argue, see evolutionary epistemology as an important, but somewhat neglected reaction to the failure of logical positivism. Positivism is widely seen today as failing to account for the growth of human knowledge, for major shifts in the history of science (like the shift from Newtonian physics to Einstein's general relativity), in the history of theology (like the dramatic shift from Medieval scholastics to the Reformation), or general paradigm shifts in cultural history (for instance, from modernity to postmodernity, etc.). What is often ignored, however, is the fact that there occurred two very different and competing moves away from positivistic philosophy of science: one move was toward Wittgenstein's philosophy of language games and Thomas Kuhn's now famous theory of paradigms; the other was toward Karl Popper's evolutionary epistemology and the all-important injection of Darwinism into philosophy/philosophy of science. Thus, in addition to the acknowledgement of the theory-ladenness and paradigm dependency of knowledge in the first instance, evolutionary epistemology seeks to explain the knowledge we have as an extension of the adaptive evolutionary process that began millions of years ago. I would argue that *both* these very important reactions to positivist views of human knowledge, in very different ways, opened our eyes to the interpretative, hermeneutical dimension of all knowledge. It should, therefore, not be surprising that in contemporary postfoundationalist views of knowledge, hermeneutics and epistemology would powerfully merge.

The interactionist nature of all human knowledge, because of its deep biological history, thus emerges as a deeply embodied knowledge. And through our language abilities we have created cultures and a vast body of knowledge: these can be seen as evolutionary artifacts that enable us to benefit from the trials and errors of our ancestors. Or, as some evolutionary epistemologists would put it: with the arrival of *Homo sapiens* human evolution became the evolution of this embodied knowledge. On this more embodied, holistic view of human knowledge, not only are narrowly conceived notions of reason or rationality included, but also human consciousness becomes more richly redefined in terms

6 van Huyssteen, *Alone*, 75–106.

of feelings, emotions, instinct and intelligence. Thus one of evolutionary epistemology's most valuable contributions to notions of biological and cultural evolution becomes clear: once embodied intelligence evolved in our species, our self-conscious brains achieved a causal force equal to that of our genes.

What evolutionary epistemology shows us, finally, is that we humans can indeed take on cognitive goals and ideals that cannot be explained or justified in terms of survival-promotion or reproductive advantage only. Therefore, once the capacities for rational knowledge, moral sensibility, aesthetic appreciation of beauty, and the propensity for religious belief have emerged in our biological history, they cannot be explained only in biological/evolutionary terms. In this sense we clearly transcend our biological origins, and do have the ability to transcend what is given to us both in biology and culture. As British philosopher Anthony O'Hear strikingly puts it: we are prisoners neither of our genes, nor of the ideas we encounter as we make our way through the world.⁷

2. Postfoundationalism in Theology and Philosophy

Against the background of these all-important epistemological and hermeneutical pointers from evolutionary epistemology, I have argued for a postfoundationalist approach for understanding not only the nature of theological cognition/knowledge, but also for understanding our methodology for doing theology.

Crucial to any theory of postfoundationalist rationality is a theory of experience that will enable us to reason adequately about the rich variations and facets of our human experience. For the postfoundationalist, human experience is embodied, embedded in, and filtered through complex networks of belief. Because of this all our radically contextual experiences have a deep hermeneutical dimension precisely because we relate cognitively to the world, and to one another, in terms of interpreted experience. It is the complex interpretation of all experience (hermeneutics) in terms of networks of beliefs we already hold even as we critically evaluate them (epistemology), that not only fuses hermeneutics and epistemology in the way we know the world, but which also is reminiscent of the structure of the evolutionary history of all human cognition (evolutionary epistemology). It is in this sense that evolutionary epistemology, now on a cultural and philosophical level, creates a natural epistemic space for a postfoundationalist approach to human cognition.

7 O'Hear, Anthony, *Beyond Evolution: Human Nature and the Limits of Evolutionary Explanation* (Clarendon, 2002), vii.

Against this background I have argued that on a theological level a postfoundationalist approach frees us from epistemic narcissism and epistemological tribalism, and allows theology to become *public, interdisciplinary theology*. Although our epistemologies, as well as our standards for rationality, are always contextually shaped, they are not hopelessly culture-bound. This ultimately allows for the public voice of theology, even as it protects the rational integrity of theology as a reasoning strategy while at the same time allowing for the identification of overlapping issues, shared problems, and even parallel research trajectories in disciplines as different as theology and the sciences.

On this view, then, theology is neither transformed, modernistically, into natural science nor rejected as nonscience. In fact, theology emerges as a reasoning strategy on par with the intellectual integrity and legitimacy of the natural, social, and human sciences, even as it defines its own powerful domain of thought that in so many ways are also distinct from that of the sciences. Because of this, we theologians should be able to enter the pluralist, interdisciplinary conversation with our full personal convictions intact while at the same time we are empowered to step beyond the limits and boundaries of our own contexts and traditions. A postfoundationalist approach thus allows us to explore freely and critically the experiential and interpretive roots of our beliefs from within our deep commitments to contexts and traditions, and to discover patterns in our lives and thought that might be consonant with what we regard as the canon(s) of our respective religious/theological traditions. The persuasiveness of these patterns should be taken up in critical theological reflection, where their problem-solving ability should then be evaluated and judged in an interpersonal and cross-contextual conversation.

Finally, rationality itself can now be seen as a skill that enables us to gather and bind together the patterns of our interpreted experience through rhetoric, articulation and discernment. It is on exactly this point that the important postfoundationalist notion of *transversal reasoning* replaces modernist, static notions of universality in a distinct move to see human reason as dynamic and practical in the way we use it to communicate with one another. In *The Shaping of Rationality* I argued for the 'transversal performance' of rationality precisely when referring to this dynamic and multi-leveled interaction of our discourses with one another.⁸ The notion of transversality thus emerges as a heuristic device, a way to describe what actually happens in the performative praxis of our reasoning. As such it is helpful for highlighting the human dynamics of consciousness that enables us to

8 van Huyssteen, *The Shaping*, 135–139 and 247–250.

move between domains of intelligence with a high degree of cognitive fluidity, and as such it is at the heart of my notion of interdisciplinary reflection.

3. Transversal Rationality

A postfoundationalist view of transversal reasoning thus is a distinct move away from the domination of reason and from hierarchical ways of structuring different disciplines and reasoning strategies. Transversal reasoning is also a move away from static notions of rationality to the dynamic pluralization of our ability to reason. Here the axis of reason is rotated from verticality to horizontality, and embodied human reasoning now becomes a dynamic faculty of performative transitions that interconnect various strategies of rationality in our interpersonal and interdisciplinary communication. Transversality enables us to see that different forms of human reasoning are often irreducible but at the same time also non-hierarchical, and as such, highlight important differences between various domains of rationality. On a postfoundationalist view, transversal reasoning, therefore, has direct and important implications: it allows for the emergence of paradigmatic interdisciplinary networks and opens up the possibility that different disciplines, although never fully integrated, can learn from one another and actually benefit by appropriating insights presented in interdisciplinary dialogue.

As such transversality or transversal reasoning is rationality in movement, the dynamic movement of both our everyday and academic discourses. Transversal reasoning now emerges as a performative skill which is dynamically realized in the praxis of these interactive communicative processes. As an achievement of communicative praxis transversal reasoning is at the same time fused with our embodied consciousness and self-awareness, and as such it is the communicative space where our multiple beliefs and practices, our habits of thought and attitudes, our prejudices and assessments, converge. Importantly, the performative praxis of transversal reasoning is not only *discursive* (through language and conversation), but also occurs *non-discursively* beyond the realm of language and the spoken word. Therefore, as there is a time and space for conversation and discourse, so there also is a time and space of action, of mood, of desire, and our experiences as 'events of interpretation' are again always situated temporally and spatially.⁹

In rethinking interdisciplinary discourse as a form of transversal reasoning, human reasoning emerges as a practical skill that enables us to gather and bind

9 Ibid., *The Shaping*, 111ff.

together the patterns of our daily experiences and make sense of them through communal, interactive dialogue. This reveals much about the nature of interdisciplinarity itself as we learn that the dialogue between the partners of different discourses, like theology and the sciences, are often asymmetrical in the sense of focusing on radically different objects of study, and using different explanatory and interpretative strategies. As a result interdisciplinary dialogue has its own set of strengths and weaknesses, possibilities and limitations. It is against this background that I have argued that a multidisciplinary conversation can actually lead to true interdisciplinary results if the guidelines for a postfoundationalist approach are mutually honored. We should also know, however, that the interdisciplinary dialogue between theology and science (like all forms of communicative praxis) can break down if a certain point of no return is reached. When science claims a reductionist, scientific world view as the only valid view, theology as a research strategy is by definition explained away and all possibility of further interdisciplinary communication ceases. But with theology it is even more complex: interdisciplinary dialogue ceases to exist when over-particularist theologies retreat quite consciously from interdisciplinary dialogue, but also when theology leaves behind the particularity of its own tradition(s) in favor of an abstract, generic religious metaphysics.

In the interdisciplinary conversation between theology and the sciences the boundaries between our disciplines and reasoning strategies are indeed porous, but that does not mean that deep theological convictions can be easily or uncritically transferred to philosophy, or to science, to function there as 'data' in foreign systems. In the same manner, transversal reasoning does not mean that scientific data, paradigms, or world views can be uncritically transported across disciplinary boundaries into theology to there set the agenda, as it were, for theological reasoning. Transversal reasoning means that we also have to be alert to *degrees of transversality*, and that different theological approaches could have different degrees of success in interdisciplinary dialogue. Most importantly, though, theology and the sciences can share concerns, can indeed converge in their methodological approaches on specifically identified problems. But precisely by also recognizing the limitations of interdisciplinarity, the disciplinary integrity of theology, and of the sciences, will be honored.

4. Continuity and Change in Research Traditions

On this view it now quickly becomes clear that there are no easy 'blue prints' available today for 'doing science and theology'. In fact, postfoundationalist

theology, like science, relies on a community, a community that converses with itself but also seeks to engage it dialogue across disciplines because of the relational resources that these various research strategies share. In this way a door is opened for seeing *problemsolving* as a central activity of research traditions. And as philosopher of science Larry Laudan has argued, one of the most important shared rational resources between even widely divergent disciplines is problem-solving as the most central and defining activity of all research traditions.¹⁰ And as will be come clear, the very diverse reasoning strategies of theology and the sciences clearly overlap in their shared quests for intelligible problemsolving, including problem-solving on an empirical, experiential, or conceptual level.

As an important step beyond any universalist and generic notions of rationality, I have argued for developing a postfoundationalist notion of rationality where a rational agents situated in the rich, narrative texture of our own social practices and traditions, our self-awareness and our self-conceptions are not only intrinsically embedded in our own embodied rationality, but are indeed indispensable starting points for an account of the values that shape human rationality. This explains why in theology, as well as in the sciences, our traditions, paradigms, and worldviews, like all other traditions, are historical creatures. The identity and integrity of any tradition is preserved in what we may call its heart or canon, which normally functions as an authoritative narrative and conceptual framework that shapes and molds continuity and change in traditions as lived realities. And as historical creatures, also our intellectual traditions can wax and wane. Larry Laudan has convincingly pointed out that Thomas Kuhn's famous notion of a radical paradigm shift or conceptual 'conversion' or 'revolution' from one paradigm to another, can most probably rather be seen as a natural evolution within and between research traditions. Traditions, therefore, not only imply ongoing change and evolution, but also exhibit continuity. Precisely continuity and change, then, should be seen as the primary categories of any adequate theory of traditions.¹¹

To understand what continuity and change might mean in the dynamics of evolving traditions, Larry Laudan, like Imre Lakatos, suggests that certain elements of a research tradition are sacrosanct and can therefore not be rejected without a repudiation of the tradition itself. Unlike Lakatos, however, Laudan

10 cf. Laudan, Larry, *Progress and its Problems: Toward a Theory of Scientific Growth* (University of California Press, 1977), 190ff; and van Huyssteen, *Theology and the Justification of Faith: Constructing Theories in Systematic Theology* (Eerdmans, 1989), 172–189; and *Ibid.*, *The Shaping*, 164ff.

11 cf. Laudan, *Progress*, 77ff.

insists that what is normally seen as sacrosanct in traditions can actually change with time. From recognizing that the canonical core of traditions can actually shift and change through time, Laudan can then conclude that by relativizing the 'essence' or core of a research tradition with respect to place and time, we actually come closer to capturing the way that scientists and historians of science have used the concept of tradition.¹² For me this not only reveals again the radical historical nature of all traditions, but also that intellectual revolutions do not necessary take place through complete conceptual shifts, but rather occur through the ongoing transversal and interdisciplinary integration and grafting of (research) traditions.

On a postfoundationalist view, then, and because we are deeply embedded in the history of our times, our research traditions in a sense constitute the present and finally explain why we relate to our world epistemically through the mediation of interpreted experience. Our intellectual traditions are therefore dynamic, evolving phenomena, that live precisely in the dialectic of continuity and change. And like cultural traditions, research traditions are rarely, if ever, isolated from one another, because the borders separating traditions from their milieus and from other traditions are always exceedingly porous.¹³ This makes continuity and change in traditions even more intelligible: all traditions, as we have seen, have sacrosanct elements that, even if they shift and change over time, form the canons of these traditions and ultimately define their identity. It is these core canons of traditions that ultimately serve as the sources of creativity as well as the principles of identities of traditions.

This postfoundationalist view of rationality and the way it reveals the structure and functions of traditions, clearly have important consequences for theological reflection. It also shows why any uncritical retreat to a fideist commitment to a specific tradition and its canon(s), would seriously jeopardize the epistemic status of theological reflection as a credible partner in a pluralist, interdisciplinary conversation. Within a fideist context all commitment and religious faith seem to be irrevocably arbitrary. However, the most serious limitation to any fideist epistemology would be its complete inability to explain why we choose certain viewpoints, certain networks of belief, and certain traditions over others. Surely there must be more to religious commitment, and to using theological language, than to just understanding and adopting the internal working of some

12 cf. Ibid., *Progress*, 99f.

13 cf. Brown, Delwin, *Boundaries of our Habitations: Tradition and Theological Construction* (State University of New York Press, 1994), 26f.

specialized linguistic system that is not answerable to anything or anybody outside itself.¹⁴

5. Problem-solving and Progressive Theory Choice as the Hallmark of a Postfoundationalist Theology

The kind of epistemological fallibilism that naturally follows from a postfoundationalist approach to interdisciplinary theology will, therefore, not result in that one, ideal modernist knowledge system for systematic theology or for research programs in theology and science. Instead of the one perfect representation of God, or of the world, or of God's relation to the world, however, it may yield for us a collage of knowledge claims that aims to be the most adequate, the most reliable, and, for now, the most meaningful we can claim in certain specific contexts. However, the fact that there are no longer any pre-set, foundationalist, universal, cross-cultural or interreligious rules for science or for theology does not necessarily mean that all our criteria for good reliable knowledge are now always going to be only strictly local or exclusively contextual. In Delwin Brown's words: if none of our criteria were to be acceptable beyond the boundaries of a specific research tradition, then the giving of rational reasons beyond the boundaries of any tradition would be impossible.¹⁵

The crucial problem for a theology located in interdisciplinary conversation therefore remains the following: is it at all possible to make sensible and rational choices between different viewpoints and alternative, competing research traditions? At this point Larry Laudan's admonitions to scientists and theologians again comes to mind: unless we can somehow articulate criteria for choice between diverse research traditions, we neither have a theory of rationality nor a theory of what progressive growth in knowledge should look like.¹⁶ In theology, as in other forms of inquiry, providing warrants for our views thus becomes a cross-contextual obligation.¹⁷

Remarkable parallels are now surfacing here between theology and other modes of knowledge. A good example is again found in reasoning strategies as different as theology and the sciences: in both we are called to trust our traditions

14 cf. van Huyssteen, *Alone*, 28f.

15 cf. Brown, *Boundaries*, 6.

16 cf. Laudan, *Progress*, 106.

17 cf. Brown, *Boundaries*, 6f.

as we reach out beyond them in interdisciplinary conversation.¹⁸ In both theology and the sciences we should be able to identify some criteria to warrant our theory choices, and neither scientific nor theological knowledge can ever claim demonstrably certain foundations for making these choices. Epistemic similarities between theology and the sciences do not mean, of course, that scientific knowledge is 'just like' theology, but they do mean that methods in science do not provide us with a uniquely rational and objective way of discovering truth. In both theology and the sciences good arguments should therefore be offered for or against theory choice, or for or against the problem-solving ability of a specific research-program. Obviously, our good arguments and our value judgments rest on broader assumptions and deeper commitments which can always again be challenged. This does not mean, however, that any opinion is as good as any other, or that we can never critically compare radically different points of view. What all of this does mean, however, is that we certainly seem to be in need of a more comprehensive epistemological program, which can facilitate and create an interdisciplinary space that would not be totalizing in any reductionist sense of the word.

This kind of postfoundationalist challenge always to critique our own assumptions certainly means that there are no universal standards of rationality against which we can measure all other beliefs or research traditions. But sharing our views and judgements with those inside and outside our epistemic communities could therefore lead to a real conversation, which we should enter not just to persuade, but also to learn from. Such a style of inquiry can provide a way of thinking about rationality that respects authentic pluralism and a healthy openness for different convictions and opinions: it will not force us all to share the same assumptions of commitments, but it will find ways in which we can talk with one another and criticize even our own traditions while standing in them.

Problem-solving and progressive theory choice, therefore, goes together closely in a post-foundationalist theology. Implied in this claim is one of the most important criteria for 'good theology': through our theological statements we should be able critically to identify and analyze real problems, and to construct theories that might provide valid and adequate solutions to those problems.¹⁹ This not only includes a critical analysis of the process of theorizing in interdisciplinary theology, but also challenges the theologian to think anew about the following questions:

18 van Huyssteen, J. Wentzel, *Duet or Duel?: Theology and Science in a Postmodern World* (Trinity Press International, 1998), 28ff.

19 van Huyssteen, *Theology*, 172ff.

- What would qualify as a problem in interdisciplinary theology?
- What constitutes a shared interdisciplinary problem in theology and the sciences?
- What is it that sometimes makes one problem more important than another problem in interdisciplinary reflection?
- How would scientific problems be similar and different from problems in theology?
- What constitutes problem-solving in interdisciplinary theology?
- What criteria would be valid for a converging process of problem-solving in theology and the sciences?
- How are interpretative styles of problem-solving in theology similar or different from explanatory styles of problem-solving in the sciences?

In contemporary philosophy of science Larry Laudan in particular has offered a model for scientific problem-solving, progress, and rationality, that has proven to provide important links to problem-solving in theological reflection, and thus – by implication – would be valuable in our thinking through the issue of problem-solving in interdisciplinary theology. Like Thomas Kuhn, Laudan has sought to demonstrate that important nonempirical, even non-scientific factors play a key role in rational development. Similarly to Kuhn, Laudan has argued that the rationality and ultimate progressiveness of a specific theory are closely related, not in terms of a positivist notion of justification, or even a Popperian notion of falsification, but rather in its capacity for effective problem-solving in a given context. Different from Kuhn, Laudan points out that scientific progress is not so much only a matter of problem-solving in specific theories, but also the potential for scientific progress and the growth of knowledge in global theories, which he has specifically called research traditions.²⁰

Laudan has also argued, as is well-known, that scientific theories have to cope with mainly two kinds of problems, and he states explicitly that this model might also be applied to theological reflection. I have taken up this distinction within the wider scope of a postfoundationalist notion of rationality and revised it as now including interdisciplinary problems.²¹ These two types of problems we can now identify as *empirical* and *conceptual* problems,²² and these concepts finally get us to Laudan's definition of intellectual (scientific and theological) progress: for science it means that scientific progress is the solving of empirical problems,

20 cf. Laudan, *Progress*, 70ff.

21 van Hussteen, *The Shaping*; and *Ibid.*, *Alone*.

22 cf. Laudan, *Progress*, 910f.

and the transformation of unsolved problems into ones that have been solved as effectually as possible.²³ When Laudan, however, states, that “determinations of truth and falsity are irrelevant to the acceptability or the pursuitability of theories or research traditions,”²⁴ a broadly anti-realist approach shines through that seems to negate the possible ontological status of theoretic entities in science in general. In all fairness, however, and important for the constructions of theories in theology, Laudan does suggest that his problem for progressive problem-solving does not in principle exclude the possibility that scientific theories might be true, or might even be advancing toward the truth.²⁵ What he wishes to avoid, however, is some utopian nearer-to-the-truth ideal which is in any event not scientifically ascertainable.

On exactly this point I think theology has much to learn in thinking more pragmatically about the concrete capacity of theories for finding adequate and meaningful solutions for interdisciplinary problems, instead of obsessing about truth claims *per se*. This does not take away at all from the fact that we have good reasons to believe in the constructive and progressive quality of the statements in interdisciplinary theology. From a postfoundationalist viewpoint this means finding the best available interdisciplinary reasons for making the most progressive theory choices, and thus guaranteeing a theory of intellectual growth. As to the reality of what we are referring to in our theory choices on a postfoundationalist view, in developing a criterion for progress, we will in principle have to leave room for tentative, critical or hypothetical references to the reality status of that in regard to which we believe our problems are solved progressively.

As regards the status of problems in interdisciplinary problems, an empirical problem might be anything that strikes us as unusual, and thus as calling for an explanation within, first the Christian paradigm, and secondly, within an interdisciplinary research paradigm. I have argued that the following might be identified as examples of empirical problems for interdisciplinary theology: the reality of evil or sin, the meaning of suffering of death in the light of faith in a good, loving God, the experiential basis of faith and the problems it causes in questioning the presence and action of God in daily life, ethical and sociopolitical questions, etc.²⁶ A second problem, however, is as important as empirical ones for the advancement of interdisciplinary reflection in theology and science: this type of problem has already been identified by Kuhn, but has been developed further

23 cf. *Ibid.*, *Progress*, 120.

24 *Ibid.*, *Progress*, 120.

25 cf. *Ibid.*, *Progress*, 126.

26 van Huyssteen, *Theology*, 175.

by Laudan as *conceptual problems*, problems with the specific aim of providing a broader and richer theory of problem-solving than the merely empirical. Insight into these kinds of interdisciplinary problems arise specifically on a conceptual level as a result of interdisciplinary interaction between divergent and especially conflicting theories. Clearly the broad spectrum of issues dealt with in the current theology and science dialogue is a classic example of these kinds of conceptual problems.

In conclusion, Laudan has also further refined his notion of conceptual problems by helpfully making a further distinction between *internal conceptual problems*, which arise from apparent inconsistencies or ambiguities within a particular theory, and *external conceptual problems*, which may arise from direct philosophical conflicts between two theories (the most notorious example being the ongoing conflict between Darwinian evolution by natural selection, and 'biblical theories of creation'). These broader problems may have scientific, philosophical, ideological, methodological, or specifically religious/theological causes. Laudan's useful distinction between internal and external conceptual problems would in my view need even further refinement, in the sense that what normally could be defined as an empirical problem in theology often hides a more profound conceptual or ideological problem; and what may appear to be internal conceptual problems often reveal more profound external conceptual problems.²⁷ This gets us as close as we can get to a definition of 'intellectual progress' in postfoundationalist, interdisciplinary theology: in the progressive and constructive quality of interdisciplinary theories it will be the solving, however provisionally, of empirical and conceptual problems that will be at the heart of a model for advancement or 'progress' in interdisciplinary theology. We may also put it as follows: in interdisciplinary theology too a theory gains if it can offer provisional solutions to empirical problems; but it loses if it raises more conceptual problems.

Importantly, then, Laudan has argued persuasively that scientific and other problems are not all that different, and that the differences are often not a difference in kind, but largely a matter of degree. In fact, he has shown that his perspective in scientific problems could, with a few qualifications, be applied to all forms of intellectual problems.²⁸ I have now argued that, on a distinctly postfoundationalist view, this would mean that the focus now is on the analysis of *problems* as the true focus of scientific as well as theological thought. Theories

27 van Huyssteen, *Theology*, 176.

28 Laudan, *Progress*, 13.

in theology and in science, then, are important only in so far as they offer adequate solutions for real problems. On an interdisciplinary level this means that if problems constitute the real questions of science (and of theology), then it is theories (and in theology, theories and doctrines) which constitute the answers or solutions.

For theologians this means that we have to learn to identify real problems that arise out of religious and spiritual experience, and intellectual problems that emerge out of a reflection on these problems. This implies a deeply liberating move for theological reflection: by reclaiming a broader postfoundationalist notion of rationality, theologians are now freed from reductionist models of rationality. Instead of having to ask whether a given theory is provable, correct, justified or true, we can now first ask whether a theory offers adequate solutions to meaningful, real problems in concrete situations.

Willem B. Drees

Insiders and Outsiders in 'Religion and Science'

Places and Perspectives

Ian Barbour's *Issues in Science and Theology* and the founding of *Zygon: Journal of Religion and Science* by Ralph W. Burhoe and others (both in 1966) might be taken to mark the beginning of contemporary scholarly discussions on 'theology and science' in America. Today in the USA there are many activities, among which the Center for Theology and the Natural Sciences in Berkeley, with the recently endowed Ian Barbour chair held by Robert J. Russell, the Zygon Center for Religion and Science, at the Lutheran School of Theology in Chicago, and the James McCord chair in Princeton (Wentzel van Huyssteen). In recent decades many more initiatives have been encouraged by funds from the John Templeton Foundation and other sponsors. As in any intellectual engagement, the commitment of dedicated individuals has been of major importance, and among these Robert J. Russell¹ (Berkeley), and Philip Hefner² (Chicago) deserve special recognition.

In the United Kingdom there is also substantial interest in 'theology and science'. Major voices have been Arthur Peacocke³ and John Polkinghorne,⁴ both scientists who have become theologians. In 1994 a lectureship in Cambridge, endowed by the novelist Susan Howatch of the Starbridge novels, was filled by Fraser Watts. Andreas Idreos endowed a chair in Oxford, to which John Hedley Brooke was appointed in 1999. These and other initiatives such as the textbook by Christopher Southgate and colleagues⁵ strengthened the field in the UK.

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- 1 Russell, Robert J., *Time in Eternity: Pannenberg, Physics and Eschatology in Creative Mutual Interaction* (University of Notre Dame Press, 2012).
 - 2 Hefner, Philip, *The Human Factor: Evolution, Culture, and Religion* (Fortress, 1993).
 - 3 Peacocke, Arthur, *Creation and the World of Science. The Bampton Lectures, 1978* (Clarendon Press, 1979).
 - 4 Polkinghorne, John, *Science and Christian Belief: Theological Reflections of a Bottom-Up Thinker* (SPCK, 1994).
 - 5 Southgate, Christopher et al., *God, Humanity and the Cosmos. A Textbook in Science and Religion* (T&T Clark, 1999).

In continental Western Europe developments have been different. Around the time Ian Barbour's first major book was published and the journal *Zygon* was founded, there was in the largest Protestant Church in the Netherlands a working group on faith and science. In the resulting volumes⁶ the conclusion was that there wasn't much to be discussed as long as proper boundaries and fundamental differences were respected. Under the influence of Karl Barth and the Dutch theologian K.H. (Heiko) Miskotte, the orientation of theology was understood to be different from the issues addressed by science. This Dutch example might have been fairly typical of Protestant circles in the north-west of Europe in that period. In recent decades interest in interactions of theology and science has been revived, partly under the influence of American and British literature and initiatives. European Conferences on Science and Theology have been held every two years since 1986.⁷ ESSSAT, the European Society for the Study of Science And Theology, was founded in 1990. In the universities, we have not seen the creation of dedicated chairs, but rather the use of existing positions in theology or philosophy of religion to focus on the interactions with the sciences; Michael Welker in Heidelberg, Niels Henrik Gregersen in Copenhagen, Günther Thomas in Bochum, Dirk Evers in Halle, and my own chair in Leiden being examples of such arrangements.

In Germany there was an older tradition with the work of the FEST, the Forschungsstätte der Evangelische Studiengemeinschaft, founded in 1957 in Heidelberg. In later decades the FEST provided a home for contributions to 'religion and science' by Jürgen Hübner and others.⁸ There was a major interest in the epistemological consequences of quantum physics (e.g., Günther Howe, Carl Friedrich von Weizsäcker). Ever since the first director, Georg Picht, a major concern has been the changing character of war in the light of the invention of nuclear weapons. Many other programmes of the FEST had a major moral and civil dimension as well, and involved social scientists, economists and legal scholars.

6 Dippel, Cornelis, de Jong, Johannes, *Geloof en natuurwetenschap, Deel 1: Scheppingsgeloof, natuur en natuurwetenschap* (Boekencentrum, 1965); Dippel, Cornelis, et al., *Geloof en natuurwetenschap, Deel 2: Wijsgerige en ethische aspecten der natuurwetenschap* (Boekencentrum, 1967).

7 Andersen, Svend and Peacocke, Arthur, eds., *Evolution and Creation: A European Perspective* (Aarhus University Press, 1987).

8 e.g. Hübner, Jürgen, ed., *Der Dialog zwischen Theologie und Naturwissenschaft: Ein bibliographischer Bericht* (Chr. Kaiser, 1987); Ibid., "Science and Religion coming across." In *Science and Religion: One World – Changing Perspectives on Reality*, eds. Fenenma, Jan and Paul, Iain (Kluwer, 1990), 173–181.

What have all such initiatives delivered? And why do they differ by context? The short answer is that they are different because social circumstances, interests and assumptions are different. I value highly many smart and relevant reflections, but still am also concerned that 'religion and science' has not been as effective as might have been. In this contribution I will explore some sources of variation within 'religion and science'. The main analytical tool will be a distinction between insiders (scientists, religious believers) and outsiders (those who consider science or religion as object of study). Before turning to this analysis, I will offer first a sober assessment of the current state of the field 'religion and science', drawing on a major handbook.

'Religion and science' – assessing the state of the art

*The Oxford Handbook of Religion and Science*⁹ is a thousand page package of studies on religion in its relation to the sciences. This volume covers multiple sciences and various religions, including indigenous ways of life, religious naturalism, and atheism. Its fifty-five contributions (one by the current author) represent the state of the art in this field. *The Oxford Handbook* is exemplary, but it is so also in its biases.

Almost all authors advocate the religious perspectives they discuss: a Christian writes on Christianity and science, an ID-advocate on Intelligent Design, an atheist on atheism and science. Presenting and legitimizing positions takes precedence over analysis. Theological content and metaphysical issues have priority. Social and political dimensions of religious traditions such as institutions, communities, ethos, and rituals, and their settings (cultural and political power, legal and educational issues) are not in the picture. What is almost completely absent is engagement with an external perspective on religious beliefs, practices, and traditions. Furthermore, the unity of one's tradition is assumed. Disagreements *within* traditions are neglected. When it comes to science, authors also focus on content. The study of science in relation to its cultural and social conditions is not taken into account. Technology and chemistry don't play a role.

Furthermore, the *Handbook* is Anglo-Saxon with respect to authors: fifty-one come from the USA, Canada and the UK. Just six are based in continental Western Europe, and merely two elsewhere on the globe. Anglo-Saxon issues shape

9 Clayton, Philip and Simpson, Zachary, eds., *The Oxford Handbook of Religion and Science* (Oxford University Press, 2006).

the content. Chapters on evolution-creation controversies assume the American context. A chapter on sociology and religion ends with the American constitution. The European protestant reticence with respect to natural theology is not represented in the *Handbook*. 'Secularization' seems to be the driving concern, and re-establishing the plausibility of religious beliefs is treated as the remedy. This agenda treats secularization as an intellectual issue, rather than a consequence of modern urban life, technology, or the rise of modern states that provide education and social welfare and thereby render religious communities less significant. With this underlying concern comes an irenic but naive approach, as various religions are treated as if engaged in a similar project. The one atheist is the typical outsider. Such features are not exclusive for *The Oxford Handbook*, but by and large characterize the field. The field flourishes, with endowed chairs and two major dedicated academic journals, *Zygon: Journal of Religion and Science* (Wiley Blackwell) and *Theology and Science* (Routledge). At the global level (with Anglo-American dominance) there is the International Society for Science and Religion (ISSR), with selective membership. There are monographs, encyclopedias and other overviews such as *The Oxford Handbook*.

Though there are many excellent intellectual contributions to 'religion and science', research in this area has its specific biases as indicated above. These features might explain why this literature seems to be of limited interest to scholars in religious studies and other branches of the humanities. Historians of science provide the exception to these weaknesses. Recent studies stress the contextual character of discourses on religion and science and changing conceptions of science (or natural philosophy) and of religion.¹⁰ For example, Livingstone¹¹ showed that Calvinist responses to Darwinism in the late 19th century differed from place to place. Though both science and religion in their self-understanding and ambitions tend to be universal, their practices are situated in historical, disciplinary and confessional contexts. In systematic reflection, this deserves more attention.

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- 10 Brooke, John H., *Science and Religion: Some Historical Perspectives* (Cambridge University Press, 1990); Brooke, John H. and Cantor, Geoffrey, 1998. *Reconstructing Nature: The Engagement of Science and Religion* (T&T Clark, 1998); Dixon, Thomas, *Science and Religion: New Historical Perspectives* (Cambridge University Press, 2010); Harrison, Peter, "Religion" and the Religions in the English Enlightenment (Cambridge University Press, 1990); Numbers, Ronald L., *The Creationists: From Scientific Creationism to Intelligent Design*. Expanded Edition (Harvard University Press, 2006).
 - 11 Livingstone, David N., *Putting Science in Its Place: Geographies of Scientific Knowledge* (University of Chicago Press, 2003), 112–123.

Insider-Outsider Tensions

'Religion and science' discussions are driven by insiders. As 'insiders' I consider active and retired scientists with a personal interest in the issues (including 'new atheists' such as Richard Dawkins), and engaged believers, both professional theologians and lay people. For such insiders, these debates are about the truth, plausibility or legitimacy of convictions and worldviews. Typical outsiders can be scholars in religious studies¹² and in science studies, including historians of science and of religion.

Tensions between insiders and outsiders are typical of the humanities, especially in the interaction with social and natural sciences. Evolutionary psychology and sociobiology have encroached upon the domain of ethics, thus offering an outsider analysis of our moral discourse. Cognitive neurosciences seem to undermine the meaningfulness of human mental life; a tension that creates the central theme for the philosophy of mind. After Thomas Kuhn's *The Structure of Scientific Revolutions* (first published in 1962)¹³, philosophy of science has had to engage with the sociology of knowledge and the history of science. The challenge thus became to articulate an understanding of science that captured its success without naiveté.¹⁴

While insiders claim the meaningfulness and significance of a particular issue, an outsider might point to human interests, social conditions, historicity, or issues of authority and power. Philosophy may have the role to reflect upon the co-existence of two such different perspectives on the same human practice. Philosophy reflects upon the relevance of scientific and scholarly perspectives for the human concerns, and upon the relevance of human experiences for the scientific study of these phenomena. When it comes to the way religion relates to the natural sciences in our time, it is a major task for philosophy of religion to engage with a religious studies perspective (studying religious practices, beliefs and communities 'from a distance') and the discourse on the meaningfulness and validity of concepts and claims (the 'theological' interests of insiders).

I suggest that awareness of the difference between insider and outsider perspectives may help us understand better the interaction of religion and science.

12 McCutcheon, Russell T., ed., *The Insider/Outsider Problem in the Study of Religion: A Reader* (Cassell, 1999).

13 Kuhn, Thomas, *The Structure of Scientific Revolutions* (University of Chicago Press, 2nd ed. 1970).

14 e.g. Kitcher, Philip. *The Advancement of Science: Science without Legend, Objectivity without Illusions* (Oxford University Press, 1993).

My thesis is as follows: *We tend to lean towards an insiders perspective, but also behave as outsiders to gain credibility in the world of science-based epistemic attitudes. Betting on both horses may be necessary but it also makes our kind of exploration more difficult.*

Insider-outsider problems in the Study of Religion

Could someone who is deaf, understand music? In his study on *Das Heilige* (1917)¹⁵ Rudolf Otto wrote at the beginning of the third chapter: “The reader is invited to direct his mind to a moment of deeply-felt religious experience, as little as possible qualified by other forms of consciousness. Whoever cannot do this, whoever knows no such moments in his experience, is requested to read no farther.” Otto’s idea is that personal experience is necessary to gain access to the real meaning of religion.

Unlike Otto, I make no claim about the priority of the participant over the observer, as if the one would have real knowledge and the other an incomplete, limited and hence distorted understanding. However, I think it is heuristically useful to pay attention to differences in approaching a subject. Speaking very generally, an *insider* participates in practices considered meaningful, true, or right. An *outsider* might concentrate on the discourses, contexts and interests involved, and consider the way these practices may be useful to insiders. Can one have both, say timeless insight mediated by human scriptures and institutions?

Insiders and outsiders have different problems to deal with. When considering horrible, immoral or miraculous stories from the Bible, an outsider might treat such passages as throwing some light on what people once believed – it is merely history. A Christian, for whom the Biblical text is supposed to be normatively significant, has a problem: how to read those texts as relevant for us, and as appropriate to the story of God, without endorsing their unwelcome aspects. This type of problem is as old as religion; a distinction between the literal or superficial meaning and the deeper or true meaning has been argued for again and again. And even though suffering is an existential issue for all humans, the question how to combine the reality of evil with belief in a good and almighty God,

15 Otto, Rudolf, *The Idea of the Holy: An Inquiry into the Non-Rational Factor in the Idea of the Divine and its Relation to the Rational*, transl. by Harvey, John W., 2nd edition. (Oxford University Press, 1950), 8. The passage involved is also reproduced in McCutcheon, *The Insider/Outsider Problem*, 74–81.

is only a problem for a theistic believer. An outsider might describe the insiders discourse on theodicee perhaps as a way to handle cognitive dissonance.¹⁶

My teacher in philosophy of religion, H.G. Hubbeling,¹⁷ defined the task of philosophy of religion in relation to religious studies as follows:

Science of religion does not ask for the truth or falsity of religious institutions or statements, it just describes and explains them. Philosophy of religion, then, may be characterized as follows: *Philosophy of religion = science of religion + the investigation of truth or falsity.*

In that sense, philosophy of religion comes close to systematic theology, the intellectual concern of the insider. However, there is also a relevant distinction¹⁸: "in a philosophical statement a reference to revelation is not permitted, whereas in theology one may refer to revelation as an argument". That is, in philosophy of religion we do not have any particular religious creeds, revelations or experiences, but we do have the attempt to think through the truth and value of religion with the best available truth about religions. Thus, the philosopher of religion should address the co-existence of insider and outsider perspectives.

The main part of this essay will be on insider-outsider differences as they arise in the 'religion and science' area. I'll first come to a few insiders approaches that might be illuminated in terms of an outsider perspective: apologetics for science and for religion and the use of appeals to science in controversies within a religious setting. Thereafter, we will consider insider agenda's for 'religion and science'. Before discussing these, let me make one general remark: Valuable insights can be learned from *both* perspectives. They help us see different aspects of the processes. By acknowledging multiple perspectives, these may be modified, or at least challenged.

An outsider perspective on insider's interests

Why engage in 'religion and science'? From an outsider perspective, 'religion and science' often appears to be apologetics, in particular social contexts. Many think of it as apologetics for religion, but in my opinion, it is as much apologetics for science and technology.

Among religiously minded people, 'religion and science' may serve as *apologetics for science*. Quite a few communications presented as religion-and-science,

16 McCutcheon, Russel T., *Studying Religion: An Introduction* (Equinox, 2007), 54–56.

17 Hubbeling, Hubertus G., *Principles of the Philosophy of Religion* (Van Gorcum, 1987), 3.

18 Ibid., 1.

whether on web sites or in books, are almost indistinguishable from science popularization. To promote the acceptance of science, presenting fascinating scientific insights in a non-threatening way might already be effective. Elaborate arguments are not needed for most people; the purpose is served by popular science with a pious gloss or by a presentation of suggestive parallels between religious convictions and scientific insights. If the parallels are inspiring, science cannot be perceived as a threat to these religious convictions. One may even conclude that the religious tradition was there first, a matter of priority that makes science even less threatening.

Among the more specific strategies that may make science acceptable to religious believers we find epistemic arguments against scientism.¹⁹ Quite a few appeal to Thomas Kuhn²⁰ and other philosophers of science to argue that science is tied to paradigms and personal preferences and hence is not as objective and universal as it seems. Reconciliatory goals also can be served by ontological arguments, indicating that there might be 'room for God' in the context of scientific insights, as is the common theme of the Vatican Observatory – CTNS (Center for Theology and the Natural Sciences) series on "scientific perspectives on divine action".²¹

There are other strategies that might also make science more acceptable, such as pointing out that there are major scientists who are believers of the appropriate kind. One might also draw on the history of science to point out the religious origins of modern science, for instance in a reformed emphasis on human work or in a broader conception of creation as a contingent order. Such examples and analogies are not much as formal arguments, but they serve to appease, and thus serve as apologetics for science among those who suspect that their beliefs are under threat. Useful for a similar purpose can be Stephen Gould's²² plea to consider science and religion as non-overlapping magisteria (NOMA), for then too the message can be that people need not be afraid of evolutionary ideas, as religious beliefs are not threatened thereby.

My general point is that a wide range of strategies, among which quite a few are weak as formal arguments, are all adequate if the purpose is to make science

19 Midgley, Mary, *Science as Salvation* (Routledge, 1992); Stenmark, Michael, *Scientism: Science, Ethics and Religion* (Ahgate, 2001).

20 Kuhn, *Structure*, 1970.

21 Russell, Robert J., Stoeger, William R. and Ayala, Francisco J., eds., 1998. *Evolutionary and Molecular Biology: Scientific Perspectives on Divine Action* (Vatican Observatory, and Berkeley: Center for Theology and the Natural Sciences, 1998).

22 Gould, Stephen J., *Rocks of Ages: Science and Religion in the Fullness of Life* (Ballantine, 1999).

acceptable to a religiously minded audience. It is not whether a strategy is logically strong, but whether it is effective that is decisive here. Promoting science may well be of interest to sponsors rooted in the business community and within the scientific community at large, e.g. in the Academies of Science. Whatever the strategy, one major role of 'religion and science' in a religious culture is to serve as apologetics for science.

Nowadays, apologetics for science may be especially relevant to the United States, with its widespread popular sentiment against evolution and against scientific elites. Given that the acceptance of science is much more widely spread in Europe, this drive for religion and science may be less relevant there. However, in the European context, a different apologetic agenda may be more significant: the *advocacy of religion to a science minded, secular audience*. Thus, the message might be: Given science, religion is not impossible. The same strategies might be drawn upon. Even though an argument stressing separate spheres (NOMA) isn't needed to insulate pre-existing beliefs from science, it might be useful to suggest the relevance of a domain of moral and aesthetic values and spiritual orientation, complementary to science and co-existing with it.

So far, I suggested that 'science and religion' may serve well as apologetics. However, the engagement with science has another role as well. Religious communities are not homogeneous; there is always debate on the way to relate to one's tradition to the world. Engagement with science may be helpful in such internal debates. Both dissenters (advocates of a minority position) and established religious authorities appreciate the legitimacy provided by science at their side. 'Religion and science' thus may be about authority *within* religious traditions. It can be a battleground between revisionists and traditionalists in a tradition.

Even the most well-known title suggesting a conflict between science and theology, Andrew White's *History of the Warfare of Science with Theology in Christendom*,²³ is misunderstood if the intrareligious dimension is neglected. White was the first president of Cornell University, a nondenominational university. Cornell was set up as a Christian university, with compulsory attendance at chapel services.²⁴ Frustration about the ecclesiastical opposition he met from those in charge of denominational colleges shaped White's articulation of warfare of science with theology. White took religion seriously but quarrelled with sectarianism and theological dogmatism. He envisioned a religion that would be

23 White, Andrew D., *A History of the Warfare of Science with Theology in Christendom* (2 vols) (Appleton, 1896).

24 Altschuler, Glenn C., *Andrew D. White – Educator, Historian, Diplomat* (Cornell University Press, 1979), 68 and 81.

in harmony with science: "Religion, as seen in the recognition of 'a Power in the Universe, not ourselves, which makes for righteousness', and in the love of God and of our neighbour, will steadily grow stronger and stronger"²⁵

The perception of White's book as antireligious is an example of a more general trend, described by Jeffrey Stout in his study *Democracy and Tradition*.²⁶ Stout signals how orthodox believers and outspoken secular authors use each other as contrast, as if these two approaches are the only ones. The black and white picture excludes more liberal and irenic positions. Conflicts over evolution in the United States may be seen as a fight among Christians over Christianity. Should it be Christianity as creationists and other evangelical Christians understand it, or might it resemble more the self-understanding of what used to be called the main stream? In a court case in Arkansas in 1981, the opponents of a pro-creation science 'balanced treatment law' were parents and teachers, but also "the resident Arkansas Bishops of the United Methodist, Episcopal, Roman Catholic and African Methodist Episcopal Churches, the principal official of the Presbyterean Churches in Arkansas, other United Methodist, Southern Baptists and Presbuterean clergy".²⁷

'Religion and science' is not just an intrareligious issue within Christianity. In the work of the Dalai Lama, science is also an instrument in a struggle over a reform of Tibetan Buddhism. And though popular understanding has it that Islamist groups oppose Western culture, their main opponents are other Muslims. The struggle is over the answer to the question 'Who speaks for the Islam?' Controversies in Christianity in the nineteenth century over science, Scripture, hermeneutics and historical knowledge have close parallels in current controversies among Muslims.²⁸

When one considers what is going on in 'religion and science' from an outsiders perspective, the prime question is what the engagement with 'religion and science' *might do*, rather than whether the ideas themselves are true. 'Religion and science' is about power within religious traditions, about the acceptance of religion in a science minded culture, and about the acceptance of science in a religiously minded culture. However, for insiders the discourse is about the truth of ideas. I'll turn to this perspective now.

25 White, *A History*, xii.

26 Stout, Jeffrey, *Democracy and Tradition* (Princeton University Press, 2004).

27 Overton, William R. "United States District Court Opinion: McLean v. Arkansas", [1982] reprinted in Ruse, Michael, ed., *But Is It Science? The Philosophical Questions in the Creation-Evolution Controversy* (Prometheus, 1988), 307–331, 308.

28 Taji-Farouki, Suha., ed., *Modern Muslim Intellectuals and the Qur'an* (Oxford University Press, 2004).

Agenda's for insiders

Fides quaerens intellectum, 'faith seeking understanding', is a formula used in the 11th century by Anselm of Canterbury to describe his view of the intellectual theological project, repeated by Karl Barth in the 20th century,²⁹ and throughout the ages by many other theologians as well. Theology, upon this view, takes its point of departure in faith. There is no non-religious trajectory leading to religious belief, no proof for the existence of God or the truth of Scripture. Faith is given by tradition or individual life experiences, or rather, given by God, one would say upon such a perspective. If that is the believer's position is like, what might be a role for 'religion and science'? A role might be *conceptual clarification*; enriching convictions by providing a model that allows one to represent and communicate an idea. A more far reaching ambition would be to construct *plausible models*, or at least models that show that particular religious ideas are consistent with modern knowledge, and thus not excluded by science. The situation is similar to that of using analogies and thought experiments in science; they may serve heuristic and didactic purposes, but also aspire to present something as it really is, though from a perspective that is in practice inaccessible to us. I appreciate as such reflections on divine action and modern science, reflections on divine eternity, on creation, and many other themes.

Understanding reality is a somewhat different priority, as it is not so much an already accepted faith that is the point of departure. Rather, the aim would be the construction of a worldview. Examples of such projects could be the manifold discussions on quantum physics, chaos, or emergence (though these can also have their role upon the previous agenda). As a participant in 'religion and science', this is one of my own interests. I consider it important to think through science as best available understanding of reality. Given the success of science in unifying theories and in making it possible to control natural processes, the understanding of reality I advocate might be considered a form of naturalism, at least about the created order or natural world.³⁰ In my opinion, any theist has good reasons to be a naturalist, not in the ultimate sense of denying God's transcendence as creator, but in the sense of welcoming that nature has an impressive integrity and coherence. God is not to be found in the lacuna in our current knowledge, in the gaps, but rather in the world we have come to understand.

29 Barth, Karl, *Fides quaerens intellectum: Anselms Beweis der Existenz Gottes im Zusammenhang seines theologischen Programms* (München: Kaiser, 1931).

30 Drees, Willem B., *Religion, Science and Naturalism* (Cambridge University Press, 1996).

If our skills and powers are gifts of God, we should not look for God when we fail, but rather appreciate God for all that has become possible. Nature might be valued as God's gift. With the quest to understand reality comes also the aspiration to consider the limitations of such an understanding. I am convinced there are persistent *limit questions* regarding any scientific understanding of reality. There is no absolute end to the scientific quest. The horizon may shift, but there always will be a horizon. Archetypical limit questions are: Why is there something rather than nothing? And why is the world this way, and not differently?

For me, a *second* priority is to communicate science. Scientists and their work deserve the respect of their fellow humans. More important is a pastoral concern for ordinary humans. Understanding the scientific perspective helps protect them against superstition, and thus against being abused by sellers of nonsensical cures and therapies. There is also an intellectual concern: if the scientific community is so successful in cooperating across cultural boundaries, there might be lessons to be learned – lessons that could be of some use for the humanities.

Thirdly, I am interested in understanding and communicating religion and morality, also to a science-minded audience. Upon a simplistic understanding of science, human religious, moral and aesthetic traditions might be dismissed as misguided and outdated. However, such a scientism would be misguided as the human traditions are part of reality, and thus have to be understood in the context of human reality – a scientific understanding that need not imply their elimination. Thus, I like to encourage people to live with their traditions while reconstructing them, just as humans have always done. Perhaps science might itself play a role in rethinking elements of the tradition. Science might help us in finding new narratives and metaphors, and reshape our experiences and guide our actions. A photo of the Earth just rising above the moon, a lasting image of one of the Apollo missions, has given us a new perspective on our planet. I think it important to reflect upon values in world of facts, on ultimacy in world of finitude, and on serenity in a world of actions.

Concluding remarks

'Religion and science' is a complex of discussions, carried through in books, articles, websites, and conferences. In this essay I have argued that it may be helpful to distinguish between the perception by the participants, as a quest for understanding, and the way it might be understood by outsiders, as apologetics and as an assertion of legitimacy and power in intra-religious competition. Given this multi-faceted nature of the discussion, one might conclude that there seem to be

no generalities on 'religion and science'. To understand what is going on one has to analyze the situated, contextual, uses of the discourse, the dynamics of the interactions (not just the ideas but the alliances and shifts). As John Brooke³¹ wrote,

it is almost always assumed that there are lessons to be learned from history. The object of this book is not to deny that assumption, but to show that the lessons are far from simple. (...) The real lesson turns out to be the complexity.

The lack of generalities is the rule – a rule contradicting itself.

All insider discourse is object for the outsider study; there is no safe haven. The insider may hope for timeless truth in situated processes, but the outsider studies the interactions without assuming more than the historically contingent. However, it might be that self-referential coherence arises, in that the outsider analysis does not undermine the insider perspective, but reformulates it. All outsider discourse has to be incorporated in the account of the insider, as any religious perspective tends to be totalizing.

There is an important difference between the two discourses: for the outsider, understanding is separate from justifying. One may understand why people make a false argument or why they behave in despicable ways, without thereby excusing their behaviour. For the insider, understanding a point of view is often the same as accepting it as legitimate; the pinnacle of understanding is being converted. What will be? My hope is that some versions of insider and outsider accounts may be compatible, with epistemic modesty where appropriate. Minimally, outsider's descriptions may be incentives for insiders to reconsider and reformulate their own position, while insider's engagement calls upon the outsider to consider the ideas, values and beliefs *as* ideas, values and beliefs.

Acknowledgments

These issues have been discussed previously in a lecture given at the Twelfth European Conference on Religion and Science, held in Sigtuna, Sweden, April 30 – May 5, 2008³²; and more extensively in my monograph *Religion and Science in Context: A Guide to the Debates*.³³ Currently, my research and writing stands in

31 Brooke, *Science and Religion*, 4–5.

32 Drees, Willem B. 2010b. "The Multiplicity of Purposes in Religion and Science." In *How Do We Know? Understanding in Science and Theology*, eds. Evers, Dirk, Jackelén, Antje and Smedes, Taede (T&T Clark, 2010).

33 Drees, Willem B., *Religion and Science in Context: A Guide to the Debates* (Routledge, 2010).

the context of the project funded by the Netherlands Organization for Scientific Research, NWO, as the horizon-programme ‘What Can the Humanities Contribute to our Practical Self-understanding?’

V. Astronomy and Mathematics

Chris Impey

Cosmology and the Human Condition

Introduction

For the past five years I've been traveling to remote parts of India to teach cosmology to a group of three dozen Tibetan monks, part of a program called "Science for Monks" initiated by His Holiness the Dalai Lama. Tenzin Gyatso is a visionary spiritual leader who worries that Tibetan culture will unravel without being in its homeland. He's also technically inclined, noting in his autobiography that he would have been an engineer if he had not been identified at age two as the 14th manifestation of the Bodhisattva of Compassion.¹ The Dalai Lama thinks Buddhist monks should be suitably trained for the modern world that's so dependent on math and science.

Western educators in the Science for Monks program live in simple, cloistered surroundings and experience immersive teaching with a hand-picked group of Buddhist monks who are interested in science. Sitting cross-legged on mats in a Spartan classroom, the monks can transcend their bodies and project their minds into the universe. With no visible effort, they explore black holes, exoplanets, the interiors of stars, and the early phases of the big bang. They become Geshes of time and space, engaging playfully in the process of science and its rewards of discovery and understanding. There are twenty thousand monks in the Tibetan diaspora and it takes three years to train one small group in math and science. When the millennial scale of the project was pointed out to His Holiness, he giggled—Buddhists are expert in taking the long view. The goal is now to take each monk to the level where they can educate other monks in their home monasteries.

This article is an account of that singular experience. For a gorgeous, illustrated view, see the recent book by Sagar.² The backdrop for the Science for Monks program is a set of people without a country who have suffered greatly for their religious beliefs and their culture, and who bear their burdens with grace and

1 Dalai Lama, *Freedom in Exile: The Autobiography of the Dalai Lama* (Harper Perennial, 1991).

2 Sagar, Bobby, *Beyond the Robe* (Power House Books, 2012).

lightness. Buddhist monks are inspiring students because they're open to new ideas and they're absolutely committed to learning. The classroom is a two-way street; excitement and glimmers of enlightenment flow in both directions. For any educator this is the mother lode.

In my conversations with the monks I realize they have an idealized view of how science works. They think that scientists can measure the quantities they're interested in with arbitrary precision, that it's just a matter of good equipment and dedication. Science seems implacable and authoritative, and because of that, a bit remote and aloof. But I recognize the flip side of that coin—my idealized and simplistic notion of Buddhism and monastic life. Buddhism is more accurately described as philosophy than as religion. It has no theology and no metaphysical speculation about first causes. The Buddha was not a god, nor did he claim to be. Buddhism is pragmatic and not dogmatic. It aligns with science in accepting natural causation and in always trying to verify a worldview with observations.³ This quote is attributed to the Buddha: "Monks and wise men, just as a goldsmith would test his gold by burning, cutting and rubbing it, so must you examine my words and accept them, not merely out of reverence for me."

The Art of Estimation

When I ask the monks for the biggest number they know in their guts, I get quizzical stares. Scientists manipulate large numbers mentally but it's important to experience them in the solar plexus. What's the largest number where your knowledge of it is intuitive and visceral as opposed to simply intellectual?

Geshe Nyima Tashi volunteers the number of monks in his monastery near Bangalore, about four thousand. That's not a huge number but I imagine he really does experience it when they all gather in the great hall for prayers or ceremonies. Dawa Dorjee chimes in with six million, the number of Tibetans, but I counter that unless he knows them all, or has actually seen all of them in one place, it's an abstract number, not directly experienced. Then Jeme Jatso recalls a two-week festival when he said a million mantras. I'm unable to imagine having enough patience to count anything up to a million.

"To see the world in a grain of sand, and heaven in a wildflower." So wrote William Blake 150 years ago. In the classroom we use grains of sand as a microcosm and a metaphor for large numbers, and later on, for distant worlds in space.

3 Hagen, Steve, *Buddhism Plain and Simple* (Broadway Books, 1998).

I ask the monks how many grains of sand are in a sand mandala. A sand mandala is the evanescent expression of Tibetan cycles of time in exquisitely colored and perfectly formed patterns of sand grains, often in a form called a Kalachakra.⁴ The monks create a sand mandala with a small brass funnel that pours sand through a narrow opening. They tap gently on the side to ensure a smooth flow, “drawing” on the surface with lines a dozen grains wide. A mandala takes four or five skilled practitioners several days to make; it’s then swept away in seconds in a powerful reminder of impermanence.

I uncover a bucket of sand I’ve hauled into the room and say that the mandala is a stepping stone to estimating the number of sand grains in the bucket. But first they need to know how many grains of sand are in a cubic centimeter, similar to a sugar cube. The method’s pure low-tech; raw materials are a piece of paper, a ruler, a little sand and a lot of patience. Within each group a monk lines up grains in a row, just touching, until they span a centimeter. This number cubed is the number of sand grains in a cubic centimeter. My students back home would struggle with this activity, not because it’s technically difficult, but because it’s painstaking and tedious. The monks perform the task without a hint of self-consciousness, and with care and delicacy, like it’s a devotion.

I caution them about errors in the method. They’re lining up grains edge to edge, but in any real volume of sand the grains do not sit in neat rows and layers, they jostle and settle into closer packing. And they will naturally tend to pass over the tiniest grains when they set them into a line. Both effects will tend to make their estimates low. The second issue sets off a spirited debate about the sand used in a mandala. It’s high grade quartz sand, made by grinding larger rocks until the fragments reach a nearly uniform size. All I could get hold of was builder’s sand, which is much cruder; rubbed between the fingers the smallest particles are little more than dirt. The monks debate the issues vigorously. They display perfect scientific form, weighing up systematic errors like the pros.

The sand mandala and the bucket are both cylinders, very squat in the case of the former. After a while they report their answers: averaged among the six different groups, 80,000,000 grains in the mandala and 700,000,000 in the bucket. They’ve now acquired a gut-level feeling for numbers like a hundred million and a billion. I ask them to return after the tea break with a large number from their own experience.

Sherab Tenzin is the first to share. He estimates that he has taken 18 million breaths in his life. I like his example, concrete yet evanescent. The breaths have

4 Bryant, Barry, *The Wheel of Time Sand Mandala* (Snow Lion Publications, 1995).

merged seamlessly into the air, with no sign of their existence. Gelek Gyaltzen offers the number of grains of rice he eats per year. At 60,000 grains per cup, and three meals a day, it adds up to 7 million grains. I ask him, how many grain of rice are eaten each year in India? He goes to the white board and calculates. When there are more than six or seven significant figures, the monks tend to lose track of them and get untethered. Gelek struggles but others help him out. With a billion Indians and assuming children are just as hungry as adults, the answer is 7 thousand trillion, or 10^{16} . That's an impressive number. Gelek looks at the class and flashes a megawatt smile.

This would be a difficult exercise for my students back in the United States. They generally view large numbers with suspicion and are uncomfortable manipulating them. An order of magnitude calculation would send them scrambling to the Internet for an answer, or make them stab numbers into a calculator with increasing frustration. With no technology available as a crutch, the monks go to the white board and multiply the old-fashioned way. They take their time; the others who are watching wait patiently. It feels like there's no downside in a wrong answer.

As we finish our exploration of large numbers, I realize there's been nothing superficial about it. What we did gets to the heart of science. Facile manipulation of numbers—plug and chug into a calculator—is a long way from the hard-won intuitive understanding that professional scientists strive for. I have a colleague who is a gravity theorist and I once asked him “How many people understand general relativity?” He said maybe ten thousand have taken a graduate class in it, but that's not a good measure. I recalled my own shaky experience with a grad class in GR and had to agree. He thought for a moment. “If you mean those who have fully absorbed its insights and elegance and can apply it in novel situations, less than a hundred.” Relativity at gut level.

Monk Scale Model

The largest number that was part of the monks' common experience is several million. We reached a billion with our estimate of the number of grains of sand in a big bucket. It turns out that the monks' tradition contains a truly prodigious number. In a text attributed to the Buddha from the 1st Century B.C.,⁵ he competes with five other suitors for the hand of a beautiful princess. He defeats them

5 Ifrah, Georges, *The Universal History of Numbers: From Prehistory to the Invention of the Computer* (Wiley, 2000).

all in the writing, wrestling, archery, running and swimming events, then he is given a final test by the eminent mathematician Arjuna: “Young man, do you know the counting that goes beyond the koti (ten million)?” The Buddha ascends the ladder of numbers and doesn’t stop until he reaches the gleaming pinnacle of 10^{421} , one followed by 421 zeros.

The monks get off their mats and we construct the universe in stages. Thupten holds a colorful metal Earth about the size of a small lime; it’s stamped made in China, which would be disconcerting for any Tibetan. Then I hand him a marble and ask him to place it in space at the right distance to be the Moon. The other monks offer generous and voluble advice on the correct position of the Moon. Like most non-scientists, they think the Moon snuggles close to the Earth. He holds the spheres beside his cheeks, connected by gravity and a grin. I beckon him to move them farther apart and stop him when the Moon is arm’s length from the Earth. That’s as far as humans have ventured and the Apollo moon shots cost \$50 billion in current-year dollars.⁶ A few monks comment with charming naivety that they’re shocked we could spend so much money on space when the world has such large, unsolved problems.

Lobsang Choephel volunteers to be Mars, the nearest planet. He holds a larger marble, a red cat’s eye, naturally. The class thinks he should stand on the far side of the classroom and they laugh when I direct him out the door and back him up around the stairwell and to the far side of the building. I tell them that on this scale the Sun is a 3-meter globe 500 meters away. I need another volunteer and Geshe Nyima obliges, nimbly rising from a cross-legged position. I hand him a pale blue plastic ball the size of a grapefruit and with a straight face direct him to walk up to McLeod Ganj. The hill town that hosts the Tibetan government in exile is twenty kilometers away. He’s razor sharp and already accustomed to my sense of humor so he nods and marches out of the door. I call him back in.

We all pause for a moment to contemplate the emptiness of the Solar System. Sol comprises almost all the mass, then a region the size of a large city is scattered with eight planets: four rocky objects the size of cherries and plums orbiting within a half mile of the Sun, and four gassy spheres the size of baseballs and beach balls orbiting the outer regions. Apart from a swathe of orbiting sand particles to represent asteroids and occasional dust mote-like interlopers that represent meteors and comets, that’s everything. Several monks are curious about Pluto’s demotion from the pantheon of planets, but they show none of

6 Chaikin, Andrew, *A Man on the Moon: The Voyages of the Apollo Astronauts* (Penguin, 2007).

the dismay I sometimes encounter with public audiences in the United States.⁷ They're just not that attached.

On this scale the nearest stars would be nowhere on Earth. They'd be several times the Earth's circumference away, giving a perspective on the enormous challenge of interstellar travel. Enormous ingenuity sent two dozen men that one yard to the Moon and it cost so much that we haven't been back for forty years. This choice of a reduction in scale by a factor of 300 million isn't accidental. It brings the speed of light down to a 1 meter per second, a brisk walking pace. That's why light saunters from the Sun to the Earth in eight minutes, and crosses the Solar System in five hours, but takes several years to reach us from even the nearest stars.

This scale model barely captures the distances between stars and it reveals nothing about the Milky Way. I reach into the bucket of sand that's been sitting in the corner of the classroom for a few days and, relieving Thupten of his Earth and Moon, place a tiny grain on the tip of his forefinger. Be careful, I say, six billion souls depend on you not to sneeze or otherwise harm the planet. Lobsang reluctantly hands me back Mars; he's enjoyed being caretaker of a planet. I place a grain of sand on his fingertip and position him halfway across the room. These specks are entire solar systems, I tell the monks, where the stars and planets are far too small to see, so the grain represents the diameter of the entire system. Proxima Centauri is a binary system and each of its Sun-like stars might harbor rocky planets.⁸ When Lobsang hears this he perks up and he gazes thoughtfully at the speck on the tip of his finger which may host untold billions of sentient creatures of unknown function and form.

This second scale model is 100 million times smaller than the first. If sand grains are a few meters apart on average, then the Milky Way is a sparse agglomeration of 400 billion grains spread over an area the size of India.

Still we're not there; the universe is not yet in view. So we take the scale down another factor of 100 million and a spiral galaxy like the Milky Way shrinks to the size of a dinner plate. I have a stack of dinner plates and a box of cotton wool balls with me; we push aside the mats to create a three-dimensional model of the nearby universe. Everyone gets to be a galaxy. The tiles on the floor act as an X-Y coordinate grid and height above the floor as the third Z coordinate. A lucky few get to be substantial galaxies: the Milky Way, M33, and M31 or Andromeda. After

7 Brown, Mike, *How I Killed Pluto and Why It Had It Coming* (Spiegel and Grau, 2012).

8 Endl, Michael, and Kürster, Martin, "Toward Detection of Terrestrial Planets in the Habitable Zone of our Closest Neighbor: Proxima Centauri." *Astronomy and Astrophysics*, Vol. 488 no. 3 (2008): 1149–1153, 1149.

some discussion the three dinner plates take their places.⁹ Two wads of cotton wool are held by monks a foot from the Milky Way to represent the Magellanic Clouds, a fuzzy feast for the eyes visible only in the southern hemisphere. Two dozen more dwarf galaxies take their places around the room, held by monks down near the floor or above their heads or, in a few convenient cases, balls of cotton wool rest on their heads. Our classroom has become a million light years side to side.

A million light years sounds capacious but this is still a nearby corner of the cosmos. Three large galaxies and a few dozen dwarfs indicate that there are many puny galaxies for every massive one. If we could extend the scale model, we would be positioning dinner plates within the monastery grounds and across the countryside and also high into the air since they occupy three-dimensional space. We would position many small galaxies, placing most of the cotton wool balls fairly close to the dinner plates. We would continue doing this until we had placed 100 billion galaxies spanning the entire Indian subcontinent. Only then would we have represented the visible universe. I imagine that Indian families have flung their crockery about, perhaps in a fit of pique at the enormity of the universe.

The monks are taking notes but they're also absorbing this sleight of hand. After reducing the size of the universe by more than 24 powers of ten, it's still the size of India. And now the questions come. How do we know how many galaxies are out there? What about the edge? What lies beyond the last galaxy? How do we measure sizes this large? But these questions will have to wait until tomorrow. Research shows that the attention of any audience drops by 30% to 50% after fifteen minutes of lecturing, no matter what the topic, no matter how dynamic the lecturer.¹⁰ This news is lost on the men who sit in front of me, who are as fresh and alert as when we started. Their stamina is phenomenal.

Billions of Galaxies

Each monk holds in his hand the deepest image of the sky ever made.

It's a high quality color print of the Hubble Ultra Deep Field, which was created when astronomers used the most powerful telescope ever built to stare at a small patch of sky for three weeks. The telescope was not pointed at any known galaxy or cluster; it was designed to be a boring part of the sky so that the

9 van den Bergh, Sidney, "Updated Information on the Local Group." *Publications of the Astronomical Society of the Pacific*, Vol. 112 (2000): 559.

10 Wilson, Karen and Korn, James, "Attention During Lectures: Beyond Ten Minutes." *Teaching of Psychology*, Vol. 34 no. 2 (2007): 85–89, 85.

resulting galaxy census would be typical of the whole universe.¹¹ They will work in groups to estimate the number of galaxies in the visible universe. Their first job is to count the galaxies in the image. This isn't trivial; many are so faint they register as a couple of pixels of pale white fuzz on a black background. Some are big enough to show spiral or elliptical shapes and the subtle colors that represent young and old stars. Peering closely at these prints it's amazing to see how many galaxies have been snared by the Hubble Space Telescope, like dewy points of light caught in a dark cobweb.

The monks are fully capable of counting every galaxy, even though there are several thousand. Their patience and concentration eclipse that of any students I've taught in twenty-five years as a professor. But I tell them that a sampling approach is perfectly adequate; they should divide the page into quadrants or sectors and count in one of them. There are six groups, each formed from three or four monks at the same monastery so there will be six independent estimates of the number of galaxies. The room is quiet as they work. Their average is 2800, with a scatter of 20%. The image we're working with spans 3 minutes of arc, one tenth of the Moon's diameter. If this one sightline through the universe is typical of all directions — a major assumption about the uniformity of the universe called the cosmological principle — the number of galaxies in this tiny patch must be multiplied by the number of times the patch can fit on the entire sky.

How many galaxies fit on the head of a pin? We've just answered this question because the tiny Ultra Deep Field is no bigger than the head of a pin held at arm's length. I've already worked out that the front wall of the classroom is a good model of the sky: the number of times a pinhead can fit on the wall is approximately equal to the number of times the Ultra Deep Field fits across the entire sky, both north and south hemispheres. Each group gets a tape measure and a pin and soon they are measuring the size of the wall in square centimeters. Estimating how many pinheads will fit in a square centimeter is easy; the work with grains of sand served as a warm-up.

We take this average too. It's a large number: 3,500,000. The Hubble Ultra Deep Field spans less than three millionths of the total sky, and several thousand remote stellar systems can be found there to the limit of vision. The product of the two numbers is 10 billion. There's a final upward correction. Not impugning the monks' vision or counting ability, I point out that the depth the original digital image is can't be faithfully portrayed in the print they are holding. That's a

11 Beckwith, Steven V. et al., "The Hubble Ultra Deep Field." *The Astronomical Journal*, Vol. 132 (2006): 1729.

factor of two in distance lost, meaning the faintest galaxies they have counted are only 5 billion light years away, rather than 10 billion light years. The distance correction is a factor of two, but in volume the factor is two cubed or eight, so their estimate bumps up to 80 billion. That's close to the astronomers' calculation of 100 billion.¹² Their crude census is an unqualified success.

Buddhist monks don't have the kind of prominent ego that's common in our avaricious western culture. Even when I've seen them compete, on the basketball court or in a debate, they do so with a light grip that can easily release into laughter. But as their estimate sinks in—nearly 100 billion or 10^{11} , a fantastic number—satisfied glances pass around the room and many of them visibly register pride. Just as well we used a sampling method. If they had actually counted all galaxies the same way it would have taken a hundred thousand years. This activity also demonstrates the incredible power of the scientific method. With the naked eye, just three galaxies are visible. With telescopes to aid our eyes, we see many fuzzy patches of light in the sky. Spectroscopy shows that the light is the combined radiation of myriad stars and the redshift shows the entire system is moving away from us. This method can be extended to the faintest smudges of light that the monks were counting, extending Edwin Hubble's original work a thousand-fold in distance and a billion-fold in volume.

We return to the familiar metaphor of grains of sand. Let sand grains stand in for planets, stars and galaxies. The bucket of sand is still in the corner of the classroom. If each sand grain stands for a star it would take 400 buckets — enough to fill the classroom with sand a foot deep — to represent the stars in our galaxy. But there are about 100 billion galaxies in the universe, so we have to imagine 100 billion classrooms a foot deep in sand or a billion times that area a hundred feet deep in sand. There are more stars in the universe than there are grains of sand on all the Earth's beaches.

Each galaxy on average holds 100 billion stars so the stellar census of the universe is 10^{22} .¹³ That's the raw material for thinking about life beyond Earth. How unlikely is it that among all the planets around ten thousand billion billion stars this is the only one to host biology? There is a connection with the monk's training. Buddhism has long contained the idea of world-systems in space, which are like solar systems hosting sentient beings.¹⁴ The nearest billion

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- 12 Beckwith, Steven V. et al., "The Hubble Ultra Deep Field." *The Astronomical Journal*, Vol. 132 (2006): 1729.
 - 13 van Dokkum, Pieter G., and Conroy, Charlie, "A Substantial Population of Low-Mass Stars in Luminous Elliptical Galaxies." *Nature*, Vol. 268 no. 7326 (2010): 940–942, 940.
 - 14 Sadakata, Akira, and Nakamura, Hajime, *Buddhist Cosmology: Philosophy and Origins* (Kosei Publishing, 1997).

worlds-systems are said to be within the field of influence of the Buddha. While bold, the idea is scientifically plausible. I can imagine an advanced civilization that can control or influence 1% of the Milky Way. Buddhism assigns no limit to the world-systems; they're infinite in number.

I ask the monks to stare at their Hubble images and think about the likelihood that, in many or all of those fuzzy patches of light, someone or some *thing* is staring back at them across space and time.

Those stars in the universe contain 10^{80} atoms. However, each particle is outnumbered by 100 billion to one by feeble microwave photons left over from the big bang that fill the space between galaxies. We can't count those 10^{88} photons, even in principle, because unlike grains of sand or galaxies, they're identical to each other and slip through our fingers at the speed of light. We've reached the largest number that can be calculated in cosmology (although it's dwarfed by Buddha's staggering 10^{421}) and take a well-deserved rest.

The questions I get from the monks continue to provoke me to think about my subject at a deeper level. I've reassured them there is no such thing as a stupid question and often the simplest questions are the best. "What is a nature of space?" comes to me after translation from Tibetan. We've spent much time talking about what the universe contains and how big it is, but we haven't addressed the nature of the container. If space didn't have stars and galaxies in it to mark it could we measure it at all? What is space if it's really nothing and how can nothing expand? Is space quantized like matter or can it be infinitely subdivided? I have no answers to these well-posed questions. I feel like a child in the garden of the universe.

Harvesting Old Light

We return to the first stage of our scale model to see the implications of the finite speed of light. I'm holding the toy Earth in one hand and the small grey marble in the other to act as the Moon. A red marble on a ledge at the opposite end of the building represents Mars and a clear sightline from a window across the courtyard, down the dirt road next to the grassy field where the monks practice debating, reveals a large circle pieced together from sheets of yellow construction paper. That's the Sun. If light went infinitely fast we'd see everything in the universe as it is right now. Not just the Moon right here, and Mars over there on that ledge, but also the Sun down the road and stars that in the model are tens of thousands of miles away.

But that's not how nature works. Einstein postulated the speed of light as a fundamental physical constant and a limit and nobody has proved him wrong. It's blindingly, but not infinitely, fast. In the scale model it can't travel

instantaneously. Instead, it strolls. So if a flare erupted on the Sun and a jet of magnetized plasma looped out from its surface, the light showing it would take eight minutes to walk to us. If Neptune suffered a major impact that decimated its surface we wouldn't learn about it for five hours, the time it would take light to walk down from McLeod Ganj. Or, if an evil monk empire from the other side of the galaxy ripped up the Sun or squashed it out of existence—I point out the window toward the dot of yellow cardboard just visible down the road—the lights wouldn't go out for eight minutes. There laughter in the room and I'm not sure if it's because of the implausibility of the Sun's demise or my postulating the existence of evil alien monks.

I hand around a picture of M31, our spiral neighbor in the constellation of Andromeda. The light from this galaxy takes about 2.5 million years to reach us. We see M31 as it was when our ancestors *Homo habilis* were confined to a small part of Africa, surviving and foraging with brains a third the size of ours. The light streaked across intergalactic space and passed the nearest dwarf companions to our galaxy just as humans' brain sizes had doubled and *Homo erectus* left Africa for the first time. The light reached the edge of the Milky Way as anatomically modern humans fanned out over Europe and Asia and were reaching North America. The light angled in over the Perseus spiral arm as the first cities were being built in Mesopotamia. It whipped by the nearby luminous blue star Almach as New Amsterdam fell into British hands and was named New York City. It grazed close to the Sun-like star Lambda Andromeda as Edwin Hubble first measured the distance to M31. Eighty years later it finished its long journey.

Distant light is old light. The monks look perplexed and the concept of look-back time is indeed counter-intuitive. When in doubt, move about. Four monks volunteer to represent intelligent life forms on the planets around four different stars. One stands nearby; he is on Terra orbiting Sol. The other three spread across the room at distances representing 10, 40, and 80 light years. The idea isn't implausible. NASA's Kepler mission is showing that Earth-like planets are abundant and Buddhism has enough sensible and appealing features that it might have taken root around the galaxy. So the issue of communicating with distant monks is a real one that needs to be addressed.

Four more monks volunteer to be photons. They are the information carriers, traveling at light speed, which in this classroom experiment means transporting images and messages at a slow shuffle. With this setup, the challenges of meaningful conversation become clear. We play it out once more to reinforce the point. I suggest the monks on Earth and the three Earth clones actually try to age as the photons travel. The solemnity of aging and dying friends doesn't dampen the

monk's natural playfulness, and as they mime becoming stooped and wrinkled and falling down dead, the room is filled with mirth.

Such is the problem if we encounter potential pen pals on Earth-like planets in the local universe. Even the closest of these sites is likely to be at least 10 light years away. It's not a very satisfying conversation. Lobsang on Planet A: Thupten, what are you doing? Thupten on Planet B: Visiting a friend in Bangalore. Lobsang on Planet A: Really, you are? Tell me about the trip. Thupten on Planet B: Lobsang, it was 20 years ago! I've totally forgotten what happened. Interstellar communication is going to be a hard sell for the Internet generation.

In the larger realms of the universe, light travel times are enormous. We see the center of our galaxy as it was 30,000 years ago, and M31 as it was 2.5 million years ago, but that's just the galactic backyard. Light from the nearest big cluster of galaxies in the Virgo constellation has been traveling for 50 million years ago, since the time of the first birds, and the huge Coma cluster is seen as it was 150 million years ago, when Earth was ruled by dinosaurs. All of these look-back times are small fractions of the 13.7-billion-year age of the universe, but by using large telescopes we can easily gather light from galaxies 10 or 11 billion light years away.¹⁵ We can see these galaxies as they were long before the Earth formed, when the entire universe was young. The beauty of astronomy is the use of telescopes as time machines.

It's the perfect opportunity to harness a core skill from the monastic tradition: debating. Buddhists consider that all suffering is related to a failure of wisdom, even the suffering of death. Philosophical debate is a tool to see the nature of things and achieve wisdom. It's a core part of the training of all Buddhist monks.¹⁶ Debate is fluid and dynamic with the rhythm and grace of dance. It goes like this.

The Challenger approaches the Defender respectfully with a quandary. He stands while the Defender sits. The Challenger poses his question with right hand raises above shoulder level and left hand stretched forward with palm upward. At the end of his statement the Challenger claps his hands loudly and stomps his left foot. He then quickly draws back his right hand with the palm upward and leaves his left hand forward with the palm downward. The left hand represents wisdom and the right hand represents method, particularly the practice of compassion. Bringing the two together is the union of wisdom and method. At the moment of

15 Bouwens, Rychard J., et al., "Discovery of $z \sim 8$ galaxies in the Hubble Ultra Deep Field from Ultra-Deep WF3/IR Observations." *The Astrophysical Journal Letters*, Vol. 709 (2010): L133-L137.

16 Tillemans, Tom, "Formal and Semantic Aspects of Tibetan Buddhist Debate Logic," in *Journal of Indian Philosophy* Vol. 17 no. 3 (1989): 265-297.

the clap the foot comes down hard to slam the door on rebirth at the lower levels. Holding out the left arm keeps shut the door to all re-birth. Drawing back and raising the right hand symbolizes the will to raise all sentient beings out of cyclic existence and grant them the omniscience of Buddhahood.

I propose this statement for the debate: We can understand what is happening *now* in the universe. The Challengers and Defenders take their positions. Arguments are unleashed, rebuttals are parried. The air fills with the sound of slapping hands and stamping feet. And the debate wheels into the night.

Beginning and Ending

In Einstein's general relativity time and space are joined at the hip and the universe can be understood spatially and temporally. Yet they are distinct. Space is omnidirectional, while time dramatically cleaves the anticipated from the remembered. With no choice in the matter, we ride the gossamer-thin membrane of "now". Argentinian writer Jorge Luis Borges wrote: "Time is a river which sweeps me along, but I am the river; it is a tiger that devours me, but I am the tiger; it is a fire that consumes me, but I am the fire."¹⁷

In Buddhism, the relativity or subjectivity of time is uncontroversial. Not only that, Buddhist scholars recognize that time is an "imputed" entity, which is to say it's identified and measured on the basis of something other than itself. We point to the clock as a "substantial" entity, but in pointing to the clock we have not pointed to time. Time is not mental or physical, but belongs to a third class of phenomena. In physics, time is associated with entropy, the number of equivalent microscopic states of a system. There are many ways for atoms and molecules to be similarly disordered, but relatively few highly ordered states. I watched several monks constructing a sand mandala of the Buddha of Compassion at a local temple and was enthralled at their patience and precision. After three days of construction, chants, and prayers, the sand was swirled into a muddy brown pile; pattern and symmetry turned to chaos. Ritualistic destruction is a reminder of the transitory nature of material life and cosmic impermanence.

A day without a yesterday. That's how the Belgian priest and part-time cosmologist Georges Lemaitre described the big bang. The universe is currently large and diffuse and, for most of the volume that's not near a star, frigid. But it was not always that way. About 13.7 billion years ago the mass that would later

17 Borges, Jorge Luis, *Labyrinths: Selected Stories and Other Writing* (New Directions Publishing, 1964), 290.

make 100 billion galaxies was crammed into a space no larger than the head of a pin, making another allusion to the counting experiment the monks did in class.

When Edwin Hubble measured galaxies redshifts in the 1920's it was the first indication of cosmic expansion. The universe used to be a lot smaller, denser, and hotter. There have been three phases. Until about 10,000 years after the expansion started, radiation was so intense that nothing could congeal in that white heat. Then gravity began to exert its long-fingered grip and until five billion years ago the expansion rate was steadily slowing. In the third phase an enigmatic entity called dark energy has become dominant. It was always present in the vacuum of space but it has asserted itself as matter thinned out, pushing on the fabric of space-time, acting as an accelerator to dark matter's brake. Radiation now runs a distant third and the space between galaxies is at a temperature close to absolute zero. The early expansion was so quick that any two points in space receded faster than light speed. A result is that the distance to the edge of the observable universe is 46 billion light years.¹⁸ What of the physical universe? It might be vastly larger, meaning that the census of 100 billion galaxies represents the lower bound. There may be many more galaxies and stars and planets (and even people) in regions we can't see now and may never see.

The clinching evidence for the big bang is the bath of microwaves that permeates the universe. This feeble radiation was discovered in 1965, seen with equal intensity in every direction of space. A NASA satellite measured extremely subtle variations in the radiation, patches with a scale of one degree where the temperature varies by 0.001%. I hand out images of the microwave sky made by the satellite.¹⁹ The variations are shown as red and blue speckles; while the picture looks pretty I see the monks aren't convinced. One asks, are the microwaves everywhere? Yes, there are millions in every cubic centimeter of space. We're literally breathing the big bang. They look skeptical.

When we break slightly early for tea and I walk into the shimmering heat and down the dusty road from the monastery to Yoshi's shop, a ten by twelve foot cinder block building with a tin roof and one wall missing. Yoshi is lying on a cot on his side watching a small black and white TV with a grainy picture set

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- 18 Davis, Tamara, and Lineweaver, Charles, "Expanding Confusion: Common Misconceptions of Cosmological Horizons and the Superluminal Expansion of the Universe," *Publications of the Astronomical Society of Australia*, Vol. 21 no. 1 (2004): 97–109.
 - 19 Komatsu, Eiichiro, et al., "Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretations," *The Astrophysical Journal Supplements*, Vol. 192 no. 2 (2011): No. 18.

on a nearby chair—just what I need. The images I handed out is like a picture of the infant universe, like a picture of an old person when they were an hour old. Since then the universe has expanded by a factor of a thousand and the energetic photons have been stretched in the cooling universe into microwaves. I switch on the borrowed TV, and turn the dial until I find a frequency between stations. A few percent of the flickering speckles are caused by interactions of the phosphor with microwaves from cosmic creation. We stare at the blizzard of white noise which is, dare I say it, Zen-like. Monks don't watch TV, but I assure them that watching the big bang is more edifying than watching hundreds of cable channels back home.

After talking about the past we pivot to speculate about the future. A central pursuit of cosmology is the understanding of beginnings and endings.²⁰ In Buddhist tradition, the higher realms of existence have very long duration. In the realm of forms, lifetimes stretch out to 25 million years, and in the realm beyond forms, out to thousands of trillions of years. Most Westerners have misconceptions about reincarnation because they hear parables that were used around the time of the Buddha to cement the idea as moral law among simple villagers.²¹ There are a myriad of pathways through lives in Buddhist tradition. Reincarnation isn't just about fate and it's not just about transmigration of the soul. Karma is action, and actions can change the present and the future. We are all subject to the effects of our actions; karma is like a law of conservation of moral energy.

If we survive as a species, various astronomical hazards are lined up to end the party: catastrophic impacts from space debris, the demise of the Sun, and a nearby supernova going off. Then, on timescales of more than a trillion years: death of all stars, evaporation of galaxies, and diffusion of the universe due to dark energy. Astronomers aren't unrelenting gloom mongers; they bring a ray of hope. At the frontier of speculation, there may be no beginning or end. Since the universe started as a quantum event, there may be a "landscape" of quantum phenomena, leading to universes like and unlike ours.²² This process of spawning universes could be eternal.

I watch the monks for a hint of angst. But they absorb these austere scenarios with equanimity, their essential lightness untouched. These cosmic events are tiny corrugations on the great wheel of existence. They know I'm presenting

20 Impey, Chris D., *How It Ends: From You to the Universe* (Norton, 2010); Ibid., *How It Began: A Time-Travelers Guide to the Universe* (Norton, 2011).

21 Forrest, Peter, "Reincarnation Without Survival of Memory or Character." *Philosophy East and West*, Vol. 28 (1978): 91–97, 91.

22 Rees, Martin J., *Our Cosmic Habitat* (Princeton University Press, 2003).

speculative theory; no point in getting out of sorts due to metaphysics. Also, they've fully accepted their role in the universe, not in the preening way that western cultures often do by finding ways to feel central or important but in the sense that they know their role in whatever the outcome might be.

In Buddhism, a kalpa, the lifespan of the universe, is a trillion years. This is similar to the timescale of the cosmological prediction when all stars will burn out and die and the accelerating universe will be ripped apart by dark energy. During a kalpa, the universe comes into being, it's destroyed, and emptiness ensues. Then it all starts again. No sad goodbyes. In the eons where the universe has lost all structure, time will have no meaning, just as it had no meaning before the birth. The quantum foam that spawned our universe may have generated space-time confections and life beyond imagination. As poet ee cummings said: "There's a helluva universe next door, let's go!"

The Living Cosmos

Materialism is science's greatest strength and its greatest limitation. Theories of matter have led to insight on the structure of atoms and the way they combine into the chemicals and materials that fuel the modern world. We're at the logarithmic midpoint of scales spanning quarks and the observable universe; made of fundamental particles and part of a vast universe, we hold both in our heads. Such a unity is symbolized by the ouroboros, a snake that eats its tail. The ouroboros is found in cultures spanning over 5000 years of history. It represents a primordial unity or a self-reflexive structure; Jung identified it as an archetype of the human psyche. In cosmology it refers to the fact that the big bang can only be understood in terms of a fundamental theory that reduces matter to its essence. And the corollary means that tests of the fundamental theory might only be possible via observations of the early universe. The Dalai Lama makes reference to this idea in his book "The Universe in a Single Atom".²³

Yet theories can't explain consciousness or the profound capabilities of the brain. They are mute to meaning. We're bounded by suffering and joy, tethered in our mortality, and have no theory to cast light on the human condition.

If the Copernican principle holds and we're not special, the universe is built for life. Biologists think life has three key requirements: carbon, energy, and water. The infant universe contained only hydrogen, the simplest element, and the

23 Dalai Lama, *The Universe in a Single Atom: The Convergence of Science and Spirituality* (Three Rivers Press, 2005).

helium that was fused within three minutes after the big bang. Those ingredients account for 99.9% of the normal matter (dark matter being another matter entirely) and the rest is the result of generations of stars living and dying. Our story is intimately connected with the stars. We are literally and metaphorically stardust. Our atoms have taken billion-year journeys through many generations of stars before coming together in the form of a sentient being. The ultimate engine for biology is fusion in the cores of stars, where the temperature and pressure are enough for atomic nuclei to overcome electrical repulsion and fuse to make a heavier element. The higher the star's mass the higher up the fusion chain it can ascend because more mass makes a higher core temperature. Late in their evolution massive stars burp or violently eject gas into space that's enriched in heavy elements.

When the first generation of stars formed, a few hundred million years after the big bang, there were no planets and no people because there was nothing to make them out of. Over time, stars create the heavier elements and return some fraction of that gas into the space between stars, where it can become part of the next generation of stars. And it continues; over cosmic time, stars form with successively more heavy elements mixed into their gas and so are able to make planets. In a sense the universe has been getting more hospitable to planets and people since the big bang. It doesn't take much. Adding up the inner planets and the rocky cores of gas giant planets, and tossing in the asteroids, gives a total of about 20 Earth masses, 0.01% of the mass of the Sun. When stars form, just a tiny bit of grit is left over, but like the grit that grows a pearl, it's interesting what it gives rise to.

I hold up the small metal sphere painted with blue oceans and brown land masses. How special is this, with its amazing and persistent web of life? How special are we, with our hopes and fears and aspirations? The Roman poet and philosopher speculated two thousand years ago: "It is in the highest degree unlikely that this Earth and sky is the only one to have been created... So we must realize that there are other worlds in other parts of the universe, with races of different men and different animals."

Lucretius and other thinkers dreamt about other worlds long before we had the technology to address the question. Finally, the answer is just around the corner. Theorists had long expected that the circumstances that formed the Earth were not unique. Planets should form as natural byproducts of star formation. But how many and what kind? Nobody knew and the observations were fiendishly difficult. I summarize the results of this exciting research. There are now over 3000 exoplanet candidates, with several hundred that are Earth-like and a few dozen that are both Earth-like and in the habitable zones of their stars. The

data is consistent with all Sun-like stars having terrestrial planets. It projects to a hundred million habitable worlds in the Milky Way and a jaw-dropping billion billion in the universe.²⁴

Before we break into groups to discuss the implication of so many Petri dishes where biological experiments may have occurred, I pass around a thimble of sand and a magnifying glass. This isn't the builder's sand we used in our estimation experiment, which was plain quartz. This is sand from a shell beach in England, and under a magnifying glass the multi-colored dots resolve into miniature worlds: cone-shaped, spiky, scalloped, whorled, beaded, soft like chalk, hard like obsidian, all the colors of the rainbow. This is how many worlds we've discovered so far and we haven't inspected any this closely. The number of worlds in the universe is all the grains of sand from all the beaches of the world.

Yet none of these arguments capture the special feeling we have as humans. The Buddha once told his disciples: "Imagine that the whole Earth was covered in water and that someone threw a wooden yoke with a hole in it on to the surface. And suppose that once in a hundred years, a blind turtle were to rise to the surface. What are the chances that it would put its head through the hole in the yoke?" His disciples replied: "It's very unlikely, Lord!" "Well," said the Buddha, "it's equally unlikely to be born as a human being." This was the Buddha's way of saying that being born human is an extraordinarily rare privilege, and one to be treasured.

If the evolution of life and the transition to sentience are not flukes, they're probably occurred many times on a fraction of the habitable worlds in the cosmos. It's also unlikely that we are either the first or the most advanced life form, given 8 or 9 billion years for evolution to take place even before the Earth formed. Some have even speculated that life and intelligence might take purely computational forms, not dependent on carbon chemistry as a substrate. One argument says this has already happened, and we are the consequence—simulated, computational playthings of a hyper-advanced civilization.²⁵ It takes far less energy and is much faster to digitize life and transmit the information from A to B than to actually travel from A to B so computational forms of life are a natural evolutionary stage. An advanced civilization could potentially trivially create vast numbers of computational entities like us, so the Copernican principle says they should outnumber actual biological life forms by a huge margin.

24 Borucki, William, et al., "Kepler Planet-Detection Mission: Introduction and First Results," in *Science* Vol. 327 no. 5968 (2010): 977–980.

25 Bostrom, Nick, "Are we living in a computer simulation?" in *The Philosophical Quarterly* Vol. 53 No. 211 (2003): 243–255.

I see signs of incredulity. But when the monks debate the idea, they find it's a difficult hypothesis to disprove. Geshe Nyima says that in Buddhism, there is no bound on the number of living worlds—they're infinite in number and are eternally going in and out of existence. And there's no insistence that humans are the most advanced form of life. Buddhist cosmology talks about a trichilocosm, a system of a billion worlds, and a highly enlightened being, or supreme nirmankaya, with purview over those worlds. It's striking to me that the concepts map perfectly to the likely number of habitable worlds in a galaxy and the most advanced life form in that galaxy. I doubt that it's us.

Interdependence

In my dream I was back at the big bang. The moment was filled with expectation; the universe has taken a breath and is poised to speak. I look out at the smiles and nut-brown faces and know why I had that dream. My particles and the particles of each of the monks have taken an amazing journey through the universe, fleeing from the coruscating heat of the big bang into the shock of night, buffeted by nebulae and floating in the interstellar void, riding the Milky Way's carousel, and passing through the fusion cores and atmospheres of numerous stars, then churning through a tectonic world, before coming together into my body and the bodies in front of me. We are multitudes. Our atoms diverged from a single point and took myriad paths through space and time before arriving here to reflect on this moment. We're at one with the universe.

Acknowledgements

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Matthias Baaz

Note on Formal Reasoning in Theology

1. Introduction

In the tradition of Thomas Aquinas, the business of logic is the guidance of reasoning, as reasoning needs guidance to proceed without errors. Logic is therefore some sort of superscience or superart¹.

The modern development of logic provides however a somewhat more modest picture: contemporary logic is useful for the analysis of argumentations and for the fine-tuning of reasoning, mathematics being the most prominent field of application. Nontrivial applications of logic to other sciences depend on the adaption of mathematics' logical methods and aims at the peculiarities of the sciences in question. This note should be considered as modest step towards the identification of a logical framework for theology².

2. Medieval logic and theology

From a modern viewpoint, the impact of scientific concepts is more important than their classification. The most important operational concept of medieval logic is without a doubt the syllogism together with the separation of assumption (invention) and judgement. Aristotle twice defines the syllogism as a discourse (oratio) in which – certain things being stated – something other than what is stated follows of necessity from their being so (Prior Analytics 24b 18–20, Topics 100a 25–26). The following syllogism and its analysis is intended to demonstrate the application of logic to theology.

1 An excellent overview on Thomas Aquinas and subject of logic can be found in [5], p. 372.

2 For the adequate definition of technical concepts of contemporary logic, such as first-order language, valuation & derivation, cf. e.g. [3].

Major Premise: *Jesus Christ is God.*
Minor Premise: *God cannot be tempted. (James 1:13)*
Conclusion: *Jesus Christ cannot be tempted.*

However, Jesus Christ was tempted in all points (Hebrews 4:15) and this is a contradiction.

As the Holy Scriptures cannot contain contradictions, the Major Premise has to be understood differently, which asserts the two natures of Christ (human nature / God-nature)³.

3. Modern formal logic

The main appeal of modern formal logic lies in the possibility to analyse the interrelated arguments beyond mere truth: given statements A_1, \dots, A_n, B , it is possible to prove or disprove that A_1, \dots, A_n imply B without further additional assumptions. This insight is at the heart of David Hilbert's axiomatic method, which is the basis of the scientific revolution in mathematics at the end of the 19th century. [1] (The axiomatic method relieved mathematics of ontological challenges: reasoning about objects of arbitrary complexity is reduced to reasoning about finitely many properties of these objects, i.e. a finite amount of information⁴.)

Contemporary mathematical logic obviously fulfils the following preconditions which are essential for the application of formal logic to sciences such as theology:

1. Informal arguments can be faithfully represented by formal arguments.
2. Logical validity is global.
3. Logical and factual validity can be separated.

3 It is therefore obvious that paraconsistent logics (logics not collapsing in the presence of contradictions) are useless for theology as contradictions arise from errors of understanding and are an incentive to remove such errors, not to work with them.

4 The efficiency of the axiomatic method can be illustrated as follows: suppose we want to show that the parallel axiom is not implied by Euclid's other axioms. Before Hilbert's scientific revolution, it would have been necessary to develop a convincing notion of geometric truth such that the parallel axiom is false and Euclid's other axioms are true (this happened in [6]). Nowadays, the existing universal notion of logical truth is sufficient.

4. The setbacks of classical logic

Classical, i.e. two-valued, logic is the logic fundamental for contemporary mathematics. Its leading position has been established by the ground-breaking work of Frege (cf. [2]) and is partly due to the unrestricted symmetry of true and false. Outside of mathematics, the application of classical logic might lead to difficulties, as the following example shows:

Assumptions

1. Up until now there lived and live only a finite number of beings.
2. Human beings originate from non-human beings by evolution.
3. No human being is born exactly at the same moment as another human being.

Conclusion: There is a first human⁵

Note that similar examples can be constructed for concepts as God, love, beauty, etc.

What makes us so uneasy about this argumentation? The underlying problem is that classical logic presupposes the existence of an exhaustive definition of all concepts involved, although we might not know this definition. Most of our everyday concepts are of a different kind. If we intend to identify an object as a chair, we consider the flow of information about the object, and after having obtained some, we might state “this is a chair” or we might state “this is not a chair” – or we might not decide at all (formally, $(A \vee \neg A)$ does not hold).

In other words, we accumulate knowledge through the passing of time and draw conclusions from this knowledge. This more modest approach towards logic is essential for sciences which are based on traditions and where exhaustive definitions go too far (as an exhaustive definition of “God” in theology). Operationally, this logic of reasoning from accumulated knowledge can be described as follows:

1. If a statement is asserted at a time point it is asserted at all following time points, same for the existence of objects.
2. At any time point a statement is interpreted according to the usual (classical) meaning of connectives and quantifiers.

Note that the progress of knowledge is not predetermined, i.e. restricted to one direction, so the flow of time should rather be imagined as a tree of time points.

5 i.e. the earliest born human being, whose both parents are not human beings.

5. Intuitionistic logic

The logic of reasoning from accumulated knowledge can be formally described by a semantic of trees (time frames) with branches of type $\omega = \langle \{D_\alpha \mid \alpha \in W\}, \leq \rangle$ $W \neq \emptyset, D_\alpha \neq \emptyset$ for all α , such that

- 1.1 $\Vdash \alpha A \Leftrightarrow$ for all $\beta \geq \alpha \Vdash \beta A$
- 1.2 for all $\alpha, \beta D \subseteq D$ if $\alpha \leq \beta$
for all α
- 2.1 never $\Vdash \alpha \perp$
- 2.2 $\Vdash \alpha A \wedge B \Leftrightarrow$ for all $\beta \geq \alpha \Vdash \beta A$ and $\Vdash \beta B$
- 2.3 $\Vdash \alpha A \vee B \Leftrightarrow$ for all $\beta \geq \alpha \Vdash \beta A$ or $\Vdash \beta B$
- 2.4 $\Vdash \alpha A \supset B \Leftrightarrow$ for all $\beta \geq \alpha \Vdash \beta A$ implies $\Vdash \beta B$
- 2.5 $\Vdash \alpha \forall x A(x) \Leftrightarrow$ for all $\beta \geq \alpha$ for all $d \in D \Vdash \beta A(d)$
- 2.6 $\Vdash \alpha \exists x A(x) \Leftrightarrow$ for all $\beta \geq \alpha$ there is $d \in D \Vdash \beta A(d)$

1.1 and 1.2 express the accumulation of knowledge in time as they guarantee the stability of already obtained knowledge. 2.1–2.6 guarantee that classical logic is the limit case of this form of reasoning when the time parameter is removed. We say that A is valid iff for all $\langle \{D_\alpha \mid \alpha \in W\}, \leq \rangle: \Vdash \alpha A$: for all time points $\alpha \in W$. The semantics of Kripke frames is described as follows (cf. [3]): $\langle W^*, \{D\alpha^* \mid \alpha \in W^*\}, \leq \rangle, W^* \neq \emptyset, D\alpha^* \neq \emptyset$ for all α

- 1.1* $\Vdash^* \alpha A \Leftrightarrow$ for all $\beta \geq \alpha \Vdash^* \beta A$, A atomic
- 1.2* for all $\alpha, \beta D^* \subseteq D^*$ if $\alpha \leq \beta$
for all α
- 2.1* never $\Vdash^* \alpha \perp$
- 2.2* $\Vdash^* \alpha A \wedge B \Leftrightarrow \Vdash^* \alpha A$ and $\Vdash^* \alpha B$
- 2.3* $\Vdash^* \alpha A \vee B \Leftrightarrow \Vdash^* \alpha A$ or $\Vdash^* \alpha B$
- 2.4* $\Vdash^* \alpha A \supset B \Leftrightarrow$ for all $\beta \geq \alpha (\Vdash^* \beta A$ implies $\Vdash^* \beta B)$
- 2.5* $\Vdash^* \alpha \forall x A(x) \Leftrightarrow$ for all $\beta \geq \alpha$ for all $d \in D^* \Vdash^* \beta A(d)$
- 2.6* $\Vdash^* \alpha \exists x A(x) \Leftrightarrow$ there is $d \in D^* \Vdash^* \alpha A(d)$

A is valid iff for all $\langle W^*, \{D\alpha^* \mid \alpha \in W^*\}, \leq \rangle : \Vdash^* \alpha A$ for all worlds $\alpha \in W^*$.

Proposition. Validity w.r.t. time frames and validity w.r.t. Kripke frames with branches of type ω coincide.

Proof. 1.1 obviously implies 1.1*, 1.2 coincides with 1.2*. Consider

$$\begin{aligned}
 2.2^{**} \quad & \Vdash^* (*\alpha) A \wedge B \Leftrightarrow \text{for all } \beta \geq \alpha (\Vdash^* (*\beta) A \text{ and } \Vdash^* (*\beta) B) \\
 2.3^{**} \quad & A \vee B \Leftrightarrow \text{for all } \beta \geq \alpha (\Vdash^* (*\beta) A \text{ or } \Vdash^* (*\beta) B) \\
 2.6^{**} \quad & \Vdash^* (*\alpha) \exists x A(x) \Leftrightarrow \text{for all } \beta \geq \alpha \text{ there is } d \in D_- \\
 & \beta^{\wedge *} \Vdash^* (*\beta) A(d)
 \end{aligned}$$

We have to show that 2.2*, 2.3*, 2.6* are equivalent to 2.2**, 2.3**, 2.6**. This follows by induction on the complexity for formulas proving 1.1 in parallel.

The logic of Kripke frames is Heyting's intuitionistic logic. [4]

$A \wedge B \supset A$	$A \wedge B \supset B$
$A \supset A \vee B$	$B \supset A \vee B$
$A \supset (B \supset A)$	$\perp \supset A$
$A \supset (B \supset A \wedge B)$	$(A \supset C) \supset ((B \supset C) \supset (A \vee B \supset C))$
$\forall x A(x) \supset A(t)$	$A(t) \supset \exists x A(x)$
$\forall x (B \supset A(x)) \supset (B \supset \forall x A(x))$	$\forall x (A(x) \supset B) \supset \exists x (A(x) \supset B)$
$(A \supset (B \supset C)) \supset ((A \supset B) \supset (A \supset C))$	

Modus Ponens: from A and $A \supset B$ infer B

Theorem. The logic of the accumulation of knowledge coincides with intuitionistic logic.

Proof. We refer to the proposition and argue for soundness and completeness w.r.t. Kripke frames. Soundness follows by induction on the length of derivations, completeness follows from Takeuti's proof which is preferable to other completeness proofs as it directly refers to Kripke frames with branches of type.

6. Conclusion

The efficiency of the axiomatic method might be fruitful to analyse the interrelation of arguments in theology if the underlying logic is chosen with modesty. This note proposes to use intuitionistic logic (or suitable variants of it).

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- [1] D. Hilbert, Grundlagen der Geometrie, Leipzig: B. G. Teubner, 1913.
- [2] G. Frege, Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens, Halle a. S.: Louis Nebert, 1879.
- [3] G. Takeuti, Proof Theory. Studies in Logic and the Foundations of Mathematics, North-Holland, 1987.
- [4] A. Heyting, “Die formalen Regeln der Intuitionistischen Logik,” in Sitzungsberichte der preußischen Akademie der Wissenschaften. Physikalisch-mathematische Klasse, 1930.
- [5] R. v. d. Lecq, “Logic and theories of meaning in the late 13th and early 14th century including the modistae,” in Handbook of the History of Logic, vol. 2, North-Holland, 2008, p. 347.
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VI. Physics and Biology

G. A. D. Briggs

The Search for Evidence-Based Reality

Science in the context of religion

In the science and religion dialogue, a common language is only partially possible. Some words are readily translated. Others denote concepts developed within a particular discipline, which may not have an equivalent outside it. If the captain of a yacht invites a guest aboard, some sailing jargon can be quickly abandoned. Front, back, left and right serve just as well as bow, stern, port and starboard. But some nautical terms have to be learned. A halyard, a downhaul, and a mainsheet have different functions, and to designate them all as ‘that bit of rope over there’ incurs a loss of useful meaning. Eschatology is no more translatable into scientific language than entropy is into theological language. These words have developed as labels for important concepts, which have to be acquired if they are to be of service in scholarly inquiry and practical thought. Even if their definitions are understood, often they carry a wealth of implications and depth of meaning which are only unpacked with detailed study.

Science and theology share a passion for the truth, though we need to recognise that our knowledge is tiny about both, and so our current understanding may miss a lot and will certainly evolve. The Merton Professor of English at Oxford wrote in the preface to *The Faber Book of Science*, “... its aims seem identical with those of theology, in that they both seek to discover the truth. Science seeks the truth about the physical universe; theology, about God. But these are not essentially distinct objectives, for theologians (or at any rate Christian theologians) believe God created the universe, so may be contacted through it.”¹ If God communicates with the world, then theology extends to studying that revelation as a disclosure of truth.

The New Testament provides the definitive record of the life of Jesus, and its writers are passionate about the reality of what they describe. A letter attributed to one of Jesus’ closest friends begins, “It was there from the beginning;

1 Carey, John, *The Faber Book of Science* (Faber and Faber, 1995).

we have heard it; we have seen with our own eyes; we looked upon it, and felt it with our own hands: our theme is the Word which gives life. ... It is this which we have seen and heard that we declare to you also, in order that you may share with us in a common life, that life which we share with the Father and his Son Jesus Christ.”² An early letter to Jewish Christians emphasized the truth of invisible realities, “My main point is this: this is the kind of high priest we have, and he has taken his seat at the right hand of the throne of Majesty in heaven, a minister in the real sanctuary, the tent set up by the Lord, not by man.”³ Other writers have taken up the theme that things are most real in heaven. A 20th Century Oxford professor wrote, “Hell is a state of mind—ye never said a truer word. And every state of mind, left to itself, every shutting up of the creature within the dungeon of its own mind—is, in the end, Hell. But Heaven is not a state of mind. Heaven is reality itself. All that is fully real is Heavenly.”⁴

The concept of reality underpins the search for truth. An approach which has been adopted by both scientists and theologians is critical realism, whereby there is a reality which we seek to describe, but knowledge of that reality is provisional and subject to improvement as better information is obtained and progress is made in understanding. “This path leads to critical reflection on the products of our enquiry into ‘reality’, so that our assertions about ‘reality’ acknowledge their own provisionality.”⁵ Conventionally, reality is that which is the case, independent of any observer or enquiry. In quantum theory it is hard to identify straightforwardly a component of reality which is independent of the means of investigating it.

Quantum theory and the nature of reality

In physics before quantum theory, it was thought that physical objects have definite properties, and occupy definite states, independently of whether they are observed. This is consistent with our macroscopic experience of definite events and outcomes. But in quantum mechanics all possibilities with non-zero probability amplitudes remain open. One of the fathers of quantum mechanics, Neils Bohr, has been paraphrased as saying that quantum mechanics

2 1 John 1:1,3.

3 Hebrews 8:1–2.

4 Lewis, Clive S., *The Great Divorce: A Dream* (Bles, 1945).

5 Wright, Nicholas T., *The New Testament and the People of God* (SPCK, 1992).

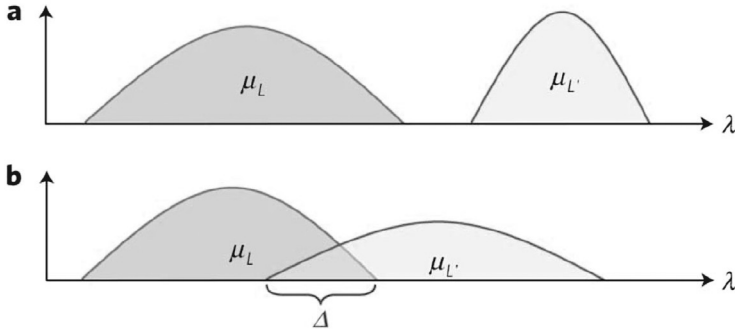
asks only “What can one say?”, as opposed to “What is the world like?” If physical objects do not possess properties independent of the apparatus used to measure them, then it is natural to insist that the only reality is the outcome when an experiment is performed. Albert Einstein found this unsatisfactory. He was convinced that there was an underlying reality, beyond what quantum theory can tell us. One of his papers, which subsequently provided the basis for demonstrating quantum entanglement, was written to show that quantum theory is incomplete, because it predicted counterintuitive correlations between measurements which individually were random.⁶ He wrote, “I incline to the opinion that the wave function does not (completely) describe what is real, but only a (to us) empirically accessible maximal knowledge regarding that which really exists. ... This is what I mean when I advance the view that quantum mechanics gives an incomplete description of the real state of affairs.”⁷

Since the early days of quantum theory, therefore, the question has been raised whether there are hidden variables, not included in the theory, which might give an account of microscopic reality. Quantum randomness might then arise through probability distributions over these variables. An analogy can be considered in human population distributions. One group of the population in a region might be all the females. Another might be all the children aged twelve or under. Each of these categories can be considered as a statistical distribution over individuals. If you are now required to use a computer application which allows you to click at most one classification for each person, some cases would be unambiguous. A thirty-year-old woman would belong to the first category. A six-year-old boy to the second. For an elderly man you would tick neither. But a ten-year-old girl would qualify for either classification, and so in the absence of other guidance you would have to make a random choice, because the two distributions overlap.

6 Einstein, Albert *et al.*, “Can quantum-mechanical description of physical reality be considered complete?” *Phys. Rev.* 47, no. 10 (1935): 777–780.

7 Einstein, Albert, *Letter to P. S. Epstein, 10 November 1945*, quoted in Howard, Don, “Nicht sein kann, was nicht sein darf, or the Prehistory of EPR, 1909–1935: Einstein’s Early Worries about the Quantum Mechanics of Composite Systems,” in Miller, Arthur, ed., *Sixty-Two Years of Uncertainty: Historical, Philosophical and Physical Inquiries into the Foundations of Quantum Mechanics* (Plenum, 1990), 61–111, 103.

Figure 1: Representations of quantum states, represented by the shaded humps, in terms of underlying ontic states, distributed over λ . (a) The distributions are disjoint, and any given λ cannot correspond to more than one quantum state. (b) The distributions overlap, and in the region D a given λ may be consistent with either quantum state.⁸



In a somewhat similar way, it is possible to have two or more distinct states, giving rise to distinct quantum probabilities in such a way that no single measurement can tell you which of those states a system was in (technically these are called *non-orthogonal* states). How can this be? One way of accounting for this is to postulate that each quantum state is made up of a statistical distribution over underlying hidden variables, or so-called *ontic states*:⁹ specifications of how things determinately and mind-independently are (from the Greek root $\delta\upsilon\tau$, which in English has come to mean *having or relating to real as opposed to phenomenal existence*¹⁰). They have never been seen, but if they exist then they could be interpreted as the reality underlying quantum states. Two possible scenarios are portrayed in Fig. 1. Each figure portrays two quantum states, represented by the humped curves μ , as distributions over underlying ontic states λ . The λ -axis is shown as one dimension for simplicity. In Fig. 1a the two distributions are separate; this is sometimes described as a *y-ontic* situation, because the two quantum states cannot both correspond to the same underlying physical reality, *i.e.* there is not a single value of λ which could underlie both. Accordingly, it seems we ought to assign real physical significance to the states themselves: the quantum state a

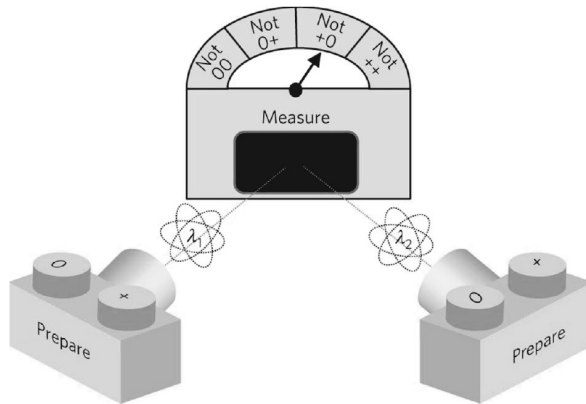
8 Pusey, Matthew F. *et al.*, “On the reality of the quantum state,” *Nature Phys.* 8 (2013): 4–477.

9 Spekkens, Robert W., “Contextuality for preparations, transformations, and unsharp measurements,” *Phys. Rev. A* 71, 052108 (2005).

10 *Oxford English Dictionary Online* (OUP, <http://www.oed.com>).

system is in becomes part of (is entailed by) the objective physical facts.¹¹ In Fig. 1b the distributions overlap; in this case, known as *y-epistemic*, – the kind of case that would have interested Einstein – the underlying ontic states might explain why you cannot distinguish the quantum states by a measurement, because an ontic state in the overlap region Δ could have arisen through the preparation of state μ_1 or state μ_2 , and you cannot tell which.

Figure 2: Two systems are prepared independently. The quantum state of each, determined by the preparation method, is either $|0\rangle$ or $|+\rangle$. The two systems are brought together and measured. The outcome of the measurement can only depend on the physical properties of the two systems at the time of measurement.¹²



An important new theorem has ruled out this kind of statistical interpretation, at least with certain natural assumptions.¹³ Suppose you have a pair of generators each capable of preparing the non-orthogonal states $|0\rangle$ and $|+\rangle$, as illustrated in Fig. 2. By simultaneously pressing one button at random on each generator, two states are fed into the meter system. The theorem requires the assumption that the underlying states from the two generators are uncorrelated; mathematically the combined state (*i.e.* the joint probability distribution over the ontic states) can be factorised into a product of the two individual states. The combined system is then analysed by the meter, which is designed to find a preparation which can be excluded; in Fig. 1 the meter has found ‘not +0’.

11 Harrigan, Nicholas and Spekkens, Robert W., “Einstein, incompleteness, and the epistemic view of quantum states,” *Found. Phys.* 40, no. 2 (2010): 125–157.

12 Pusey et al., “On the reality.”

13 Ibid.

Standard quantum theory predicts that for a given input, one of the four meter indications should never occur. But this is incompatible with the prepared states $|0\tilde{n}\rangle$ and $|+\tilde{n}\rangle$ being represented by overlapping distributions as illustrated in Fig. 1b. Thus within the scope of the theorem distinct (but overlapping) quantum state vectors cannot share the same underlying physical reality, and therefore this does not explain why different states can sometimes give the same result in a measurement.

The theorem has been tested using trapped ions.¹⁴ Not surprisingly, the results are fully consistent with the predictions of quantum theory. A sceptic might ask how you can be sure that the prepared states are not correlated, perhaps through some unidentified principle of physics. That problem has now been overcome by a new no-go theorem which does not require a combined state which is factorisable into a product of two states.¹⁵ Someone already persuaded of the validity of quantum theory would find the theorem convincing by itself, but an experimental test would need up to fifteen dimensions of Hilbert space (rather than the four of the previous theorem), and a fidelity of about one part in 10^5 . This lies beyond the scope of any known kind of experimental test. To be more tractable, it will be necessary to refine the theorem to be more tolerant to experimental imperfections, and preferably less demanding on the number of dimensions. This growing family of no-go theorems addresses the problem of whether ontic states could provide the reality underlying quantum states which Einstein sought. Statistical distributions do not provide the answer.

An experimental test for reality

A different approach to the problem has been provided by Sir Anthony Leggett.¹⁶ He has long been concerned with the mismatch in perception of the quantum

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- 14 Nigg, Daniel et al., “Can different quantum state vectors correspond to the same physical state? An experimental test,” *arXiv:1211.0942* (2012).
 - 15 Maroney, Owen J. E., “How statistical are quantum states?” *arXiv:1207.6906* (2012).
 - 16 Leggett, Anthony J. and Garg, Anupam, “Quantum-mechanics versus macroscopic realism: Is the flux there when nobody looks?” *Phys. Rev. Lett.* 54, no. 9 (1985): 857–860; Leggett, Anthony J., “Experimental approaches to the quantum measurement paradox,” *Found. Phys.* 18, no. 9 (1988): 939–952; Ibid., “Testing the limits of quantum mechanics: motivation, state of play, prospects,” *J. Phys.: Condens. Matter* 14 (2002): R415–R451; Ibid., “The quantum measurement problem,” *Science* 307, no. 5711 (2005): 871–872; Ibid., “Realism and the physical world,” *Rep. Prog. Phys.* 71, no. 2 (2008): Article 022001.

world of the atom and our very classical experience of our ‘us-sized’ lives. He characterised the latter by two postulates which he reckoned are widely held at the macroscopic level, at least implicitly:

1. *Macroscopic realism*: a system with two or more distinct states available to it will at all times *be* in one of these states.
2. *Noninvasive measurability*: It is possible to determine the state of the system without affecting its subsequent dynamics.

A third postulate of *induction* is also implicit, namely that no intervention can affect the previous history. This is equivalent to making Postulate 2 symmetric in time. With Anupam Garg, Leggett developed an inequality which would be satisfied by any system obeying these postulates. This is similar to the inequality used to test for entanglement, and is sometimes therefore referred to as Bell’s inequality in time. However, in this case the question of locality does not arise, since it describes correlations between measurements Q made on a single system at successive times. If the quantity Q can take the values ± 1 , and defining $K_{ij} = \langle Q_i Q_j \rangle$, then the inequality can be stated in terms of the Leggett-Garg function

For a quarter of a century no one could see how to devise a practical experiment that would test this inequality. In recent years there have been different experiments involving photons,¹⁷ superconducting devices,¹⁸ and nitrogen-vacancy centres in diamond.¹⁹ The experiments with photons required a weak measurement, in which the middle value Q_2 was slightly disturbed, which is not therefore non-invasive. The experiments with nitrogen-vacancy centres invoked stationarity, which asserts that changes in Q depend solely on the time elapsed. The superconducting device experiments involved both weak measurements and stationarity. In my laboratory we devised an experiment using phosphorous impurities in silicon which required neither.²⁰

The phosphorous atoms in the silicon were sufficiently far away from each other that interactions between them could be neglected. Each such atom has

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- 17 Goggin, Michael E. et al., “Violation of the Leggett-Garg inequality with weak measurements of photons,” *Proc. Natl. Acad. Sci. USA* 108 no. 4 (2011): 1256–1261.
 - 18 Palacios-Laloy, Agustin et al., “Experimental violation of a Bell’s inequality in time with weak measurement,” *Nature Phys.* 6 (2010): 442–447.
 - 19 Waldherr, Gerald et al., “Violation of a temporal Bell inequality for single spins in a diamond defect center,” *Phys. Rev. Lett.* 107 (2011): Article: 090401.
 - 20 Knee, George C. et al., “Violation of a Leggett-Garg inequality with ideal non-invasive measurements,” *Nature Commun.* 3 (2012): Article 606.

a nuclear spin of $\frac{1}{2}$, which we used as our *system*, corresponding to $|0\hbar\rangle$ when the spin is pointing up, in the same direction as an applied magnetic field, and $|1\hbar\rangle$ when it is pointing down. At low temperature each atom has an associated electron which we could use as an *ancilla* to make a non-invasive measurement. We did this by applying a selective microwave pulse which flips the electron spin if the nuclear spin is up, but not if it is down. We selected only the cases where the electron spin did not change, on the grounds that in that case there could be no effect on the nuclear spin and therefore the measurement was non-invasive. We could have performed the kind of experiment described by Leggett²¹ in which the system is prepared in a such a way that a quantum mechanical calculation would predict that it is definitely in the state $Q_0 = +1$. We could then have compared its behaviour after a fixed time interval: first under the condition that we did not measure Q at time t_0 , and second under the condition that we did measure it then to be $Q_0 = +1$ (if not, then the calculation was wrong). If the behaviour in these two cases is indistinguishable (as we confidently expect) then it would be reasonable to say that the measurement is indeed non-invasive.

Our experiments were performed at finite temperature and magnetic field, albeit not extremely low temperature or high field in terms of the state of the art. A consequence is that not all the spins are correctly initialised at the start of the experiment. Imperfect initialisation of the nuclear spins by itself does not spoil the experiment, but the imperfect initialisation of the electron spins is potentially more serious since they provide the ancillas for the non-invasive measurement. Therefore when after a measurement we try to select for those electron spins which did not flip, we shall include some that did flip but were wrongly initialised. We must take this into account when analysing the results. Because the incorrectly initialised electron spins are susceptible to corruption, we described them by a venality parameter z . We considered two possibilities. The first we called a moderate realist; in this view invasively perturbed systems act in a random way, and hence on average produces no net correlation. The second we called an adversarial realist; in that view invasively perturbed systems act, by some unidentified process, to give the worst possible correlations. Serge Haroche has described this as the neurotic realist!

21 Leggett, "Experimental approaches."

Figure 3: The experimentally determined value of the Leggett–Garg function in a static field of $B = 3.357$ T is plotted (left) at 2.6 K for a thermal initial state with $z = 0.150$ yielding $f = -0.031$ and (right) at 2.7 K using a hyperpolarized initial state with $z = 0.056$ yielding $f = -0.296$. The minimum bound for each macrorealist approach is also plotted: blue for moderate, red for adversarial. Error bars represent uncertainty in measurement of the final state, and the grey point and error bars are the result of correcting for known systematic errors.²²

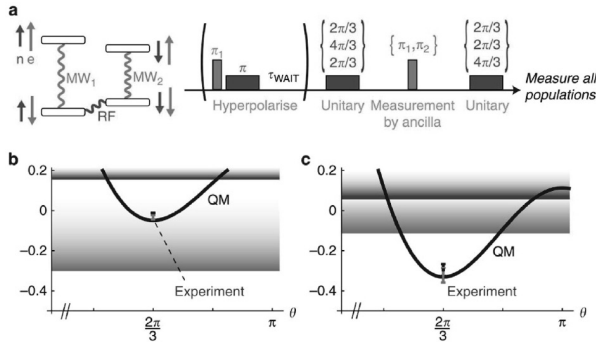


Figure 3 presents result from two experiments with different values of venality. In each case the horizontal axis indicates the rotation applied to the nuclear spin between measurements, and the vertical axis is the Leggett–Garg function f . The blue shaded area gives the limit for a moderate realist, and the red shaded area gives the limit for the aggressive realist. The solid curve is the quantum mechanical prediction for that value of venality. The black square is the experimental measurement, which in the grey square is corrected for systematic experimental errors, with error bars representing uncertainty. In the first experiment, the result lies below the Leggett–Garg bound for a moderate stance, but not for an aggressive stance. In the second experiment the venality was reduced by hyperpolarizing the nuclear spins, and now the result lies below the Leggett–Garg bound whatever the stance. These experiments show that for the system being investigated it is not possible to believe that both state-definiteness and non-invasive measurability hold.

The quantum three-box paradox

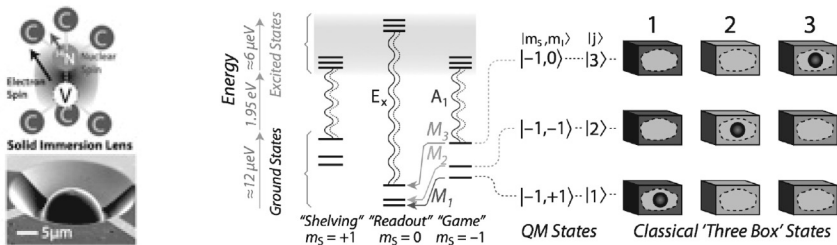
A further test of realism is provided by the quantum three-box paradox.²³ This can be expressed as a game between Bob, who adheres in his beliefs to classical

22 Knee et al., “Violation.”

23 Aharonov, Yakir and Vaidman, Lev, “Complete description of a quantum system at a given time,” *J. Phys. A: Math. Gen.* 24 (1991): 2315–2328.

reality, and Alice, who in this account is the younger and more intelligent of the two, and who believes in quantum superposition.²⁴ The game is devised so that according to classical physics Bob will win, but according to quantum theory Alice will win. It is analogous to the three-shell game which is still used as a confidence trick for the gullible. In the quantum three-box game, Alice puts a ball with equal probability in one of three boxes. Bob is then allowed to open either Box 1 or Box 2 without Alice seeing. If he does not find the ball, then he wins, but only if Alice subsequently accepts that round. After he has closed the box, without leaving any trace of which box he opened, Alice is allowed to manipulate the boxes, and she decides whether to accept that round by then opening Box 3; if she does find a ball in it she accepts. Alice has offered Bob better than 50% odds that if she accepts the round she can correctly predict that he did see the ball. Bob reckons, according to classical probability, that at best Alice can inspect one of the two boxes which he might have opened, and that therefore on average he will win at least half the time. He therefore accepts her odds. To his astonishment, in a perfect experiment he finds that she wins every round that she accepts. Bob's thinking is equivalent to asserting that at any given moment the ball is in one and only one box, and that opening and examining a box makes no difference to the subsequent history, in other words the postulates of macrorealism. In those terms the result is paradoxical.

Figure 4: NV⁻ centre and solid immersion lens. Energy levels of the NV⁻ centre, showing the microwave transitions between different spin states and the fluorescence transition used in measurements. The corresponding quantum mechanical (QM) and classical 'three box' states of the game are indicated.²⁵



- 24 Aharon, Nati and Vaidman, Lev, "Quantum advantages in classically defined tasks," *Phys. Rev. A* 77, 052310 (2008).
- 25 George, Richard E. *et al.*, "Opening up three quantum boxes causes classically undetectable wavefunction collapse," *Proc. Natl. Acad. Sci. USA* 110 (2013): 3777–3781.

Figure 4 illustrates an experiment which was carried out with colleagues in Delft to implement the quantum three-box paradox.²⁶ The materials structure was a centre in diamond consisting of a nitrogen atom substituted for a carbon atom adjacent to a lattice site where a carbon atom is missing, with an extra electron added. A solid immersion lens is used to collect light from this NV⁻ nitrogen-vacancy centre. The energy levels are illustrated, and for the boxes in the “Game” the three lowest levels in the $m_s = -1$ column are used. A box is selected and opened by applying a microwave pulse at the corresponding frequency, M_1 , M_2 , or M_3 , and then shining light of wavelength corresponding to E_x . If the “Game” state was occupied, corresponding to a ball being in that box, then the excitation will be transferred to the “Readout” state and fluorescence will be observed. After observing the fluorescence, the box can be shut by applying a second microwave pulse, and a further operation can be performed to check that the box is indeed shut (and that the excitation has not been inadvertently transferred to one of the “Shelving” states of the NV⁻).

To play the game, Alice first selects the “Game” state $|3\tilde{n}\rangle$, using the M_3 measurement, and she then applies radiofrequency NMR pulses to produce the state $(|1\tilde{n}\rangle + |2\tilde{n}\rangle + |3\tilde{n}\rangle)/\sqrt{3}$, which corresponds to the ball being found with equal probability in each of the boxes. Bob then performs either M_1 or M_2 , keeping both the choice and the result secret. Alice’s decision whether to accept the round is governed by the projection, following Bob’s measurement, on $(|1\tilde{n}\rangle + |2\tilde{n}\rangle - |3\tilde{n}\rangle)/\sqrt{3}$. She finds this by applying further NMR pulses and then measuring M_3 . She accepts the round whenever she gets a positive result, which in a perfect experiment occurs only when Bob had also obtained a positive result.

Before playing the game, there are a number of checks which Bob can perform to satisfy himself that it is being played fairly, and thus *en passant* to ensure that the conditions for a test of macrorealism are satisfied. The results of these are shown in Fig. 5. First Bob checks that Alice has used one and only one ball, with equal probability of it being in each box. He does this by measurements of M_1 , M_2 , or M_3 over a series of experiments (1,200 for each case in Fig. 5). He finds that the probability of each is 1/3 within experimental error. He then checks that if he finds the ball in, say, Box 2, he will still find it there if he looks repeatedly, and conversely if he finds the Box empty he will still find it empty if he looks again. The results in Fig. 5 are not perfect, but as we shall see they are adequate.

26 Ibid.

Figure 5: Bob verifies that there is one and only one ball with equal probability in each box, and that repeated measurements give consistent results, using measurements within the $m_s = -1$ manifold only. The first bar chart shows that Bob's measurement results $P_{M_j}(B)$ when observing the state prepared by Alice in the $|j\rangle\langle j|$ basis are independent of the j -value selected to within experimental error. The other bar charts show the results of a second M_j measurement conditioned on the result M_2 or the result $\neg M_2$.²⁷

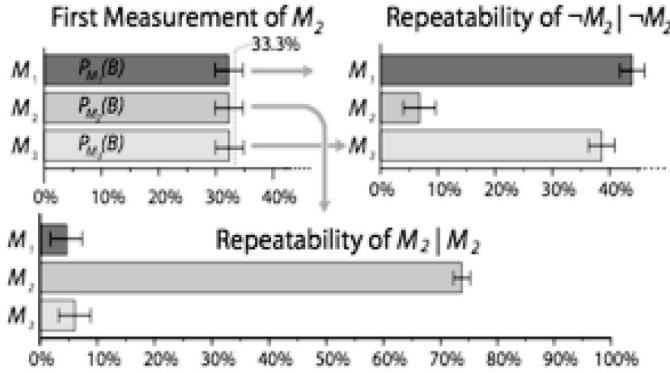


Figure 6: Alice's Marginals show that Alice's measurement M_3 cannot tell whether Bob chose to perform measurement M_1 , M_2 , or neither (N). Alice's Performance shows the probability, in the games which Alice post-selects to play, that Bob has ('Wins') or has not ('Loses') seen state M_j given that Alice has seen M_3 . Alice's probability of winning exceeds 50% by much more than the experimental error regardless of whether Bob chooses M_1 or M_2 .²⁸

The final check before playing the game is that Bob's measurements leave no effect that is detectable by Alice. Figure 6 shows on the left Alice's marginal statistics for accepting a game depending on whether Bob measured M_1 or M_2 or made no measurement N . She cannot tell, in her measurement of M_3 following her final manipulation, which box Bob had opened or even whether he had

²⁷ Ibid.

²⁸ Ibid.

opened a box at all. In a perfect experiment she would obtain a positive outcome for her M_3 in 1/9 (11.1%) of the experiments. Her actual results are closer to 15%. The experimental errors in the experiments are due primarily to imperfect control of the nuclear spins by the NMR pulses. Finally, we are in a position to play rounds of the game, in which Bob always does measure either M_1 or M_2 . Figure 6 shows on the right Alice's performance, where she wins each time she accepts a round and Bob had seen the ball, and loses each time she accepts a round and Bob had not seen the ball. She wins more than about 67% of the rounds that she accepts. This is less than the 100% success that she would obtain in a perfect experiment, but more than the 50% limit that would be allowed by macrorealism.

The result can be cast in terms of the Leggett-Garg inequality, with $Q = +1$ corresponding to the ball being in Box 3, and $Q = -1$ corresponding to the ball being in Box 1 or 2.²⁹ Somewhat remarkably, in the cases where Alice accepts the round quantum theory gives a probability of one that the ball was in Box 1 if Bob were to have looked in Box 1, and a probability of 1 that it was in Box 2 if he were to have looked in Box 2, seemingly yielding a probability of minus one that it was in Box 3.³⁰ This is incompatible with macrorealism, in which M_1 and M_2 are mutually exclusive. As in the earlier experiment, macrorealism cannot allow the Leggett-Garg function to be negative, whereas a quantum calculation has a lower bound $f \geq -0.44$. Alice's performance plotted in Fig. 6 gives $f = -0.265 \pm 0.023$. This violates the Leggett-Garg inequality by 11.3 standard deviations under the fair sampling assumptions of a moderate realist, and by 7.8 standard deviations for an aggressive realist who assigns all undetermined measurements to Alice cheating.³¹

Like the two-level experiment to test the Leggett-Garg inequality, the quantum three-box experiment rules out an interpretation that depends on both the macrorealist postulates. In the two-level experiment we cannot tell which of the postulates is untenable. By moving to a three-level system (technically, three dimensions in Hilbert space), we can perform an experiment in which Alice cannot detect from her statistics the effect of Bob's measurement. That enables each result to be obtained from a single run, in contrast with the two-level system in which the correlations must be obtained in separate runs for each Q_{ij} . Because the measurements introduce no detectable disturbance, we have demonstrated the noninvasive measurability of the second postulate. Therefore it is possible to rule out in this experiment a naïve classical understanding of state definiteness.

29 Ibid.

30 Ibid.

31 Ibid.

Experiments like this illustrate how our understanding of reality can be based on evidence. It may be that one of the reasons why even physicists working with quantum control in their laboratories nevertheless do not instinctively experience superposition in their everyday lives is that the mismatch in scale and complexity is so vast. Rigorous experiments of the kind described here provide a methodology to investigate macrorealism in ever larger systems, and thus to extend the limits to which the quantum considerations of reality can be shown to apply.

Living with unresolved questions

The reader may at this point feel rather like someone reading a mystery by P. D. James in which Commander Adam Dalgliesh has eliminated a number of suspects, but who finds that just as the identity of the murderer is about to be revealed the last few pages are missing. It may seem that we have succeeded in excluding a number of realist interpretations without establishing what is tenable instead. This may nevertheless be a worthwhile achievement. In such a way Derek Parfit, who grew up in the house where I now live, revived moral philosophy through showing that the self-interest theory of rationality is logically self-defeating, without ever finding his *Theory X* which he hoped would replace it.³² It can be useful to show what you cannot believe.

There are interpretations of quantum information that allow realism,³³ which some of my colleagues at Oxford and elsewhere espouse with passion. Interpretations such as those presented here are amenable to experimental investigation, whether in spins or photons³⁴ or mechanical systems. Measures of macroscopicity can be developed,³⁵ but no one knows whether there are limits to the scale on which quantum phenomena such as superposition play a role in our classical experience of the world. It is even being speculated that quantum randomness may play a role in human freedom through projective simulation.³⁶ As progress

32 Parfit, Derek, *Reasons and Persons* (Clarendon, 1984).

33 Timpson, Christopher G., *Quantum Information Theory and the Foundations of Quantum Mechanics* (Oxford University Press, 2013).

34 Pan, Jian-Wai *et al.*, “Multiphoton entanglement and interferometry,” *Review of Modern Physics* 84 (2012): 777–838.

35 Nimmrichter, Stefan and Hornberger, Klaus, “Macroscopicity of mechanical quantum superposition states,” *Phys. Rev. Lett.* 110, 160403 (2013).

36 Briegel, Hans J., “On creative machines and the physical origins of freedom,” *Scientific Reports* 2 (2012): Article No. 522.

is made in the mathematical theory and its experimental tests, so our concepts of reality can be increasingly evidence-based. The techniques and materials which are being developed for quantum technologies not only raise afresh questions about the nature of reality, but also provide new ways to answer them.

In both science and religion there are hard problems which have not yielded easy solutions. A recent poll of physicists, philosophers, and mathematicians revealed that the foundations of quantum mechanics remain hotly debated in the scientific community, with a divergence of views on some fundamental questions.³⁷ Scientists do not stop using quantum mechanics until these questions are resolved; the theory is too robust, and too useful, for that. For rather longer there has been a diversity of views about foundational questions in religion, in such basic topics as divine action in a world well described by the sciences.³⁸ People do not stop exercising faith until such questions are resolved; religion is too robust, and too important, for that. For scientific people engaged with this religious approach, science is not an alien creature with whom they try to dialogue; rather it is in their spinal cord and in their blood stream. Science not only elucidates the physical processes of the world, but also offers profound lessons in how we can live with unresolved questions without diminishing the quest for answers.

Thanks

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37 Schlosshauer, Maximilian *et al.*, "A snapshot of foundational attitudes toward quantum mechanics," *Stud. Hist. Phil. Mod. Phys.* **44** (2013): 222–230.

38 Ward, Keith, *Divine Action* (Templeton Press, 2007); Guessoum, Nidhal, *Islam's Quantum Question: Reconciling Muslim Tradition and Modern Science* (I.B. Tauris, 2011).

Simon Conway Morris

If the Evolution of Intelligence is inevitable, then what are the Metaphysical Consequences?

If you could meet anybody from anytime, who might it be? For historians may be Tacitus (what *were* in those missing books?) or perhaps Thucydides? For artists maybe a conversation with Giorgione, or failing that Constable? And what about evolutionary biologists? For many of them first in the list would surely be Charles Darwin. I think that I might be less enthused. Does this surprise you? After all he comes with the highest credentials. A genius, of course. But more than that. Where he felt his ideas fell short he could be painfully self-critical, although I do not think we should underestimate his rhetorical skill (If any one fact should conspire to show the opposite then my theory will be utterly destroyed, and so on and so forth...). Definitely one of the greatest of scientists, but also devoted to his children, not least the luckless Annie. Not so far as we know, and in contrast to many other Victorians, an adulterer, a frequenter of brothels, a gambler or even a wife-beater. And yet, and yet. Am I alone in wondering about his valetudinarism, the hovering women acting as ministering angels,¹ the dogged reclusiveness that ironically found its apotheosis with his permanent interment in Westminster Abbey? His mood swings of triumphalism as against a remarkably short temper with those who crossed him, not least the curious, neglected and ultimately tragic figure of St. George Mivart.

Darwin? A complex chap, alright. But why I suspect this hypothetical meeting would be more than a disappointment would be when, after a second cup of tea, we started to explore Darwin's metaphysics. Apologies, but they were truly dismal. So far as metaphysics was concerned he was totally at sea. In a letter to William Graham, written less than a year before he died, he wrote how his correspondent had "expressed my inward conviction, though far more vividly and clearly than I could have done, that the Universe is not the result of chance. But then with me the horrid doubt always arises whether the convictions of man's mind, which has been developed from the mind of lower animals, are of any value or at all trustworthy. Would any one trust in the convictions of a monkey's

1 Conway Morris, Simon, Review When the penny dropped: of Janet Browne's *Charles Darwin: The power of place, Notes and Records of the Royal Society* 57 (2003): 250–251.

mind, if there are any convictions in such a mind.”² In fairness, in this letter Darwin was careful to note how he “had not practice in abstract reasoning”. Indeed so; that is my point.

Is it not striking that, apart from such odd musings, how oblivious Darwin remained to the fact that despite the construction of a vast intellectual edifice – one that set out to encompass Galapagos finches, earthworms and the coloured bottoms of monkeys – that this too might be yet another “horrid doubt” and that his life’s labour was no more than an exercise in the arbitrary. Having devoted the best part of a career to pursuing a scientific objective, we can be reasonably sure that his doubts of whether the dog snoozing beside him might be as reliable a judge in reality never crossed his mind. As he himself said in a letter to Asa Gray,³ “A dog might as well speculate on the mind of Newton” and lamely continued “Let each man hope & believe what he can”. It is difficult to avoid the conclusion that for Darwin the roots of rationality were inexplicable. To be sure, the world worked, but ours not to reason why.

The Darwinian world we have inherited goes far beyond the tropes of natural selection and adaptation, even though in malign hands they have been employed to political and eugenic ends⁴ and with dire consequences. Rather, by dodging the question Darwin invites us to think about, albeit in some mysterious fashion that the product is to be equated with the explanation. In other words this is a world where process is equivalent to causality and meaning becomes a post-hoc imposition rather the default position. Not, of course, that I have a shadow of doubt that evolution *per se* happens. To the first approximation Darwin got it right, both in terms of combining apparently disparate observations and by the mechanism of natural (and sexual) selection. Nobel stuff. But this world-picture comes with a whole caravan of assumptions, ones that I like to call evolutionary myths. Not fairy-tales, of course, but areas of received wisdom that might benefit from a re-examination, or if you prefer a really good kicking.

The list is gratifyingly long and a proper demolition of these myths can only be tackled elsewhere. *Primus inter pares*, however, is the fundamental assumption, and almost universally observed, that for all intents and purposes evolution is random, lacking predictability at any useful level. Nor, or at least at first sight,

2 The Darwin Correspondence Project, Letter 13230 (<https://www.darwinproject.ac.uk/entry-13230>; accessed on 14. January 2014).

3 The Darwin Correspondence Project, Letter 2814 (<https://www.darwinproject.ac.uk/entry-2814>; accessed on 14. January 2014.)

4 Weikart, Richard, *From Darwin to Hitler: Evolutionary ethics, eugenics, and racism in Germany* (Palgrave Macmillan, 2004).

does this seem at all unreasonable. Counterfactual histories, either in the form of a Toynbeeian over-view (e.g. the Aztecs invade Europe) or specific episodes with momentous consequences (e.g. Pontius Pilate releases Jesus), are numerous. Their often chilling plausibility, and here Philip K. Dick's *The man in the high castle* is surely in the first league, suggests that alternative outcomes might only be avoided by some fluke of circumstances (for better or worse). Given at one level evolution is no more than history writ large, then so too we can suppose that mutations, mass extinctions and virulent epidemics ensure the process is better compared to living in a pinball machine than an unfolding billion-year saga.

Counterfactual evolutionary histories might have the same entertainment value as the fall of England in 1940 (which we can be sure would have been greeted by rejoicing in Vichy France) or the premature demise of that monster Lenin (where few tears would have been shed). For the time being the same sort of entertainment value applies to extraterrestrial life. What other biological histories might exist must await the discovery of the innumerable biospheres which, it is now confidently assumed, are bestrewn across our Milky Way. Each and every world will be a Darwinian laboratory, each an exo-solar Galapagos, safely isolated until the arrival of our intrepid Starship *Beagle* #2. Here are a billion separate histories, a billion different outcomes. On Earth humans, "out there" something squishy and most likely to our parochial eyes utterly loathsome.

What, however, if all this is a massive anticipation that is in fact grievously wrong? What would it mean if evolution leads to predictable outcomes? To be sure all worlds will be the cockpit of the same sort of Darwinian saga. But what if all depends not only on the same evolutionary processes? In an analogous way to protons, neutrons and electrons that can only arrange themselves as a Periodic Table, suppose that evolution is constrained to follow only certain pathways. What implications might this have? Most obvious would be that alien biospheres would only be "alien" in terms of remoteness rather than composition. To be sure on arrival our galactic explorers might suffer some disorientation but as trained biologists they would soon see the differences to be only skin-deep. Far more significant, however, would be that on whatever planet one visited there the emergence of intelligence would at least one day be an inevitability. Mind you, a visit to a planet at its Archean stage of development would require a certain degree of patience; in the order of a couple of billion years before the bacteria got their act together and became a brain. It is important to remember that from this perspective it is of little consequence how many planets have a biosphere which inevitably will incubate intelligence. It hardly matters if this happened only once on a peculiarly favoured planet (this conveniently confirms the Fermi

paradox) or innumerable times on any earth-like planet in its habitable zone (if so, the Fermi paradox is far more profound than we realize). Either way, it would suggest that the real interest in evolution lies in the fact that this is simply the mechanism by which the Universe becomes self-aware.

If this is correct, then a metaphysical investigation has a restored legitimacy. Thus it entitles us to ask deeper questions, ones that accept the reality of evolution, but seek an underlying order. For example, what would it be that constrains evolution to ensure such an outcome? So too if the evolution of intelligence is an inevitability (or at least highly probable), what implications might this have for the development of music, mathematics, language and rational discourse all of which seem to sunder us from the rest of creation? These, of course, are hardly the questions that surface at a typical biological seminar or even congress. If they ever are, then it is entertaining to see how the ultra-Darwinian artillery wheels round to meet this perceived threat. One can only admire the discipline, the closing of ranks, the terse orders, the gleaming eyes. Salvo after salvo will be dispatched, but we can be confident that the shots will go wild or fall as duds.

As ever the ultra-Darwinians will miss the point. To insist that either we are seamlessly attached to the apes or alternatively we are now irrevocably sundered presents us with an apparent dichotomy that results in some curiously inverted thinking. The first is biologically true but at one level curiously uninteresting. The second stance may be attractive to some religious fundamentalists but rather than attempting to restore humans to some sort of pedestal, which Darwin and his acolytes so successfully dynamited, we should stand back and consider the wider perspective. Of course we are products of evolution and trivially not only are we connected by direct descent from the apes but in fact by a vital thread that in principle we can trace to the first cell. None of this is in dispute. Rather the point is that *in principle* any organism equipped with the rudiments of intelligence is capable of travelling along the same road as we hominids embarked upon some millions of years ago.

In other words, one needs to make a crucial distinction between the traditional evolutionary trope of emergence as against a radical reformulation that thinks in terms of discovery. The former is unproblematic in terms of providing the historical narrative, however fragmentary it may be. The problem, however, is that any such narrative is hardly equipped to explain how features such as consciousness or language actually emerge. It is all very well appealing to “evolutionary roots” or whatever, but in reality in crucial instances this approach is compelled to perform a series of conjuring tricks designed to summon forth hypothetical entities without which none of the vital linkages can be explained. Note well, this

emphatically is not some sort of “gaps argument”. It is not to question evolutionary continuity, let alone “missing links”, but to provide a convincing explanation of how something actually came about. This is immediately apparent with the problems associated with things like consciousness or language. In either case we seem to face the problem of indefinite regression. Most obviously in the case of consciousness this argument, if not necessity, for regression almost inevitably entails some sort of panpsychism. The radical view, however, does not dispute that point A (bacterium) and point B (brain) must be connected by a history, but its central question is how evolution might discover a form that is pre-existent. In this context one would immediately conjure up entities mind and mathematics. Neither is this approach embarrassed to invoke when necessary realities of *any* sort. The only criterion is that in one way or another they are able to contribute to a rational framework. Such might well be of a scientific, but equally they could be of a metaphysical or theological nature. Moreover, to suppose that any one of these fields has a suzerainty would be distinctly unwise. And there is another proviso, to the effect that however impressive our intellectual edifices may look, some things may remain forever beyond our comprehension.

This distinction between emergence and discovery is all important. The latter now makes better sense if indeed evolution is a predictable process in as much it presupposes a prior “substrate” across it must navigate. But why, despite the undoubted attraction of counterfactual stories or alternate worlds, do I think that evolution is very far from random? There are several reasons. First the nature of organic chemistry suggests that the building blocks (e.g. amino acids, nucleosides, alkanes) necessary for life are readily synthesized, and often under a wide range of conditions. How they actually combine into a functioning cell is a very different question, but the likelihood of the emergence of such complex molecules as proteins, phospholipids, carbohydrates and nucleic acids can hardly be doubted. Second, although at first sight biology seems to be characterized by indeterminate forms – what could be more different than a ginkgo and a honeybee? – in fact as D’Arcy Wentworth Thompson explained it is pervaded by an inherent geometry.⁵ Amongst the most familiar is the Fibonacci series (1, 1, 2, 3, 5, 8, 13 109, etc) that is classically expressed in the spiral form of the Pearly Nautilus shell or as a sunflower floret. Of course, no such forms can exist without genetic machinery, but such genes do not determine the form. This is because the shell or floret depends on an inherent geometry whose descriptive equations

5 Thompson, D’Arcy Wentworth, *On Growth and Form*. (Cambridge University Press, 1942).

far predate the earliest life. To reiterate, the logarithmic spiral of the Pearly Nautilus does indeed emerge generation by generation via the embryo but the form itself is discovered because it fits to a pre-existent mathematical template. In this sense the Pearly Nautilus has no choice. The third reason to think evolution is predictable is the ubiquity of convergence.⁶ Be it the thylacosmilid marsupial “sabre-tooth”, the camera-eye of the octopus, the agriculture of attine ants (leaf-cutters) or the enzyme carbonic anhydrase, these four examples are just the tip of an iceberg that stretches from molecular biology to behaviour.

Evolutionary convergence is important because it suggests that the number of viable biological solutions is an infinitesimally small fraction of all theoretical possibilities. A fourth strand to the argument in support of predictability is the neglected observation that biological systems are for the most part not fairly effective, but extraordinarily so, to the degree that in one case the authors can write of “The tooth of perfection.”⁷ Consider, for example, the nature of sensory systems.⁸ In sharks electrical fields can be sensed to the level of nano-volts, in principle eyes and noses can detect respectively a single photon or molecule, ears can work to the level of thermal noise, and so on. In other words biological sensory systems have reached the limits of the physical universe.⁹ So far as a photon, for example, is concerned, biology cannot know of anything more fundamental. Nor is it any way accidental that science extends these windows of observation to entirely new domains. Radio-telescopes, electron microscopes, synchrotrons, x-rays diffractometers, particle accelerators in their different ways all serve to reveal regions of the Universe that paradoxically depend on living forms to discover them.

Such windows, of course, would remain opaque without the application of mathematics and hypotheses. Thus we return to the question that Darwin so comprehensively ducked. As already indicated his method whereby at first sight all trans-specific barriers dissolve, all species are ultimately related, has the implication that any claim for humans to enjoy a privileged status is moonshine.

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- 6 Conway Morris, *Life's Solution: Inevitable Humans in a Lonely Universe* (Cambridge University Press, 2003).
 - 7 Evans, Alistair R. and Sanson, Gordon R., “The tooth of perfection: functional and spatial constraints on mammalian tooth shape,” *Biological Journal of the Linnean Society* 78 (2003): 173–191.
 - 8 Autrum, Hansjochem, “Performance limits of sensory organs,” *Interdisciplinary Science Reviews* 13 (1988): 27–39.
 - 9 Conway Morris, “Darwin at the edge of the visible universe,” *EMBO Reports* 11 (2010): 898.

Peculiar indeed, but no more peculiar than a tapeworm. Special of course, but no more special than an aard-vark. "Just another species" as the taunt goes. And when it comes to cognitive capacities, intelligence, emotions and so forth, then the distinctions between the great apes (with their pleading eyes and furry muzzles) and us (at our laptops) seems to be paper-thin, if they exist at all. Birds are perhaps even more instructive. That they can sing hardly requires comment, although it is less often appreciated that taught song by tutors (as against innate song) has evolved three times amongst the birds.¹⁰ Many investigators¹¹ have emphasized the parallels between bird song and human language, not least the analogous babbling phase whereby chicks and toddlers experiment with the sounds emerging from their respective syrinx and larynx before it crystallizes into song and words (although these should not be assumed to be equivalent, in fact rather the reverse). Another striking link is the ability of a number of birds to make tools,¹² of which the most celebrated is the New Caledonian crow.¹³ Their capacity with probes and hooks outstrips any chimpanzee, while the evidence for successive modification makes it tempting to identify these crows as engaging in a proto-technology.¹⁴ More generally, the cognitive convergences that link the great apes and corvids seem to be all the more striking when it is recalled how radically the avian brain structure differs from the apes (and other primates).

At first sight the similar set of convergences that serve to link the cognitive worlds of the great apes to the cetaceans, notably the dolphins,¹⁵ might seem less surprising given the shared possession of a mammalian brain. Even so the dol-

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- 10 Gahr, Manfred, "Neural song control system in hummingbirds: comparison to swifts, vocal learning (songbirds) and nonlearning (suboscine) passerines, and vocal learning (budgerigars) and nonlearning (dove, owl, gull, quail, chicken) nonpasserines," *Journal of Comparative Neurology* 426 (2000): 182–196.
 - 11 Goldstein, Michael H., King, Andrew P. and West, Meredith J., "Social interaction shapes babbling: Testing parallels between birdsong and speech," *Proceedings of the National Academy of Sciences, USA* 100 (2003): 8030–8035.
 - 12 Boswall, Jeffery, "Tool-using and related behaviour in birds: yet more notes," *Avicultural Magazine* 89 (1983): 170–181.
 - 13 Bluff, Lucas A., Weir, Alex A. S., Rutz, Christian, Wimpenny, Joanna H. and Kacelnik, Alex, "Tool-related cognition in New Caledonian crows," *Comparative Cognition & Behavior Reviews* 2 (2007): 1–25.
 - 14 Hunt, Gavin R. and Gray, Russell D., "Diversification and cumulative evolution in New Caledonian crow tool manufacture," *Proceedings of the Royal Society of London, B* 270 (2003): 867–874.
 - 15 Marino, Lori, "What can dolphins tell us about primate evolution?" *Evolutionary Anthropology* 5 (1996): 81–85.

phin brain¹⁶ has a number of peculiarities (e.g. paralimbic lobe), and more importantly its oceanic habit, reliance on echolocation and effective absence of manipulative appendages (although this does not preclude tool use¹⁷) would make a divergence of cognitive capacities from those tree-dwellers (great apes, corvids) as the more probable. That across this range of ecologies and phylogenies the same cognitive capacities have emerged is noteworthy. Orthodox Darwinians would, I expect, argue that this is merely (whatever that means) the result of a shared brain chemistry and neural cells. But what exactly is this meant to explain? Alternatively one might enquire whether these similarities arise because all these minds reflect, albeit at different capacities, a Mind.

Again we are invited to choose between explanations of emergence versus discovery. Evolution is the road, but does it explain why the road is there in the first place? To see evolution as a search-engine is certainly not to deny the absolute necessity of a given substrate, say in the context of a nervous system the evolution of acetylcholine (a molecule which significantly evolved long before the earliest nervous system¹⁸). Nor is it to dispute that the only mechanism in town is broadly Darwinian. Perhaps a reminder is in order. Look in the mirror, or visit Venice, or listen to the Good Friday music of *Parsifal*: “Just another species?”; maybe, but of the billions of species that were and are humans really are very odd. What we know about hominid evolution, now brought into increasingly sharp focus through the fossil record, provokes us to ask: when did the transition from an ape, amongst which *Sahelanthropus* and *Ardipithecus* can be safely numbered, to fully human *actually* occur? Not that we should assume an overnight change nor the invocation of a primal couple, although the sheer power of the *Genesis* accounts in the Bible is a useful reminder of our sensitivity (if not vulnerability) to myth. Counterfactuals can assist, but also remind us of this gulf. Harry Turtledove’s *A different flesh* (1988)¹⁹ explores this area on the basis of a not entirely incredible supposition that the Americas were only populated by an *Homo erectus* diaspora. So it is that in this counterfactual world First Contact only

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- 16 Hof, Patrick R., Chanis, Rebecca and Marino, Lori, “Cortical complexity in cetacean brains,” *Anatomical Record A* 287 (2005): 1142–1152.
 - 17 Mann, Janet, Sargeant, Brooke L., Watson-Capps, Jana J., Gibson, Quincy A., Heithaus, Michael R., Connor, Richard C. and Patterson, Eric, “Why do dolphins carry sponges?” *PLoS ONE* 3, no. 12 (2008): e3868.
 - 18 Kawashima, Koichiro, Misawa, Hidemi, Moriwaki, Yasuhiro, Fujii, Yoshihito X., Fujii, Takesho, Horiuchi, Yoko, Yamada, Tomoya, Imanaka, Tadayuki and Kamekura, Masahiro, “Ubiquitous expression of acetylcholine and its biological functions in life forms without nervous systems,” *Life Sciences* 80 (2007): 2206–2209.
 - 19 Turtledove, Harry, *A different flesh* (Baen, 1988).

occurs when the European voyagers arrive at the shores of what is effectively a Pliocene continent. Two million years of evolution are telescoped into a single afternoon. I warmly recommend this book on account of Turtledove's enduring ingenuity but from our perspective all we need to know is that the gulf he so skilfully depicts remains almost unbridgeable. Ultimately the American hominids (or as he calls them "sims") find themselves as only useful as laboratory fodder.

We peer across the gulf that now separates us from even our immediate ancestors, but where is the strand that will link us? One might think in terms of the fossil record because whilst far from complete the outline of the story is clear enough. But invaluable as this historical narrative is in this context it may not be that much help. By "gulf" I refer not to the procession of skeletons holding hand-axes, but the fact that we expect no chimpanzee to solve equations, write music or blush. Help to bridge this gulf is all too seldom to hand, at least that is beyond the ruminations of the more credulous evolutionary psychologists. I am particularly struck by David Stove's *Darwinian fairytales* (1995)²⁰. Here we have a set of connected essays that have no quarrel with our descent from apes. Nevertheless, Stove insists that to argue that we can explain our humanness (and amongst the example Stove gives is the telling one of pets) by a simple extrapolation from ape society remains a forlorn hope. It might be assumed that Stove belonged (he died in 1994) to that band of pesky creationists, but the exact reverse is the case. Stove was an atheist and an expert on David Hume, that bane of the less experienced Christian apologists. He also subjected that darling of many scientists (notably the ever-credulous cladists), Karl Popper, to some rough handling.²¹ Stove stands as a useful reminder (and not least because of his gratifyingly deep political incorrectness) that if scientists wish to stray into philosophical territory they had better take the right equipment. Few seem so inclined.

How then might we try to place mind in any evolutionary context? First whilst we are firmly embodied, and it is now clear that nervous development has intimate links to both gut floras²² and immune systems²³, we must assume

20 Stove, David, *Darwinian fairytales: selfish genes, errors of heredity and other fables of evolution* (Encounter, 1995).

21 Ibid., *Popper and after: Four modern irrationalists* (Pergamon, 1982).

22 Heijtz, Rochellys D., Wang, Shugui, Anuar, Farhana, Qian, Yu, Björkholm, Britta, Samuelsson, Annika, Hibberd, Martin L., Forssberg, Hans and Pettersson, Sven, "Normal gut microbiota modulates brain development and behavior," *Proceedings of the National Academy of Sciences, USA* 108 (2011): 3047–3052.

23 Blalock, J. Edwin, "The immune system as the sixth sense," *Journal of Internal Medicine* 257, no. 2 (2005): 126–138.

that so far as carbaquist forms are concerned for mind to emerge (or be discovered) then a brain is a *sine qua non* and one that is built by nervous tissue. That the component cells of a nervous system are not inherently improbable is evident from the fact that a significant proportion of what is required to construct a nervous system had evolved long before the first animal. For example, some thirty percent of the genes required are already present in fungi (aka yeast) and plants (aka *Arabidopsis*).²⁴ Nor is this surprising given that many aspects of a nervous system draw on general features of cell biology. Much more noteworthy is that Katsuhiko Mineta and colleagues point out how the genes from these nerveless organisms can be allocated to the five principal categories (e.g. neurotransmission) that define the operation of any nervous system. Inherency is also apparent from the fact that in a substantial part of the synaptic machinery (ensuring the transmission of information from neuron to neuron) has evolved in protistans²⁵, lacking of course any nervous system. That nervous systems are very far from improbable is also evident from the fact that another key component, the sodium ion channel, has evolved independently a number of times.²⁶

Once a nervous system has evolved then we can be equally confident that its aggregation into a brain is a near certainty. This is simply because a brain has evolved multiple times.²⁷ So too encephalization is a recurrent phenomenon²⁸, although the staggering metabolic demands mean that disproportionately large brains evolve less often. What, though, of these giant brains? Do they make consciousness or alternatively do they access it? The former, of course, is the default assumption of nearly all biologists, but if consciousness is now “understood” are we not entitled to ask why are the Nobel Committee has been so very slow on the uptake? Lack of documentation? Considerably more likely is the fact that apart

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- 24 Mineta, Katsuhiko, Nakazawa, Masumi, Cebrià, Francesc, Ikeo, Kazuho, Agata, Kiyokazu and Gogobori, Takashi, “Origin and evolutionary process of the CNS elucidated by the comparative genomic analysis of planarian ESTs,” *Proceedings of the National Academy of Sciences, USA* 100 (2003): 7666–7671.
 - 25 Ryan, Tomás J. and Grant, Seth G. N., “The origin and evolution of synapses,” *Nature Reviews Neuroscience* 10 (2009): 701–712.
 - 26 Koishi, Ryuta, Xu, Haoxing, Ren, Dejian, Navarro, Betsy, Spiller, Benjamin W., Shi, Qing and Clapham, David E., “A superfamily of voltage-gated sodium channels in bacteria,” *Journal of Biological Chemistry* 279 (2004): 9532–9538.
 - 27 Chittka, Lars and Niven, Jeremy, “Are bigger brains better?” *Current Biology* 19 (2009): R995–R1008.
 - 28 Roth, Gerhard and Dicke, Ursula, “Evolution of the brain and intelligence,” *Trends in Cognitive Science* 9 (2005): 250–257.

from the breezy confidence of those neuromythologists (to use Raymond Tallis' useful term), the problem of consciousness is far more intractable than most neurobiologists are willing to acknowledge. The irony that we are conscious – unless one takes a much darker view that we are either metaphysical liars or pawns in a virtual world – but remain at a complete loss to explain the phenomenon needs no emphasis.

So is there any way forward? Once again the analogy of a search engine, or perhaps an antenna, might have merit. In this context consider first the nature of music. Not by humans, but by animals. As is evident from animals such as song-birds and male humpback whales music has evolved independently a number of times. Such convergences might be attributed simply to the physics of sound production, the vibrations of columns of air, but this hardly explains why the similarities to human music include harmonies, melody, riff sessions and even cultural exchange. Suppose, as Gray *et al.* suggest,²⁹ this music converges because in one way or another all are accessing a Universal Music. Such, of course, is not to be construed as some sort of cosmic hum or buzz but rather an infinite exploration of a dimension orthogonal to language. In their different ways, as Keats realized, animal song may delight, but it can hardly be said to compare with Mozart (or Bach, or ...). In the case of Mozart there is a rather famous letter to a Baron von P. (or B.) where he wrote "Nor do I hear in my imagination the parts successively, but I hear them as it were all at once."³⁰ It is only fair to say that the authenticity of this letter has been questioned, although Brian Inglis, who had more than a passing interest in the paranormal, was persuaded that assessing the likelihood of whether Mozart ever had these sorts of experience was prejudiced by one's underlying metaphysics.³¹ And maybe it was not so far from the mark. In this letter Mozart continued "What a delight this is I cannot tell! All this inventing, this producing, takes place in a pleasing lively dream". Mozart was not alone. Quite well known is Robert Louis Stevenson's description of how his stories and plots, not least that of Dr Jekyll and Mr Hyde, were arrived at in dreams.³²

29 Gray, Patricia M., Krause, Bernie, Atema, Jelle, Payne, Roger, Krumhansl, Carol and Baptista, Luis, "The music of nature and the nature of music," *Science* 291 (2001): 52–54.

30 (www.mozartforum.com/VB_forum/showthread.php?t=337; accessed 1 March 2013).

31 Inglis, Brian, *Trance: A natural history of altered states of mind* (Grafton, 1989), 125.

32 Stevenson, Robert L., *Across the plains with other memories and essays* (Chatto & Windus, 1918), chap. 8.

It may also be no coincidence that many see links between music and mathematics, although the practicalities of the latter discipline suggest the existence of yet another orthogonal dimension. If our music is a whisper (or echo) of the Universal Music, so according to many mathematicians their equations are discovered rather than invented. As already emphasized discovery implies a pre-existence. Recall how Ramanujan, who in the sphere of mathematics might be compared to a Mozart, accessed his equations.³³ For him they were displayed on a scroll, held by the goddess Namagiri, and seen in his dreams. One might protest that given Ramanujan was a Hindu he was simply imposing a cultural filter. Maybe so. But even if this has the alarming consequence that we too can only see Reality through a cultural gauze, it does not negate the fact that mathematics is universal and in some sense Platonic. So too, as Eugene Wigner pointed out,³⁴ it is far from clear why mathematics is so unreasonably effective. Unless, of course, it is embedded in the very sinews of the Universe.

As with humans there is no reason to think that animals are denied glimmerings of arithmetical competence. The independent evolution of numerosity in a wide variety of animals, including bees and fish, is one pointer in that direction.³⁵ What I find far more alarming is that although we can readily employ numbers as abstract entities, in the case of the rhesus monkey it can be shown that their numerosity follows the Weber-Fechner law of proportionality that otherwise is characteristic of sensory systems.³⁶ In other words they assess numbers in the same way as one might, to give a classic instance of the Weber-Fechner law, differentiate varying weights. Here we seem to come to an abrupt paradox between the fact that as Cartesian creatures we assume that we can only know the world by using our sensory apparatus, but the inner I inhabits an abstract (and mathematical and symbolic and cultural) world. Here perhaps is the nub of the question of consciousness.

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- 33 Kanigel, Robert, *The man who knew infinity: A life of the genius Ramanujan* (Scribners, 1991).
 - 34 Wigner, Eugene, "The unreasonable effectiveness of mathematics in the natural sciences," *Communications in Pure and Applied Mathematics* 13, no. 1 (1960): 1–14.
 - 35 Agrillo, Christian, Dadda, Marco, Serena, Giovanna and Bisazza, Angelo, "Do fish count? Spontaneous discrimination of quantity in female mosquitofish," *Animal Cognition* 11 (2008): 495–503; Dacke, Marie and Srinivasan, Mandyam V., "Evidence for counting in insects," *Animal Cognition* 11 (2008): 683–689.
 - 36 Nieder, Andreas and Miller, Earl K., "Coding of cognitive magnitude: Compressed scaling of numerical information in the primate prefrontal cortex," *Neuron* 37 (2003): 149–157.

Nowhere is this more true than when we come to language. It surely is very odd that although some animals possess a semantic and syntactical competence,³⁷ still they lack language. The standard argument goes that the vocalizations of animals are incipient to fully fledged language as numerosity presumably is to quadratic equations. As already mentioned the parallels between bird song and language are not only striking but would support the idea of inherency, that is the template for language evolved long before articulation. Maybe so, but bird song seems unlikely to be the carrier of rational meanings. So too to argue that humans possess a universal grammar or some other sort of language instinct seems to be tautological; like phlogiston it is rather difficult to actually find. There are, alternatives, but they are so radical as to discomfort almost any evolutionary biologist. I speak of the ideas of Owen Barfield.³⁸ These are complex and difficult to summarize, but in effect Barfield was struck by three things. First, words such as “scruple” moved from having external meanings, in this case an obstacle such as a stone in a shoe, to the now more familiar sense of a moral hesitation. Second, words such as “iron” or “breath” originally had extraordinarily wide meanings, whereas over time they fractured so their context became increasingly precise. Third, and most importantly, the origins and evolution of language cannot be divorced from mythopoesis. It is not surprising that Barfield exerted enormous influence on his fellow Inklings, not least J.R.R. Tolkien. I have often wondered how it is that in his *Lord of the Rings*³⁹ Tolkien manages to convey a world of such conviction. Literary skill, a vast knowledge of languages and philology, not to mention endless revisions are all contributory, but in my opinion there is something more at work here. What overwhelms me is the sheer mythopoeic power of his trilogy. This is surely why it both resonates with so many, and so too is despised by our cultural guardians.

In the Christian creed we proclaim a Creation (and of course an Incarnate Creator) who made all things, visible and invisible. It is a curious irony that Science, having opened windows that are otherwise entirely invisible to animals, resolutely insists that only what it can “see” is the totality of all that is there. If

37 Herman, Louis M., Kuczay, Stan A. and Holder, Mark D., “Responses to anomalous gestural sequences by a language-trained dolphin: Evidence for processing of semantic relations and syntactic information,” *Journal of Experimental Psychology, General* 122 (1993): 184–194.

38 Barfield, Owen, *Poetic diction: A study in meaning* (Faber and Faber, 1952); Barfield, Owen, *The rediscovery of meaning, and other essays* (Wesleyan University Press, 1977).

39 Tolkien, John R. R., *The Lord of the Rings* (George Allen & Unwin, 1966).

you need to study an object at the micron scale or a distant galaxy then you will book access to an electron microscope or an infra-red telescope. But it would not be advisable to reverse their roles. Neither would exist without a human brain, but this does not exclude the possibility that it has other metaphysical capabilities tucked up its metaphorical sleeve. To conclude here are two stories. Both are anecdotes and so far as I am aware with no precise parallel, although certainly with strong resonances of other accounts. Note if either happened – and I leave open exactly what that might mean – then the materialist world is irrevocably fractured.

The first⁴⁰ involves a man called Victor Goddard, a RAF pilot who eventually rose to the rank of Air Marshal and was also knighted. Reasonable credentials you might think. In any event in 1935 he happened to be flying near Edinburgh. The weather was rough and control of his biplane difficult. Suddenly he emerged into the sunlight and there below him (and he was very low) was the airfield of Drem. It was clearly operational, with planes, hangars and ground staff in blue uniforms. One of the planes was a monoplane. There was only one snag and that was in 1935 Drem airfield was abandoned, no monoplanes were in service and crews did not wear blue. Somehow pilot Goddard had seen some five years into the future, when Drem was fully functioning as a war-time RAF station.

Here is the second anecdote.⁴¹ It concerns a priest, one John O'Connor, who might otherwise remained in relative obscurity had he not happened to have been a good friend of G.K. Chesterton and as importantly the original inspiration for his Father Brown. His duties are wide and include visiting when necessary the local lunatic asylum. It was an April morning, but on this occasion something decidedly odd had happened. As the warders explained, the previous evening a lunatic had arrived and by necessity was put in the padded cell. Such methods of incarceration (as with "basket-case") are now more part of our folklore but at a time when few drugs were available the degree of self-harm and injury was mitigated by walls made of smooth and unclimbable leather. In this cell light was admitted by a small window, with the added precaution of bars. When Father O'Connor entered the padded cell there was, however, no inmate and high beyond reach was the window, now broken. Outside footprints were found directly beneath the window. The man himself was never seen again. As Father O'Connor said "This is not a legend."⁴²

40 Goddard, Victor, *Flight towards reality* (Turnstone, 1952).

41 O'Connor, John, *Father Brown on Chesterton* (Frederick Muller, 1972).

42 *Ibid.*, 18.

So what does all this mean? From one perspective, nothing! Assuming they are not the product of liars, or more charitably fantasists, they make no sense at all. If I had not had a few very strange experiences myself I would be inclined to move to Gallic mode and shrug my shoulders. I have, however, every reason to believe both Goddard and O'Connor were telling the truth. They are, as Jeffrey Kripal says, *Authors of the impossible*.⁴³ In this book he reminds us of how Charles Fort saw inexplicable occurrences as “damned”, that is beyond any scientific explanation. But unfortunately for the committed materialist they still happen. In my view this tells us that reality is indeed made of orthogonal dimensions that at present we can only dimly intuit. Nor is it surprising that a brain that rose to prominence in a Pliocene context might take some time to realize what it has encountered, especially if the cultural milieu is one of intense scepticism and hermeneutical suspicion. So when we read accounts of a person who strolls across lakes, turns water into wine, heals at a distance, resurrects the dead and is himself resurrected we should not flap our hands, roll our eyes and make snorts of derision, but rather murmur “Yes, now this makes sense”.

Acknowledgements

My thanks to Vivien Brown for manuscript preparation. I am also most grateful to Michael Welker and the John Templeton Foundation for the invitation to Heidelberg to participate in The Science and Religion Dialogue: Past and Future.

43 Kripal, Jeffrey J., *Authors of the impossible: The paranormal and the sacred* (University of Chicago Press, 2011).

Günter P. Wagner

The Use of Metaphors when Talking about the Nature of Organisms

The relationship between science and religion is burdened by a divisive history at many levels and it is a difficult task to identify areas in which science, religion and theology can interact productively.¹ It seems obvious that attempts by either side to do the job of the other are doomed to fail; with what I mean attempts by scientists to declare what religion is about² or religion deciding how science is done or what scientific insights are acceptable.³ Attempts to forge a joint narrative from elements of scientific and religious traditions are interesting but may quickly reach the limits of what each side takes for granted in their respective narratives. There is however, one area, in which I have great hopes for a productive interaction between theologians, clergy and scientists. A legitimate area of joint concern for both sides is the spiritual and mental wellbeing of humankind.

Science and its extension in technology affects the lives of people in direct physical as well as indirect spiritual and mental ways. It is easy to see that the consequences of technological progress affect people in ways that religious leaders and people of faith are called upon to react. Examples are the consequences of reproductive technologies on human life and wellbeing as well as the impact of economic activity on the environment. There are, however, also more subtle ways that science affects the life of people that I want to discuss in this short contribution and which also should be subjected to critical scrutiny from religions and other ethical perspectives. I am thinking here about the way science is explained to the general public, the implicit values transported in the language and the metaphors we use to explain scientific findings. In short, my thesis is that scientists and science journalist are not neutral when they choose words and metaphors to talk about science and that this conversation about science should be open to criticism from outside science itself, in particular religious and other ethical perspectives.

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- 1 Welker, Michael, *The Theology and Science Dialogue: what can theology contribute?* (Neukirchener, 2012)
 - 2 e.g. Dawkins, Richard, *The God Delusion* (Houghton Mifflin, 2006).
 - 3 Behe, Michael, *Science and the evidence for design in the universe* (Wethersfield Institute, 1999).

By inviting the criticism of my colleagues in theology and philosophy as a scientist I want to make clear that the subject of the conversation can not be the scientific results and theories themselves. This is a conversation that was tried quite often and did not lead to any productive exchange. What I acknowledge with this invitation is that there are multiple ways in which science can be interpreted and cast in non-technical language. The choice between the various ways of talking in non-technical language about science is neither ethically neutral nor fully determined by empirical facts. To exemplify what I am thinking about is a crass reductionist metaphor that is both denigrating to the dignity of life and living organisms as well as unsupported by empirical fact.

One of the guiding ideas of modern experimental biology is that the organism can be understood as a, quite complicated, machine structured to perform the various behaviors associated with life. This is an enormously productive idea that, in local realization, also is very successful. We understand the skeletal system as a system of levers and force producing devices (muscles), which move the fingers while I am typing this text; the gastro-intestinal tract can be understood as a fermentation machine to break down and extract foodstuff, the brain can be seen as a big computer transforming information from the sense organs to impulses that control the activity of muscles etc. With the advent of biochemistry and molecular biology the machine metaphor became even more powerful, conceptualizing organisms as nano-machines governed by the chemical reactions in its cells. All of these research areas are very successful in explaining well-delimited aspects of organismal activity, like reflexes, bio-mechanics of walking, the digestion of food and others more.

An enthusiastic generalization of all these successes of the biological sciences is the statement that organisms, including humans, are “nothing else but” bags of molecules. All the business of living is done by molecules, and life is just a epiphenomenon of what fundamentally is a physico-chemical reality. Of course there is no question that all life, including human life, as we understand it, is dependent on and subsisting on the biochemical processes that go on in our bodies. However, I can not help but noticing, that the metaphor of “organisms are nothing else but a bag of molecules” also has a powerful emotional impact. If I really believe that my child is just a bag of molecules, am I compelled to feel compassion with him or her? How about a stranger? Shall I waste my time to help a bag of molecules? Why should I? I also do not feel compassion with a stone!

Whether by design or not, metaphors used to speak about life and organisms have emotional and ethical consequences, and I think scientists and those who's job it is to explain science to non-scientists have to take responsibility for these

implications. And I also think that religious leaders can play a very productive role in analyzing and criticizing the way we talk about science. The unfortunate fact seems to be that many of the scientific metaphors for life have the effect of stripping life and organisms of their dignity and thus bear responsibility for the ethical, emotional and practical consequences of this language.

A hardened materialist and reductionist may argue that the emotional consequences of these metaphors are perhaps unfortunate but we have to “grow up” and face the facts as they are. But the question is, whether these metaphors are in fact fully determined and rigidly tied to empirical reality. Let us perform a thought experiment to test the assertion that “organisms are just bags of molecules” (Figure 1). If this is in fact a scientifically accurate statement then life should be an invariant phenomenon under the following experimental operation. Let us take a bag of molecules, say a cat. Then let us find a blender that is big enough to fit the cat inside, put the cat inside and flip the switch. The blender will homogenize the tissues of the cat. If the hypothesis that “the cat is a bag of molecules” is true then life should continue after we flip the switch, since at the time of homogenization we deal with exactly the same set of molecules as before. Now, we all know what will happen. The life of the cat will end and she will have no pubs or lap milk or catch mice. We can have a conversation what it is that changed after the blender was turned on, but it is undeniable that something fundamental changed (the cat is dead) and thus the prediction of the “bag of molecules” hypothesis has been falsified. I think this is a good point where to start a conversation about the nature of life; a conversation that expands the circle of participants beyond the confines of science proper.

In the next section I want to discuss another metaphor about life that is more subtle and also more debatable because it includes relatively recent scientific research.

The LEGO-fox

The recently emerged branch of biology call evolutionary developmental biology, or evo-devo for short, has led to another though more subtle generalization about the nature of organisms. The field of molecular evo-devo originated from the discovery of conserved developmental regulatory genes, the so-called Hox gene being the first to be discovered.⁴ Hox genes were discovered as the genes

4 Gehring, Walter J., (1994). “A history of the homeobox” in *The Guidebook to the Homeobox Genes* ed. Duboule, Denis (Oxford University Press, 1994), 1–10.

underlying so-called homeotic mutations, that are mutations in which one body part, say an antenna of a fly, is replaced by another body part of different identity. An example is the famous Antennapedia mutation where the antenna of a fruitfly is replaced by a leg. It turned out that many of the genes contain a conserved sequence motif called homeobox, when we speak of the DNA sequence, or homeodomain when we speak about the corresponding part of the protein. Hox proteins are transcription factors, that means they function through binding to DNA and regulating the expression of nearby genes. What was amazing is that many animals shared genes with very similar homeodomains, such as flies and mice and humans. This was the first indication that very different animals can share the same kind of developmental regulatory genes.⁵

What was even more amazing is the fact that in some respects, and this will be important later, the function of a fly gene could be performed by the corresponding gene from a mouse.⁶ It seemed that these genes not only have a highly conserved sequence, but also can perform the same biochemical functions and regulatory roles in quite distantly related animals. These discoveries led to a puzzle: how can animals have different phenotype and development, like flies and mice, but still have genes that seemed functionally equivalent?⁷ The solution was the first great empirical generalization of the field of evolutionary developmental biology, the so-called cis-regulatory paradigm.⁸ The paradigm explains both, why transcription factor genes are conserved and how different animals can develop differently using the same regulatory genes. The idea is that the conserved regulatory genes are like the tools in a toolbox, that remain the same but still can be used to produce different products, say a table and a chair. In the same way one can think of different animals as being produced by a conserved set of developmental genes where the different outcomes are the consequence of different spatial and temporal expression of these conserved genes. Finally it was argued that transcription factor proteins can not evolve since most of them are used in many body parts, and thus any change to a transcription factor would potentially affect a large number of traits. The chance that a mutation affecting many

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- 5 Carroll, Sean B., Grenier, Jennifer et al., *From DNA to Diversity* (Blackwell Science, 2001).
 - 6 McGinnis, Nadine, Kuziora, Michael A. et al., "Human Hox-4.2 and Drosophila deformed encode similar regulatory specificities in Drosophila embryos and larvae," *Cell* 63 (1990): 969–976.
 - 7 Wray, Gregory A., "Resolving the Hox paradox," *Science* 292 (2001): 2257.
 - 8 Carroll, Sean "Evo-Devo and an expanding evolutionary synthesis: a genetic theory of morphological evolution," *Cell* 134 (2008): 25–34.

traits has a net advantage seems to be low. This is a perfect narrative, explaining the existence of conserved molecular tools that are used for realizing different body-plans through the evolution of their so-called cis-regulatory elements. Cis-regulatory elements are pieces of the DNA that do not code for a protein but are like a switch that decides when and where genes get turned on or off.

This model gave rise to a view of organismal complexity that is based on the idea of equivalent building blocks that are just arranged in different ways to give different looking animals. Metaphorically one could think of an animal build from equivalent LEGO pieces. The uniqueness of the animals is thus reduced to the uniqueness of the cis-regulatory elements that determine the arrangement of the equivalent building blocks. In fact one leader in evolutionary developmental biology, Eric Davidson, wrote, that “what gets lost when a species goes extinct, are their unique cis-regulatory elements.”⁹ In other words, an animal, and humans are also animals for biologists, “is” the set of cis-regulatory elements. An organism is nothing else but a bag of cis-regulatory elements. This idea is much more subtle and sophisticated than the “bag of molecules” metaphor we discussed above, but has a familiar ring to it. It aims at replacing the notion of a living being with an emotionally distant and bloodless abstraction. Of course there is a considerable amount of scientific fact condensed in this view, but it is clearly a severe overgeneralization of that we should be weary. We can not take it as scientific fact directly following from empirical observations. In the next section I will discuss some of the scientific developments that undermine the generalization encouraged by the success of the cis-regulatory paradigm.

A fox with fur

The persistence of the cis-regulatory paradigm is a historical puzzle, since experimental and statistical evidence contradicting its most strict interpretation have been known for many years. What is even more surprising is that some of the early experimental work contradicting the assumption of strictly conserved transcription factor genes, in fact, have been found in and reported from the lab of one of the strongest proponents of the cis-regulatory paradigm, Sean Carroll.¹⁰

9 Davidson, Eric H., *The Regulatory Genome: gene regulatory networks in development and evolution* (Amsterdam Academic Press, 2006).

10 Grenier and Carroll, “Functional evolution of the Ultrabithorax protein.” *PNAS* 97 (2000): 704–709; Galant, Ron and Carroll, “Evolution of a transcriptional repression domain in an insect Hox protein,” *Nature* 415 (2002): 910–913.

As briefly mentioned above one of the strongest results suggesting that transcription factor proteins remain functionally conserved, even among distantly related organisms, is the fact that, in some contexts, the transcription factor protein of a fly can be replaced by the corresponding transcription factor protein of a mouse. The classical experiment is that of Bill McGinnis showing that the mouse HoxD4 protein can replace the *Drosophila* protein called Deformed in the fly embryo.¹¹ The experimental setup was like this: the fly gene *Def* is able to activate its own expression; one homolog of the *Def* gene in mouse is *HoxD4*. McGinnis and collaborators expressed *HoxD4* in a part of the fly embryo that normally does not express *Def*, and showed that the mouse HoxD4 protein is able to activate the fly *Def* gene in parts of the fly embryo where it is normally not expressed. Hence the HoxD4 is able to perform a function of its distant homologue, Def, in the fly embryo. That was an important discovery, but one that quickly became over-generalized and experiments contradicting the narrative were ignored (see next paragraph).

In fact the first contradictory result that I am aware of was published in 1998, eight years after the result explained above.¹² In this study the authors attempted to rescue the effects of a loss of function mutation of the *Drosophila* gene *tinman* by expressing either the intact *tinman* gene from the fly or the mammalian homolog, *Nkx2.5*. The rescue with the *Drosophila* gene was successful and restored the expression of genes that were lost due to the *tinman* mutation. But the rescue with *Nkx2.5* was only partially successful. This shows that the *tinman* and the *Nkx2.5* proteins are not functionally equivalent. A similar situation has been shown and much more publicized for *Ubx*, based on work in the McGinnis lab as well as many more examples.¹³

My lab started to investigate transcription factor evolution after realizing that one transcription factor, HoxA11, important for pregnancy and expressed in the mammalian uterus lining (endometrium) has a higher than expected rate of amino acid substitutions in the mammalian lineage.¹⁴ Later we could confirm

11 McGinnis, Kuziora et al., "Human Hox-4.2", 969–976.

12 Ranganayakulu, Gogineni, Elliott, David A. et al., "Divergent roles for NK-2 class homeobox genes in cardiogenesis in flies and mice," *Development* 125 no. 16 (1998): 3037–3048.

13 For a review see Wagner, Gunther P. and Lynch, Vincent J., "The gene regulatory logic of transcription factor evolution," *Trends in Ecol & Evol* 23 no. 7 (2008): 377–385.

14 Chiu, Chi-Hua., Nonaka, Daisuke. et al., "Evolution of Hoxa-11 in lineages phylogenetically positioned along the fin-limb transition," *Mol. Phylogen. Evol.* 17 (2000): 305–316.

that, at least some of these changes are necessary for the up-regulation of genes in differentiated endometrial cells.¹⁵ Specifically we found that the HoxA11 protein from placental mammals is activating target gene expression in cooperation with another transcription factor protein, Foxo1a. The question we wanted to answer how amino acid changes to HoxA11 turned the HoxA11:Foxo1a complex into an activating complex. To make long story short, Dr Nnamani in my lab found that even the ancestral HoxA11 protein can activate target gene expression if we removed a certain part of the protein, that I called NP (Nnamani and Wagner in preparation). Apparently the NP is inhibiting the activating function of the native HoxA11 protein and the role of Foxo1a is to relieve this intra-molecular inhibition. Furthermore this means that the evolutionary change in HoxA11 leading to cooperativity between HoxA11 and Foxo1a in regulating target genes was to make the protein responsive to the presence of Foxo1a.

This is what is remarkable. The evolutionary change in HoxA11 that happened to allow the evolution of placentation in mammals, is a change in the way the HoxA11 protein reacts to its environment, in particular to the presence of certain other transcription factor proteins. The biochemical activity, i.e. the ability to cause transcription of a target gene, was already present in the ancestral protein, presumable it was and still is used in other celltypes. The evolutionary change was one of communication between the HoxA11 and the Foxo1a proteins.

An organismic view of molecular mechanisms

The research mentioned above leads me to propose a counter-metaphor in which the empirical facts of molecular mechanisms leads one to think of molecules in terms of quasi-organismic, cognitive agents, rather than thinking of organisms in terms of inert molecular terms (bags of molecules or cis-regulatory fragments of DNA) (Figure 2). Here is how I think about our results on the evolution and function of the transcription factor HoxA11. From the work of Drs Lynch and Nnamani in my lab it is clear that the HoxA11 protein evolved the ability to up-regulate target genes in the uterus of placental mammals. It turned out that the molecular changes consisted in the ability of the HoxA11 protein to activate target gene expression in the presence of another protein, Foxo1a. The ability

15 Lynch, Vincent, Tanzer, Andrea et al., "Adaptive changes in the transcription factor HoxA-11 are essential for the evolution of pregnancy in mammals," *Proc. Natl. Acad. Sci USA* 105 no. 39 (2008): 14928–14933.

of HoxA11 to up-regulate target gene expression, however, is already present in the ancestral HoxA11 protein. In fact any HoxA11 protein can be both, a repressor as well as an activator, depending on the context it is expressed. What really evolved is that HoxA11 reacts to the presence of Foxo1a with “choosing” its gene activating capability rather than its repressive capability.

One can thus think of the HoxA11 protein as having a “behavioral inventory” which includes the ability to bind to DNA, to bind to certain proteins, to repress or activate target gene transcription. In addition there is a list of “reaction norms” that is a set of rules that determines what “behavior” the protein exhibits in what situations. That is exactly how behavioral biologists analyze and describe animals. First they establish the behavioral inventory, what the animal can do, and then try to understand the situations in which the animal chooses to preform which behavior. Hence it is possible to think of proteins and perhaps even large RNA molecules as small cognitive agents. They have ways to perceive their environment and use that information to decide on their molecular behavior. Most importantly, we have shown that one focus of evolutionary change in transcription factors is the “cognitive behavior” of the protein rather than the basic biochemical capabilities (which also occurs).

Of course the “organizistic” metaphor developed above is also just a metaphor, but it serves to demonstrate that reductive, abstracting metaphors are not the only way we can understand organismal complexity and uniqueness. There is as much scientific justification for organizistic metaphors as there is for reductive and ultimately denigrating, objectifying views of life and organisms.

Figure Captions

Figure 1: if we think that “organisms are just a bag of molecules” then life should be invariant to the application of a blender. The blender does not instantly change the chemical composition, and thus the “bag of molecules theory” should predict that it does not matter whether we put the kitten in the blender or not. Of course we know that the result of the “blender-experiment” is death. This is an illustration of the fact that many stark metaphors to talk about the biology of organisms are actually senseless if taken seriously.

Figure 2: the structural similarity between an agent (like an animal) and a transcription factor protein. An agent has three functional modalities; sensory functions, information processing (brain) and a motor-output (behavior). We found that transcription factors are similarly organized. They perceive their

environment through ligand binding and modification (e.g. phosphorylation), performing information processing through intra-molecular interactions, and have a “motor-output” which in the case of a transcription factor proteins consists of the biochemical activities a protein can have, from catalytic activity and DNA binding to protein-protein interactions. Evolutionary change preferentially seems to occur with respect to the perceptual and information processing aspects of the proteins. I propose that it is appropriate to conceptualize the very molecular building blocks of organisms, the proteins (at least the regulatory subcategory of them), as lifelike, rather than conceptualize life as a physico-chemical phenomenon.

VII. Religious Ethics and Philosophical Theology

Kelly James Clark

Atheism and Analytical Thinking

Recent atheistic attempts to explain religion away have relied on work in the cognitive science of religion.¹ In the academy and in the popular press, scholars have trumpeted God's demise based on work in the cognitive science of religion. Andrew Newberg claims that psychology and neurology have explained God away: "God cannot exist as a concept or as reality any place else but in your mind." In *Time's* sensational cover story, "Is God In Our Genes?," behavioral neuroscientist Michael Persinger proclaims: "God is an artifact of the brain." According to philosopher Daniel Dennett, God is nothing but an evolutionarily-induced figment of our imagination. Science, according to Dennett, has shown us that God is an illusion fobbed off on us by our genes.² Biologist Richard Dawkins, in *The God Delusion*, claims that God is, no surprises here, a delusion: "The irrationality of religion is a by-product of a particular built-in irrationality mechanism in the brain."³

Unbelief, however, has not received nearly so much attention. I suspect this is due to the following: the vast majority of those who work on these topics are atheists or agnostics who view religious belief as false and even bizarre. Given this assumption, the project of socio-psychological critiques of religion is to explain how otherwise rational people could hold obviously false beliefs. Unlike religious belief, their own beliefs (agnosticism or atheism), so the narrative goes, are products of rational reflection—the triumph of reason over superstition. The project then is to seek out the malfunction that produces religious beliefs; atheism gets a free pass.

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- 1 The cognitive mechanisms involved in the production of religious belief and practice have been fairly well documented. From the Hypersensitive Agency Detection Device (HADD) to Theory of Mind (ToM), the cognitive faculties involved in the production and sustenance of religious belief are well known. See Barrett, Justin, *Why Would Anyone Believe in God?* (AltaMira, 2004) and Clark, Kelly J. and Barrett, Justin, "Reformed Epistemology and the Cognitive Science of Religion," *Faith and Philosophy*, Volume 27 no. 2 (2010): 174–189.
 - 2 Dennett, Daniel, *Darwin's Dangerous Idea* (Simon and Schuster, 1995); Ibid., *Breaking the Spell: Religion as a Natural Phenomenon* (Viking, 2006).
 - 3 Dawkins, Richard, 2006. *The God Delusion* (Houghton Mifflin, 2006).

There's no lack of anecdotal evidence to support this narrative. Many cognitive scientists, whose work seems in principle neutral with respect to the truth of religious belief, betray a firm belief in the rational superiority of atheism. A cursory glance at various practitioners' conceptions of religion reveals their stance: religion is patently improbable and factually impossible,⁴ an airy nothing.⁵ One might not have thought there were so many ways of saying, "False." What could lead the human mind to entertain and accommodate obviously false beliefs? Given the pathetic absurdity yet superabundance of god-beliefs, non-truth-tracking belief-producing mechanisms must be the culprit. With the discovery of these ignoble cognitive causes, religious belief can be finally unmasked as the irrational folly we all know it is. Atheism, on the other hand, is not the product of ignoble causes, it is the result of reflection on reasons. Religious belief is debunked because it is produced by non-truth conducive psychological causes whereas unbelief is rational because it is based on rational reflection on good reasons.

One way of showing that atheism is the triumph of reason over superstition would be to show that atheists are superior to theists in rational reflection. If one could show that careful, reflective, evidence-sensitive, analytic thinking was positively associated with atheism, while hasty, sloppy, evidence-insensitive, intuitive thinking was positively correlated with theism, one might show, not to put to fine a point on it, that atheists are smart and theists are dumb. In the battle of head versus heart, atheism wins the head and religion wins the heart. Reports of a recent study reflect this view. *The Huffington Post* alone offered three sensational headlines declaring the triumph of reason: "Logic Squashes Religious Belief, A New Study Finds," "Analytic Thinking Erodes Religious Belief,"⁶ "Religion and the Brain: Belief Decreases With Analytic Thinking, Study Shows."⁷ The venerable *Scientific American* offered the following: "Losing Your Religion: Analytic Thinking Can Undermine Belief."⁸

4 Atran, Scott, *In Gods We Trust* (Oxford University Press, 2002).

5 Boyer, Pascal, *Religion Explained: The Evolutionary Origins of Religious Thought* (Basic Books, 2001).

6 http://www.huffingtonpost.com/rob-brooks/analytic-thinking-erodes-religious-belief_b_1436940.html

7 www.huffingtonpost.com/2012/04/26/intuitive-thinking-religious-belief-analytical-research_n_1457396.html

8 <http://www.scientificamerican.com/article.cfm?id=losing-your-religion-analytic-thinking-can-undermine-belief>

The study that is alleged to demonstrate the power of analytic thinking to crush religious belief, “Analytic Thinking Promotes Religious Disbelief” by Will M. Gervais and Ara Norenzayan, was published in the prestigious journal, *Science*.

In this essay, I will critically analyze Gervais and Norenzayan’s sensational claim that atheism is associated with analytic thinking whereas religious believers are more likely intuitive thinkers.

Atheism and analytic thinking, study #1

Will M. Gervais and Ara Norenzayan conducted a series of studies to determine the affect of analytic thinking on religious belief.⁹ Drawing on a sample of undergraduate students at the University of British Columbia, Gervais and Norenzayan offered a series of analytic prompts to determine their effect on self-identification of religious belief. They hypothesized that analytic thinking would elicit an override of the more natural and intuitive cognitive inclinations toward religious belief.

In the first study, they offered three problems (Cognitive Reflector Tests). Understanding their study will prove more efficacious if you consider your own response to the problems before proceeding to the analysis. The problems are as follows:

1. A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost? ____cents
2. If it takes 5 machines 5 min to make 5 widgets, how long would it take 100 machines to make 100 widgets?____minutes
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?____days

In each case, the quick and easy intuitive response is incorrect while the more deliberate analytic response is correct.¹⁰

9 Gervais, Will M. and Norenzayan, Ara, “Analytic thinking promotes religious disbelief,” *Science* 336 (2012): 493–496. Gervais and Norenzayan resist the sensational conclusions of the preceding paragraph, even though it’s hard not to draw them. They write “Finally, we caution that the present studies are silent on long-standing debates about the intrinsic value or rationality of religious beliefs, or about the relative merits of analytic and intuitive thinking in promoting optimal decision making.”

10 The quick and easy intuitive yet wrong response to (1) is 10 while the correct analytic, deliberate answer is 5, to (2) is 100 while the analytic answer is 5 and to (3) is 24 while the analytic is 47.

Upon completion of this test, participants completed three different measures of religious belief, which included such statements as

- In my life I feel the presence of the Divine
- It doesn't matter as much what I believe as long as I lead a moral life
- I believe in God
- I just don't understand religion
- God exists
- The devil exists
- Angels exist

Success on the Cognitive Reflector Test was negatively correlated with affirmations of religious belief; analytic thinking, therefore, was negatively correlated with religious belief. So Gervais and Norenzayan concluded: "This result demonstrated that...the tendency to analytically override intuitions in reasoning was associated with religious disbelief."¹¹

Response. In response to this study, let me first raise issues of randomness. The samples, except in study 4, were drawn from University of British Columbia undergraduates, hardly representative of the population. Norenzayan and the headline writers above would have done well to heed his own warning, hidden in a footnote, of psychological claims based on samples of undergraduates. He and his co-authors write: "Behavioral scientists routinely publish broad claims about human psychology and behavior in the world's top journals based on samples drawn entirely from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies. Researchers – often implicitly – assume that either there is little variation across human populations, or that these "standard subjects" are as representative of the species as any other population."¹² They warn of generalizing from this WEIRD population, the basis of most studies in psychology, to conclusions of a universal human nature. After demonstrating failures to replicate studies in non-WEIRD populations, they conclude: "Overall, these empirical patterns suggests that we need to be less cavalier in addressing questions of human nature on the basis of data drawn from this particularly thin, and rather unusual, slice of humanity."

Gervais' and Norenzayan's sample is worse than WEIRD and thusly doubly or triply problematic. 50% of UBC undergraduates are Asian, 38% are white,

11 Gervais and Norenzayan, "Analytic thinking".

12 Henrich, Joe, Heine, Steven J. and Norenzayan Ara, "The weirdest people in the world?" *Behavioral and Brain Sciences* 33 no. 61 (2010): discussion 83.

and 60% are women; more than half of first year students are not native English speakers.¹³ In Gervais and Norenzayan's study, 62% were Asian, 30% were White/Caucasian, and 8% were Mixed/Other. There were no Hispanics or African Americans. Two-thirds were female. Again, hardly representative of the population.

Since the vast majority of Asians in the study are from China (or recent Chinese immigrants) and Chinese are culturally biased against religious belief, the decrease in religious belief among the analytic thinkers could be attributed to cultural bias, not superiority in reasoning. Asians are disproportionately likely to major in the sciences and mathematics, and so are disproportionately likely to be trained in the analytic skills required to correctly answer the questions above. So the analytic test picked out precisely those people who are culturally biased against religious belief. Cultural bias, not analytic thinking, is a very likely explanation of the correlation between correct answers on the test and unbelief. In short, issues of randomness plague this study, forbidding any confidence in its conclusion.

Atheism and analytic thinking, study #2

Now let us consider the studies involving unconscious priming. The second set of studies involves a series of prompts designed to elicit analytic thinking. Let us consider just one, the art prime.¹⁴ Participants in the control group stared at a "neutral" image such as *The Discobulos* whereas the remainder were primed by staring at *The Thinker* (an "artwork depicting a reflective thinking pose"). Staring at *The Thinker* then was the allegedly unconscious analytic prime. The subjects then completed a measure of belief in God, supernatural agents, or intrinsic religiosity.

Gervais and Norenzayan conclude that these studies jointly reinforce the hypothesis that analytic processing decreases religious belief. For example, they

13 <http://fullcomment.nationalpost.com/2010/11/24/tony-keller-finding-the-white-students-on-campus-is-easy-where-the-pub/>

14 The other studies involved implicit primes and disfluency primes. Implicit Primes involved arranging words into sentences with the prime group given thinking terms (reason, analyze, ponder, etc.) while the control group was given unrelated words (hammer, shoe, jump, etc.). Disfluency Primes involved the use of fuzzy font (prime sample font) vs. a large clear font (control sample font). The claim is that having to figure out a fuzzy font engages analytic thinking in a way not required of reading a clear font.

claim that “viewing *The Thinker* significantly promoted religious disbelief.” With regard to these studies, Nicholas Epley, a psychologist at the University of Chicago, comments: “In some ways this confirms what many people, both religious and nonreligious, have said about religious belief for a long time, that it’s more of a feeling than a thought.”¹⁵ Francisco Ayala praised the studies: “You would expect that the people who challenge the general assumptions of their culture—in this case, their culture’s religious beliefs—are obviously the people who are more analytical.”¹⁶

The results of these studies are mixed, some differences between the control and the prime groups are only modestly significant, alternative explanations are admitted possible, and the problems with randomness raised previously can be found here as well (only on study 4 do Gervais and Norenzayan concede that the participants were “a broad nationwide (though nonrepresentative) sample”). Yet Gervais’ and Norenzayan’s words of caution don’t prevent them from boldly concluding:

All of the manipulations used in studies 2 to 5 plausibly produce multiple effects, and any specific finding in a given study may be open to alternative explanations and should be interpreted with caution. However, across all studies, it is difficult to think of a broad alternative explanation that could parsimoniously explain why analytically overriding intuitive answers, visual exposure to a thinking pose, implicit priming of analytic thinking concepts, and perceptual disfluency all converge on promoting religious disbelief. By contrast, the hypothesis that analytic processing—which empirically underlies all experimental manipulations—promotes religious disbelief explains all of these findings in a single framework that is well supported by existing theory regarding the cognitive foundations of religious belief and disbelief.

When analytic processes are engaged they trump/correct/erode intuitively and uncritically assumed religious beliefs. Religious belief, so the studies claim, retreats in the presence of analytic thinking.

Response. If we take Gervais and Norenzayan’s claim that the analytic primes both engage analytic *thinking* and promote religious disbelief at face-value, they seem to be suggesting:

Reflective, analytical thinking is prompted by looking at *The Thinker*; in that reflective moment the subjects unconsciously evaluate their grounds for theistic belief, find them weak, and so then revise their intuitive judgments reflectively.

15 <http://news.sciencemag.org/sciencenow/2012/04/to-keep-the-faith-dont-get-analytical.html>

16 <http://www.scientificamerican.com/article.cfm?id=losing-your-religion-analytic-thinking-can-undermine-belief&page=2>

This interpretation, though supported by their claim that the analytic primes engage analytic *thinking*, may be uncharitable. Priming studies don't typically invoke reflective beliefs, but are designed to prompt subconscious connections between ideas. So the subjects likely did not revise their intuitive judgments reflectively. Perhaps Gervais and Norenzayan mean instead:

Looking at *The Thinker* put subjects in the "analytic mode;" the analytic mode unconsciously inclines one away from religious belief.

While this interpretation ignores their sensational claim about priming and analytic thinking, it may be the best they could hope for given their reliance on unconscious primes.¹⁷ It's not so much analytic thinking as being in the analytic mood that promotes religious disbelief.

Let me suggest a more or at least equally plausible phenomenology than either of these. The behavior elicited in both groups is reported belief. So *prima facie* the studies show that analytic primes reduce the participants' *willingness to report their religious beliefs*; the studies offer no unequivocal evidence that they reduce religious *belief*—only reduced *reporting* of religious belief. As psychologist Daniel Kahneman comments in response to Gervais' and Norenzayan's studies: "It's very difficult to distinguish between what a person believes and what they say they believe."¹⁸ Of course, sometimes we can and should take people's reports of beliefs as indicative of their beliefs; is this one of those times? Why, in this sort of case, might one be disinclined to report their religious belief?

A change in deep belief is unlikely because we don't typically change deep and important beliefs as a result of staring at a statue or assembling sentences. However, we can be easily induced, with just the slightest incentive, to change reports of belief. It's unlikely that a viewing of *The Thinker* would or could affect a deeply held belief—it seems intuitively unlikely that staring at *The Thinker* ignites an evaluation of the grounds of one's religious beliefs and finding them weak, one stops believing (all that without consciously reflecting on religious belief). And it seems unlikely that staring at *The Thinker* engages one's analytic mode (which in turn unconsciously triggers religious unbelief). None of the analytic primes seems a very likely candidate for inducing radical belief change.¹⁹

17 I am grateful to Helen De Cruz for this point.

18 <http://news.sciencemag.org/sciencenow/2012/04/to-keep-the-faith-dont-get-analytical.html>

19 In Doyen, et. al. we read of the difficulties attending studies involving unconscious primes. "In social cognition, the assumption that high level semantic priming can

One might see this point better if one replaced “Democrat” for “religious believer” and “Republican” for “atheist”—one would not expect an increase in Republicans from a viewing of a Rodin sculpture (or any other of the analytic primes). Or to make the point more politically neutral, one would not expect a dramatic shift in political position based on analytic primes. One might, however, be more likely to report that one is a Republican given appropriate primes (especially if the participant thinks that the experimenter favors Republicans). Bottom line: the more likely explanation for the few participants that made the difference between the control and the prime groups is that the odd task of being presented with *The Thinker* may have elicited their response independent of analytical thinking.

Concerns re: bias

The results very likely confirm some sort of response bias not radical belief change. Gervais and Norenzayan favor their interpretation based on the analytic prime and participant performance on “an ostensibly separate task in which they were asked to report demographic information, including a single face-valid measure of belief in God.” But perhaps the tasks, as cognized in a real participant’s real brain, were not separate in some of the participant’s brains—that is, the prime might have unwittingly stimulated portions of the brain entirely unconnected to analytic thinking; there may be some sort of response bias in which the experimenter’s expectations or believed expectations influenced at least some participants’ behavior;²⁰ such response bias could happen without

occur automatically and outside of conscious awareness is almost taken for granted. Yet, this assumption conflicts with evidences accumulated in cognitive neuroscience. For instance, several authors suggest that two factors are necessary to produce the large patterns of neural activation in higher association cortices that are essential for semantic priming to occur: Top-down attention to the prime and bottom-up stimulus strength (e.g.: its saliency to the participants). Such a pattern of activation can be the signature of semantic processing of the prime and is typically associated with conscious awareness” (Doyen Stéphane, Klein Olivier, Pichon Cora-Lise, and Cleermans Axel, “Behavioral Priming: It’s All in the Mind, but Whose Mind?” PLoS ONE 7 no. 1 (2012): e29081 (doi:10.1371/journal.pone.0029081). It is unlikely that Gervais and Norenzayan’s primes engaged top-down attention or bottom up stimulus strength.

- 20 Rosenthal, Robert, *Experimenter effects in behavioral research*. (Appleton-Century-Crofts, 1966).

the participants' conscious awareness and so would remain undetected in exit interviews.

While Gervais and Norenzayan surely did not deliberately influence participant behavior (and one might think they had controlled for such bias by administering most of the surveys online), it is difficult to determine just what cognitive faculties were engaged when participants were completing the religious surveys after their believed success or failure with the analytic primes (or their confusion over the primes). Perhaps a statistically significant few reported what they thought the experimenters wanted to hear. While a few of the participants, in exit interviews, expressed an awareness of the intent of the study (and so were eliminated from the analyses), others may have felt but not been able to express the intent to tie rational reflection to religious belief. Perhaps not wishing to be identified with lunatics—those fundamentalists who claim to feel God's presence or believe in the devil—some believers felt internal pressure to downplay the report of their true beliefs. Human cognition is deeply complicated and mysterious and the precise cause of the increased reporting of disbelief on the parts of some of the subjects is unclear.

Finally, Gervais' and Norenzayan's essay suffers from publication bias and in two forms: bias against negative or neutral results (which creates an atmosphere which distorts experimental design and statistical analyses in a rush for positive results²¹ and anti-religious bias. The unrepresentative sample alone should have disqualified the essay from inclusion in such a prestigious journal. But the more serious bias is, very likely, the bias against rational religious belief, with a corresponding eagerness to publish studies that undermine religious belief. Conclusions drawn about belief rather than about reporting of belief should have raised the suspicions of the journal's editors. Publishers are biased towards more sensational and novel findings, and many are biased against religious belief. Evidence for such anti-religious bias is anecdotal. But we can take as evidence the fact that Norenzayan's more careful study showing atheism to result from a cognitive deficiency was published in a considerably less prestigious online journal, *PLoS ONE*, than *Science* and found considerably less traction in the popular press.

21 Simmons, Joseph, Nelson, Leif and Simonsohn Uri, 2011. "False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant," *Psychological Science* 22 no. 11 (2011): 1359–1366 (Available at SSRN: <http://ssrn.com/abstract=1850704>).

Reflections

There may be, of course, a correlation between analytic reasoning and atheism. And there may be a correlation between intuitive thinking and theism. These correlations would not show that any particular atheist or any particular theist was rational or irrational. Both could have or could lack rational grounds for their beliefs. Moreover, intuitive beliefs can be both correct and rational while inferential beliefs can be both incorrect and irrational.²² We intuitively believe that $2 + 2 = 4$, that causing the suffering of innocents is wrong, and that there is a world outside of our minds.²³ Intuitive thinking produces pervasive, foundational and true beliefs, which beliefs are essential to human welfare and flourishing. In fact, most of our deepest and most pervasive belief faculties are intuitive—including memory, perceptual and moral, on the one hand, and our disposition to believe in the past or in the external world, or that the future will be like the past, on the other.²⁴ Moreover, people have inferred such untrue beliefs as the phlogiston theory, women should aspire to be beautiful (since they can't be rational), and Nixon would be a great president. Because individuals, socio-historical circumstances, and available evidence vary so widely, it is impossible to say, for any particular individual, what produced their belief (or unbelief) and whether or not a belief thusly produced was rational. Intuitive theism and inferential atheism could both be rational or irrational depending on the person and their circumstances. Finally, there may be multiple factors influencing and supporting

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- 22 Elqayam and Evans warn of the tendency in the psychology of reasoning to equate the analytic reasoning with correct responses and the intuitive with incorrect responses (Elqayam, Shira and Evans, Jonathan, "Subtracting 'ought' from 'is': Descriptivism versus normativism in the study of human thinking," *Behavioral and Brain Sciences* 34 no. 5 (2011): 233–290). Gervais and Noranzayan's design equated all the intuitive responses with the incorrect answers, and the non-intuitive ones with the correct answers. A good replication of the study would be where the intuitive answer is the best one, where a prime that elicits holistic thinking is used.
- 23 Of course, people have also intuitively believed that some people are naturally suited to be slaves, that the earth is flat and that women are not rational. Bottom line: intuitive beliefs are not infallible. A belief's being intuitive implies nothing about its rationality or truth.
- 24 Clark, *Return to Reason* (Eerdmans, 1990); Clark and Barrett, "Reidian Religious Epistemology and the Cognitive Science of Religion," *Journal of the American Academy of Religion*, 79 no. 3 (2011): 639–675; Spelke, Elizabeth S. and Kinzler, Katherine E., "Core knowledge," *Developmental Science* 11 (2007): 89–96.

such beliefs, the combination of which could be rational or irrational (depending on the person and their circumstances).

There may be a simpler, more obvious explanation of the cognitive inclinations towards unbelief, one that Gervais and Norenzayan are well aware of. Psychologists have recently claimed that atheism is both correlated with and mediated by a mentalizing defect, one that is common to those suffering from autism spectrum disorder. The work of Caldwell-Harris, et. al, called attention to the connection between high functioning autism (HFA) and atheism.²⁵ Their research showed that individuals with high functioning autism are predisposed towards religious unbelief.

Norenzayan, Gervais and Trzeniewski, however, claim to have demonstrated that mentalizing deficits—the inability to “see” the beliefs, feelings and desires of other persons (ToM: theory of mind)—incline HFA individuals towards atheism.²⁶ While they replicated the Caldwell-Harris study, that those higher on autism scales are less likely to believe in a personal God,²⁷ they were also able to isolate and then eliminate other cognitive faculties or tendencies that might mediate or incline us towards atheism. Since people with higher scores on the Autism Spectrum Quotient had a reduced ability to mentalize, they claim that mentalizing deficits mediated increased tendencies towards atheism and agnosticism. Recent work in cognitive science of religion shows the centrality of mentalizing (ToM) to typical religious beliefs. If God is personal, then a properly functioning ToM seems necessary for belief in God; mentalizing deficits, therefore, seem a likely contributor to disbelief in God.

But, to get back to the main point of this section, as of right now the jury is out on whether or not there is a correlation at all between analytic reasoning and atheism.

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- 25 Caldwell-Harris, Catherine, Murphy Caitlin, Velazquez, Tessa and McNamara, Patrick, “Religious Belief Systems of Persons with High Functioning Autism,” in Carlson, Laura, Hoelscher, Christoph and Shipley, Thomas, eds., *Proceedings of the Thirty Third Annual Meeting of the Cognitive Science Society* (Cognitive Science Society, 2011), 3362–3366.
 - 26 Norenzayan’s autism studies 3 and 4 were conducted with a broader sample of Americans, and not just Canadian students.
 - 27 In Study 1, they found that “autistic participants were only 11% as likely as neuro-typical controls to strongly endorse God.”

William Schweiker

Freedom within Religion. Religious Ethics and Social Life

1. Introduction

I want to thank Jack Templeton and The Templeton Foundation and also Professor Welker and the FIIT for the kind invitation to speak at this important event. I was sorry to hear that Jean Elshtain and Michael Novak have taken ill and cannot be with us. All of us wish them a speedy recovery. This session has now changed from being a dialogue into a monologue. I don't know if I am to be envied, since I know that I will get the last word, or pitied, because, well, I am shouldering this whole session. I once had a homiletics professor in seminar define "preaching" as "to bore unnecessarily"! I promise that I'll try to avoid preaching as we explore a topic at the very heart of current social and political debate (consider the US Presidential election): "Religious Ethics in the Public Square. My main point will be that I think amid all of the turmoil of our time there is the emergence of a new form of freedom in relation to religion and that this freedom is the form of the good will in our social life. It is a fragile and difficult freedom, one that is opposed on many sides. This is why it needs articulation and defense. And that is my task in this brief lecture.

Immanuel Kant opens Section I of his famous *Groundwork for the Metaphysics of Morals* by stating that the "good will" is the only good thing in this or any other world.¹ That is probably an overstatement and in any case the many projects on Science and Religion that the Templeton Foundation has funded make clear that the human will is a bit more integrated into natural processes than Kant would allow. He is trying to understand freedom as a transcendental condition of the possibility of moral conduct. Nevertheless, without good will social life devolves into hatred, suspicion, and conflict. So, I am trying to get at the form of good will for our social and religious lives in this global age. This also clarifies why religious ethical reflection on the public square is essential to the science and

1 Kant, Immanuel, *Groundwork for the Metaphysics of Morals*, trans. M. Gregor, intro. C.M. Korsgaard (Cambridge University Press, 1998).

religion dialogue. As thinkers from Aristotle onward have known, social life—or what he called politics—is a condition for human beings to seek any other goods and purposes. Without some modicum of social order and cohesion, every other human pursuit comes to an end, including the work of the sciences. So, to reflect religiously and ethically on the public square is also to reflect on the conditions necessary for scientific work and the dialogue between religion and science in its many forms. Here too, I note, the Templeton Foundation has helped to transform the discussion precisely by enabling the formation of research projects that build up social structures of inquiry.

Once last word of introduction and then I will launch into my main argument. I mean something specific by the term “religious ethics.” On my account, religious ethics is reflection from within the resources of a religious tradition on human beings as agents in community with other agents and for the sake of orienting responsibly individual and social life. On this account, religious ethics—say, Jewish or Buddhist ethics—is not directed only to one’s co-religionists, so other Buddhists or Jews. The root issue is the meaning and orientation our being agents, that is, we are beings who can respond to and shape reality for good or ill. So, religious ethics is religious in its sources and strategies of argument, but as a form of ethics is it directed to our shared human lot of being agents in need of the responsible orientation of our lives. H. Richard Niebuhr use to speak about “Christian moral philosophy” to make the same point.² I agree with him. I realize that some will dispute this definition of religious ethics and insist that one’s moral reflection always remains within distinct communities. So be it. I cannot in these remarks defend my account of religious ethics. That is one reason, I suppose, that I am to be envied in holding this monologue.

What we are reflecting on today are the relations among religion, science, and the demands of social life that will enable and support a dialogue between science and religion. I am doing so from within religious sources but for the sake of addressing our lives as agents, whether one is religious or not. My thesis or main point is about the form of freedom the good will should take among religious folks nowadays for the sake of sustaining and shaping social life that

2 Niebuhr, Richard H. *The Responsible Self: An Essay in Christian Moral Philosophy*, intro. James M. Gustafson, foreword, Schweiker, William (Westminster/ John Knox Press, 1999). Also see Schweiker, William, *Theological Ethics and Global Dynamics: In The Time of Many Worlds* (Blackwell, 2004), *Ibid.*, *Dust That Breathes: Christian Faith and the New Humanisms* (Wiley-Blackwell, 2010), also see Jasper, David and Wright, Dale, eds. *Theological Reflection and the Pursuit of Ideals: Theology, Human Flourishing, and Freedom* (Ashgate, 2013).

is a necessary condition for a dialogue between religion and science. So we are underway. Let me turn next to the debate about religion in the public square—or more generally, social life—and then turn to ways of talking about the relation between freedom and religion.

2. Religion and the Public Square

If by the “public square” we mean the discursive or communicate space in which citizens as well as political and civil institutions meet and debate matters of shared concern for common life, then it is clear—at least historically—that religion has always been present in the public square, and, further, social questions have always been contentious. There is a range of positions on the place of religious views and values in the public square found around the world and in public debate. Indeed, the public square as a space of social debate has itself become a topic in the debate when religious views are considered in relation to so-called public reasons. That is, the debate usually focuses on the kinds of claims that can and cannot be offered for responding to shared social matters.

The extremes in a typology would be, on the one end, an ardent and relentless secularism, say, in the former Soviet Block, maybe in China, and, under some accounts, the French position, that has provoked various forms of religious reaction (violent or not), and, on the other end of the typology, various theocratic regimes that spark reactions from the so-called “New Atheists” to theorists of democracy. Between these extremes are positions, like, at times, Jürgen Habermas, that argue that religious claims must be translated into public terms, John Rawls who argues that no comprehensive doctrine, religious or otherwise, is needed in public debates about justice, to Charles Taylor, a Templeton Prize winner, who has rethought the idea of secularism itself. In a recent book Taylor and Jocelyn Maclure argue “that respect for the moral equality of individuals and the protection of freedom of conscience and of religion constitutes the two major aims of secularism today.”³ Under that account of “secularism,” religious people, he contends, can and should agree with what he calls “pluralist, political secularism.”

Now, my task is not to go through and compare these positions or to enter the endless debate about “secularism” and “post-secularism” and the proper place of comprehensive doctrines in the public square or for that matter differences between Habermas discourse ethics and Rawls’s theory of justice and liberalism.

3 Maclure, Jocelyn and Taylor, Charles *Secularism and Freedom of Conscience*, trans. J.M. Todd (Harvard University Press, 2011), 4.

Plenty of ink has been spilled on these topics, and, besides, I do not want to risk preaching, that is, unnecessarily boring you by rehashing these debates. Yet we do need to note two things. First, the current debate is carried out without substantive engagement with the resources *within* the religion to address these matters. Sadly, too many religious thinkers accept the depiction of religion given by philosophers and social theorists—always a bad idea—and then plunge into the topic. Second, there seems to be the assumption, made on all sides of the debate, that a religious identity requires subsuming all other identities under itself and that religious identities are block-like and exclusive. So, when entering the public square as a religious person, I am suppose to be just a Christian rather than a Christian and a father, white, American, fan of the Chicago Fire Soccer Club, someone who struggles with German, and on and on.

There is some point to that assumption. At least within the Monotheistic traditions, fidelity to God would seem to trump all other fidelities I might have, say, to my son or to the Chicago Fire. Comprehensive doctrines, to use Rawls's term, seem to entail total and overriding commitments. And if that is the case, how can I as a Christian bracket my Christian commitments or translate them into other terminology for the sake of public debate, or, at best, grant a reasonable pluralist political secularism? In other words, if Christian faith requires a submission of every aspect of my identity to my religious identity, it seems whatever resolution to the question of religion in public we choose, the main burden will be on me and not my fellow, but secular, citizens, because, in these terms, their identities are not constituted as to force the problem. What is more, this line of reasoning would seem to confirm a point made by Amartya Sen, that is, that religious people too easily see identity as destiny.⁴ If I must live out a religious identity it would seem to put me into conflict with others and their identities and thus back a destiny of conflict and even violence. We can see here, I suggest, the real problem of not considering the resources of the religions themselves, even by religious people, in thinking about the public square. It is simply the case that the religions hold resources for navigating these issues. Let me note just a few examples. For Jews and Christians, it is clear that the second of the two tables of the Decalogue—or 10 commandments—are concerned with human social well-being and relations. Those obligations must be lived out in relation to others no matter what their convictions. Powerfully, Rabbi Hillel (c. 110 BCE- 10 CE) when asked to explain the Torah while standing on one leg taught what is sometimes called the "Silver Rule:" "That which is hateful to you, do not do to your fellow.

4 Sen, Amartya, *Identity and Violence: the illusion of destiny* (WW Norton, 2006).

That is the whole Torah; the rest is explanation; go and learn.” (Talmud, *Shabbat* 31a, cf. Lev. 19:18) The positive formulation of the command was taught by Jesus, the so-called “Golden Rule:” “Do unto others as you would have done to you” (Mt 7:2). Even more radical is the claim in I John 4:20: “Those who say, ‘I love God,’ and hate their brothers or sisters, are liars; for those who do not love a brother or sister whom they have seen, cannot love God whom they have not seen.” Why the second great command to love the neighbor might be grounded in the love of God, here it is the love of the neighbor that is, remarkably, the proper interpretation and meaning of the love of God.⁵ As often noted, something like the Silver or the Golden Rule is found in most religious and cultural traditions. Even further, there is concern among the religions for the outcast, love even of the enemy, and also dictates of compassion for all who suffer, and justice for the widow and the outcast. And it is not at all clear that these values are only valid because they are dependent on God or Torah or the Dharma. The religions claim they have validity on their own.

Now, I realize that these are rather minimal claims and that they are also embedded in wider scriptural, ritual, and communal contexts. These commands and prescriptions would represent a “thin” ethics, as Michael Walzer has called it, rather than a thick and robust ethics that draws on the full resources of a tradition.⁶ Granting that fact, my point is there are resources within the religions for giving a more nuanced understanding of religious identity than is often done. There are resources for interpreting religious commitments that do not pit those commitments against shared moral values and obligations to others. In other words, a religious identity is defined not only with respect to its central religious tenant, like faith in God, the sacrality of the Qu’ran, or the Lordship of Christ. They are also defined at a constitutive level by moral commitments about relations with and for others not all of whom share one’s faith. If Hillel, Jesus, The Qu’ran, and scores of other sources are right, then one’s faith in God, Allah, Christ, or the Buddha cannot trump the moral meaning of one’s religious convictions and so concern and respect for other human beings. Call this the *humanistic proviso* of the world’s great religions.

5 There is an immense amount of literature on the relation between the two tables of the law, as they are called, and also between the two great commands. My point here is that the Christian tradition, the same said for Jews and Muslims, have resources to show that love and obedience to God cannot override obligation to others, including those who are outside of the religious community.

6 Walzer, Michael, *Thick and Thin: Moral Argument at Home and Abroad* (University of Notre Dame Press, 1996).

If that is a reasonable account, then we confront the real challenge to the religions and we are back to the question of the “good will.” The question becomes a hermeneutical one: in the public square how ought a religious person or community interpret the relation between their central religious tenants and those moral claims that are also constitutive of their religious identity? Is there ever a case where my devotion to Christ as a Christian can and should trump my love and obligations to the neighbor? If that way of putting the issue sounds odd, then I have already made my point. Granted that there are fanatics in every tradition who are beyond the reach of argument and thus do not and cannot enter the discursive space of the public square. Nevertheless, there are resources within the traditions to get at our question and also the danger of identity as destiny.

This brings us to a new freedom in relation to religion as the form of the good will for religious people in our post-secular global age. I now turn to this point and that turn will complete my monologue and finally open them up to dialogue among us. I also want to notes some of the ways I believe the Templeton Foundation and other institutions as well have added this new form of freedom.

Freedom Within Religion

Good will, I have suggested, is essential for a vibrant and just public square. If people enter that discursive space with ill will, with a will to render the public square impossible because it must be defined exclusively in the terms of their convictions or elide the demand of truthful public discourse and thus use of deception, it is hard to imagine civil debate about pressing social questions. To be sure, there are ardent secularists and committed theocrats who too often deny the importance of good will, but we are concerned with workable solutions in social life. In this light, it was right for Charles Taylor to insist on freedom of conscience and religion. That form of freedom is meant to further honest public discourse and the possibility of religious convictions. And to be sure, the question of religion and the public square is often put in those terms, that is, freedom *of* religion and also freedom *from* religion. The protection of freedom *of* religion is also freedom to not have any religious commitments at all, to be free *from* religion.⁷

7 For an extended discussion of freedom *within* religion, see Klemm, David E. and Schweiker, William, *Religion and the Human Future: An Essay on Theological Humanism* (Wiley-Blackwell, 2008).

The question now is whether or not those two forms of freedom with respect to religion exhaust the options and are adequate to understand a way of being religious in the public square. Do they capture the form of good will that participants should embody in the public forum? I have been hinting that they do not. I want to suggest that we are witnessing the emergence of a new form of freedom in relation to religion or in fact any tradition: freedom *within* religion and so freedom *within* social traditions. This kind of freedom is enacted when religious folks decide to interpret the complex resources of their traditions in their most humane form, and same is said for secularists who also have their own traditions.

This is a freedom that overcomes the illusion of identity as destiny because people can interpret their convictions in ways that help to sustain the public square in mutual recognition of others. It is what I meant to suggest by quoting Hillel and the Golden Rule. Hillel contends—remarkably—that religious convictions cannot trump the Silver ruler because those commitments need to be seen as commentary on that Rule. In the Gospel Jesus is both enough to say that the Sabbath was made for man, not man for the Sabbath. And as noted before, in I John the love of neighbor is used as the standard for the real love of God. It is simply not the case that in every situation one must allow the core religious convictions to trump moral convictions. It is no betrayal of Christian convictions if one focuses not on the belief in the Lordship Christ but rather to focus on neighbor love and just other-regard. In fact, a devote Christian could come to see that the moral meaning of Christ's lordship in the public square is other-regard. Christ is sovereign in one's actions, actions that enable the discursive space needed for social and political decisions.

Notice: this is not a demand that religious people translate their convictions into non-religious norms or even bracket comprehensive beliefs and doctrine. It is to recognize the freedom to interpret traditions in their most humane forms is freedom *within* religion and how to live with the complexity of a tradition rather than its reduction to a harden form of identity. Insofar as religious resources are not self-interpreting, then, it would seem that one has the freedom within those resources to interpret their moral significance for the public square.

Now it seems to me that the emergence of this kind of freedom, this form of good will, has been greatly furthered by the kind of research and programs that Templeton has funded. While not put in these terms, nevertheless research projects that seek to understand the full complexity of religious traditions in dialogue with the sciences fosters freedom *within* religion. They do so because they allow scholars to activate the complexity and vibrancy of religious traditions in

dialogue with non-religious modes of thought and research. Projects like *Images of the Divine and Cultural Orientations* funded by the German government, The FIIT, and the Martin Marty Center at the University of Chicago is another example of fostering freedom *within* religion. Scholar of the monotheistic traditions explored the ways in which various images of God actually provide orientation for cultural life.

Well, I know there is much more than needs to be argued in developing my case for freedom *within* religion. And I am mindful that the strategies of interpretation differ among religious traditions and the sciences, too. But I fear that I am beginning to bore unnecessarily. The point then is this one. The topic of “religious ethics in the public square” in our times is really about the conditions of the public square itself, that is, what makes it possible and workable. As Alfred North Whitehead once wrote, “Civilization is the triumph of persuasion over force.” I have been trying to show how the religions can reclaim their role within the task of civilization from within their own resources. That is, I have tried to get at part of the massive topic of religion in the public square by identify from within religious traditions ways faithfully and freely to participate in creating and sustaining those conditions of the public square. And I have suggested that one reason to celebrate the work of the Templeton Foundation is that it has helped to advance that work for the sake of the common good.

**VIII. Philanthropic Investment and
the Future Generations: Three (of Sixty)
Winners of the John Templeton Award for
Theological Promise (2007–2011)**

Jan Stievertmann

The Templeton Award and Professional Development for Young Scholars

It is my pleasure to open the last panel in this wonderful conference. I would like to use this occasion to briefly look back to another very successful, long term cooperation that the Templeton Foundation had with the Research Center for Interdisciplinary and International Theology: The Templeton Award for Theological Promise; an award that in many ways has also been connected to the agenda of this conference. I want to spend a few moments on, if you like, a taking of stocks of the general achievements of this award, and, more specifically, of how it served as a tool to further the science and religion debate. [I'm doing this also as a way to set the stage for three of the award winners who are here today to talk about current projects related to the overarching theme of this conference: Jonathan Edelmann, Daniel Munteanu, and Eva Harasta.] In concluding, I then want to spend another short moment to talk about the future; not only about the future of the award but also about possible future ways to move forward the "science and religion dialogue" through continuing the fruitful partnership between the Center and the Foundation.

As mentioned several times during the opening ceremony, between 2007 and 2011, the John Templeton Foundation sponsored the Templeton Award for Theological Promise housed by the Research Center for Interdisciplinary and International Theology under the directorship of Michael Welker. What many of you might not know, is just how successful the Award has been as a means for promoting the academic work and career of young scholars from around the globe. And the people sitting at this table are all walking illustrations of that. The idea behind this program was to give an award not to established, well-known figures, as many other programs do, but to *young* scholars in recognition for the merits of their first book, usually their dissertation. Another striking feature of the Templeton Award was its programmatically international, interdenominational and interfaith orientation. Applications were evaluated and ranked by a board of scholars from around 20 different countries over the years, representing diverse religious traditions, such as various Christian denominations (including Eastern Orthodox) as well Judaism and Islam. During the five-year period in which the award was sponsored by Templeton, 60 aspiring scholars from all five continents were selected. Awardees came from all over Europe, Germany, the

UK, Italy, Austria, Norway, Finland, Denmark, Switzerland, Croatia, Romania, from Israel, from the U.S., from Asia, Hong Kong, Korea, Japan, and from Australia. And like the evaluators recipients came from a great diversity of Christian traditions and churches. So, the effort of the Foundation to internationalize was really beautifully reflected in this particular program.

From my viewpoint, as one of the 2009 winners, there were three main reasons for the great success of the Award as a means to promote scholarly careers at an early stage: 1) the ingenuity of its framework format as devised by Prof. Welker; 2) the amount of money that was put into it, and the flexibility allowed in spending it. The programmatic idea behind the format of the award was that young scholars do need as much recognition and visibility (symbolic capital) as they can get; and the award with its quickly growing prestige certainly gave them that. But they equally need very real, non-symbolic capital, and they need to network. Especially for a price given to the up-and coming, the Templeton Award was very generously endowed. In addition to a \$10,000 cash prize, the 12 annual recipients of the award were also eligible for an additional \$10,000 travel stipend to be used for public lectures at universities and colleges over the course of two years. For young academics with limited opportunities for research funding and international collegiality, the award thus offered access to considerable resources that could be freely used for research travel. In the area of research, price winners did very different things with their money. Some spent it on archival work, some got help on their next project. One fellow-award winner even kickstarted a new journal with his price money. With the travel money, we all got invited to present our projects at prestigious institutions, and were thereby given the opportunity to build networks of relationships with fellow scholars and academic institutions. Networking was also an important aspect of the two-day colloquia here at the Internationales Wissenschaftsforum Heidelberg (IWH) that followed the awards ceremony each year together with various social activities. During these weekends, recipients had the opportunity to present and discuss future research projects with evaluators, board members from the Center, and fellow-recipients, and to engage in plenty of academic scheming, dreaming and planning. Apart from networking, many of us got very helpful feedback and advice on their projects.

All of this certainly made a significant and positive difference in the careers of many. I know of a good number of price winners who were able to take the next step in their career because of the prestige and the resources connected to the Awards. But I can also use myself here as an illustrative example. For me the award led to many new contacts, invitations to Yale and Harvard, and ultimately

also opened the door to finding my new position here in Heidelberg; a dual appointment with the Department of Theology and the interdisciplinary Heidelberg Center for American Studies. [I'm sure you could also give examples for the positive impact from your experiences] On behalf of all awardees, present and absent, I thus want to use this occasion to express my deep gratitude to the Foundation.

As I suggested earlier, the award was also intended as a tool to further the science and religion debate; and in my view it served that function very well. In an age where public debates are often characterized by false polarizations between religion and rationality, belief and scientific inquiry, the award gave recognition to works studying "God and spirituality" from the perspective of various scientific disciplines; if by the sciences we do not reductively understand the natural sciences only. Despite its epithet "for theological promise" the award was not reserved for scholars with a background in the classical branches of academic theology: OT/Hebrew Bible, NT, Systematic Theology and Ethics and Church History. Many of the prize-winning books were also related to ecumenical or interfaith theology. Moreover, the award specifically encouraged interdisciplinary work. Recipients came from a very wide range of fields; among the prize-winning books we find the whole spectrum of religious studies (including Jewish Studies, Jewish Thought, Islamic Studies, Hinduism), philosophy and philosophy of religion from various faith traditions, economics, sociology and various works focused on different areas of cultural and literary history. [My own book, for instance, is a study of the co-evolution of theology, aesthetics and scientific thought in the works of Ralph Waldo Emerson, to give you a sense of the breadth]

Yet, among each cohort of prize-winning books we also find studies addressing questions relating specifically to the complex relationship between the natural sciences and theology. Let me give you just three examples here to indicate the breadth: In 2007 Graham Wood from Australia received the award for his book *The Fine-Tuning of the Universe: A Philosophical Analysis*, dealing with the so-called anthropic principle in cosmology. In 2009 Willis Jenkins's book *Ecologies of Grace: Environmental Ethics and Christian Theology* was selected for its original contribution to bringing together environmental studies and theology. In 2011 Jonathan Edelmann received the prize for *When Two Worlds Meet: A Dialogue Between the Bhāgavata Purāṇa and Contemporary Biological Theory*. We will hear more about that in a moment. The dialogue between the natural sciences and theology was also fostered through the colloquia. I, for instance, remember a very engaging key-note address by Sir John Polkinghorne on the subject in 2009 that sparked a lively debate. The award certainly deepened my

interest in the relationship between science and religion and I have since regularly taught classes on this subject in the context of American cultural history.

Given these great achievements of the award, we were all overjoyed to learn that it will be carried into the future by a new sponsor, after the funding by the Templeton Foundation expired when in 2012 the maximum time limit was reached that its regulations prescribe. From next year onward the Manfred Lautenschläger Foundation will continue the program in slightly modified form under the new title “Manfred Lautenschläger Award for Theological Promise.” Luckily, the original format will be by and large preserved, which worked so well both as a means to promote young scholars and as a tool to further the science-and religion dialogue. And I think there’s much reason to be thankful for that.

Now, we here at Heidelberg of course very much hope that this conference will not mark the final culmination, however glorious, in the long-standing and very productive partnership between our university and the Templeton Foundation. As far as the Foundation’s interest in furthering the science and theology dialogue is concerned, I certainly see much potential here at Heidelberg as a comprehensive research university for new and much-needed projects. I have already heard about several possibilities that

As a scholar of American religious history, I believe that in addition to contributing to the dialogue between natural sciences and religion, it would be an important task for the Foundation to support research formats that explore the complex history of science and the religion in American culture. Of course, important work has been done in this area over recent decades; I’m thinking here of people like Edward Larson, Mark Noll, but also Laura Dassow Walls. But so much remains to be done, and especially remains to be done from a transatlantic perspective that takes into view the reciprocities but also crucial differences between the American and European developments. Such formats could help us understand why there came to be such an acrimonious “science and religion”-debate in the U.S. and why this conflict persists, despite the fact that so much progress has been made in showing that, on the level of abstraction, there needs to be no, there really is no principal or necessary conflict between physics, evolutionary biology etc. and religious faith. How did the U.S. end up in the present “culture wars,” in which substantial groups of the population on both ends of the spectrum believe that science and religion are fundamentally irreconcilable, regardless of how much agreement scholars reach at conferences such as this? Why do both fundamentalism and new atheism have so much more resonance in the U.S. than in other Western cultures? I do not think that the “science and religion”-dialogue will move forward in the larger public discourse in the U.S.

as long as we do not have a better grasp of where all the cultural resistance is coming from historically. We also need to better understand how the persisting “science and religion” debate is tied into larger conflicts over cultural authority in the U.S., in which both very different concepts of religion and science are invoked for purposes of legitimization. Of course, we know something about the reasons. But there is still much work to be done by new generations of scholars, work that needs to bring the different disciplines into dialogue: history of theology/biblical hermeneutics; history of science, history of higher education; political and legal history etc. Most importantly, the work would have to be done from a detached, neutral perspective.

But fresh studies in the history of the relationship of science and religion in the U.S. would also raise the awareness that over the past four centuries the kind of all-out confrontational attitudes were rare exceptions, and instead we usually find much more complex constellations. In talking about Sir John’s spiritual biography, Dr. Post mentioned two essential traditions in American cultural history that both provide paradigms, if very different ones, for a constructive integration of religious belief and scientific inquiry: the Edwardsean or Reformed-Puritan tradition and the Emersonian or Transcendentalist tradition. Having done considerable work on both of these traditions, I can say that they, each in their own way, still provide great resources waiting to be mined for the science and religion dialogue today. Both traditions have a lot to offer when thinking about ways to bridge the Cartesian divide; both offer different approaches to dealing with the problem of how to reconcile determinism and human freedom. The Emersonian-liberal tradition is especially interesting when it comes to thinking about religion and evolution; they are the first not only to accept Darwinian evolution in America but also to apply it to the realm of religion itself. They begin to talk about an evolution of religion, of theology and ethics [Henry Ward Beecher, Lyman Abbott]. If we take out some of the naïve progressivism of the 19th century, these are great sources.

But in the current situation, it is especially important, I think to make conservative Christians in the U.S. more aware of how the great representatives what they regard as their very own tradition, like Jonathan Edwards but also Cotton Mather, did not regard the rising natural sciences as an enemy but as a partner. They displayed an open-mindedness that is often lacking today. America’s very first comprehensive bible commentary, Cotton Mather’s *Biblia Americana*, which I’m helping to edit at the moment, is a monumental testimony to this integrationist stance. In 1721 Mather wrote that his work was supposed to “demonstrate, that Philosophy is no Enemy, but a mighty and wondrous Incentive to

Religion; and ... will exhibit that Philosophical Religion, which will carry with it a most sensible Character, and victorious Evidence of a reasonable Service.” None of these American figures and movements can be properly understood from a nation-centered perspective and from the viewpoint of just one disciple. Transatlantic/Interdisciplinary.

[If we don't understand the history, we are bound to repeat the mistakes of the past]

Templeton might well think of a new format for young scholars directed at historical questions. In this way it would also shed new light on its own origins. Heidelberg would be good partner for such a project. It has to offer a great deal of competence not only in history of theology and science, as evinced by this conference, but also in American Studies.

Daniel Munteanu

“The Divine Fire in All Things” – Orthodox Cosmology in Dialogue with Science

First of all I would like to express my deepest consideration and to thank Professor Dr. Dr. Dr. h.c. Welker for his kind invitation to this important and challenging conference. I am very grateful to the Templeton Foundation for the 2007 *Theological Award for a theological promise*. Dr. Murray mentioned in his speech that the Templeton Foundation is a *Foundation that seeks to transform lives and cultures*. I would like to confirm his short definition because the Templeton Award changed my life too, my worldview. Thanks to this award I could give lectures in different countries: England, Finland, Russia, Australia, South Africa, USA and enlarge this way my worldview.

Introduction

In this short paper I would like to present some reflections regarding the Theology and Science Dialogue and to put up for discussion my ideas regarding the meaning of a *perichoretical worldview* as paradigmatic contribution to this dialogue. I will also try to show how divine fire, i.e. divine immanence in all things might be connected with information, i.e. with an informed universe.

1. Fire as cosmic reality and as metaphor for divine presence

In the history of mankind fire played always a significant role. Throughout the centuries there has been such an *intimate connection of fire with the cultural growth of humanity*, so that a *theological analysis of fire* could give some insights on the fundamental relevance not only in tracing the *history of human evolution* but also in the *dialogue of theology with science*. Without the ability to control fire the evolution of the human being such as it was would be unconceivable. Fire was an *essential survival tool for humans*. The metaphor of fire as *source of energy* and *starting point of a dynamic complexity* might be used both for explanation of “big bang” and of the expansion of the universe.

13.7 billion years ago “the very early universe was highly energetic and for a while transformations took place with breathtaking rapidity”, underlined Sir John Polkinghorne.¹ “For several hundred thousand more years the universe was (...) a kind of cosmic plasma”.² Our physical world is an evolving, complex and dynamic system “from its elementary particles to the observable limits of the galactic cluster (...) Nothing remains stationary in nature; everything is in perpetual change, motion, and transformation”.³ Maximus Confessor, one of the greatest Church Fathers, used the metaphor of fire in order to describe the divine presence at the heart of all being. According to him there is a *divine fire in all things*: “the ineffable, supernatural and divine fire is present, as in the (burning) bush, in the being of everything that exists”.⁴ This is an image both for *divine immanence in the world* and for the salvation of the universe through the uncreated light of God as well.

In the 7th century Maximus Confessor was the first theologian to introduce into Christology the concept of περιχώρεσις⁵ as mutual indwelling of divine and human nature in Christ. Prior to him in the 5th century Cyril of Alexandria compared the effect of incarnation with the *transformation of the iron through an intense fire*. The incandescent iron participates in the power of the fire.⁶ For Maximus Confessor *incandescent iron* is a picture of the transformative power of love. Each movement of love is perichoretic like the air that becomes “enlightened by light and (like) the iron (that becomes) completely incandescent by

1 Polkinghorne, John, *Science and Religion in Quest of Truth* (Yale University Press, 2011), 47.

2 Ibid., 49.

3 Ligenides, Panos M., “Scientific Knowledge as a Bridge to the Mind of God,” in: Polkinghorne, John (ed.), *The Trinity and an Entangled World. Relationality in Physical Science and Theology* (Eerdmans, 2010), 74.

4 Maximus Confessor, Ambigua, 22a D, in: Andrew Louth, *Maximus Confessor* (Routledge, 1996) 118.

5 Cf. Disandro, Carlos A., “Historia semántica de perikhóresis,” in: *Studia Patristica*, vol. XV, Papers presented to the Seventh International Conference on Patristic Studies held in Oxford 1975, ed. Livingstone, Elizabeth A., Berlin: Akademie Verlag, 1984, 444: “De aquí transcurre a través de San Gregorio Nazianzeno (+390) hasta la prosa de San Máximo Confesor (+662), quien parece dar el vocablo *perikhóresis* su ubicación semántica definitiva en tres direcciones: a – triadológica; b – Cristológica; c – en la teología de la pístis, o sea en la eclesiología”.

6 Gaillard, Jean, Art. Feu, in: Viller, Marcel et al. (eds.), *Dictionnaire de Spiritualité ascétique et mystique. Doctrine et histoire* (Paris, 1962) 250.

fire".⁷ Later, in the 15th century, the same metaphor of an incandescent iron was used by Martin Luther as an image of the salvific "perichoresis" between God and mankind.

One could speak about the *ecumenical character of fire* as irradiance of divine, creative and sustainable light. One of the most impressive irradiance of divine light is to be found in the event of transfiguration of the Lord on mount Tabor. Jesus Christ irradiated or revealed the uncreated light of God as mystery of divine presence in the cosmic matter, so that Peter wished he could stay there forever. This divine fire in all things is correlated with *divine beauty* that overcomes boundaries. "Crossing boundaries (...) belongs the essence of the beautiful".⁸

The divine fire as divine and dynamical beauty of the Trinitarian Perichoresis of love "inflames desire, drawing one on into an endless *epektasis*, a stretching out toward an ever greater embrace with divine glory".⁹ "God is light" (1 John 1:5) and "every good gift (...) comes down from the Father of lights" (James 1:17). Humans are able of „perceiving light (the Son) from light (the Father) in light (the Holy Spirit)“ (Or. 31.3, PG 36, 136).¹⁰

The incomprehensible splendor of the divine light and beauty of the Trinitarian Creator remains the *gravitational center of all desires*: „Just as the sun (...) is itself the most beautiful of all visible things: just so is God (...) himself the highest of all objects of thought, in whom every desire finds its limit, beyond which it cannot pass“ (Gregory of Nazianzus, Or. 21.1). The Orthodox concept of salvation culminates in illumination by the divinizing indwelling of God and his uncreated energies.

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- 7 S. Maximi Confessoris, *Ambiguorum liber*, in: *Patrologia Latina et Graeca*, ed. J. P. Migne, (Paris: Garnier Frates, 1863), Tomus XCI, col. 1076a.
 - 8 von Balthasar, Hans Urs, *The Glory of the Lord: A Theological Aesthetics. Vol. 1: Seeing the Form*, San Francisco: Ignatius Press 1982, 216; cited by Hart, David, *The Beauty of the Infinite. The Aesthetics of Christian Truth* (Eerdmans, 2003), 20.
 - 9 Hart, David B., *The Beauty of the Infinite*, 20.155: "The Christian understanding of beauty emerges (...) from the Christian understanding of God as a *perichoresis* of love, a dynamic coinherence of the three divine persons, whose life is eternally one of shared regard, delight, fellowship, feasting, and joy"; 190: According to St. Gregory of Nyssa "human nature's perfection (*teleiōthj*) is nothing but this endless desire for beauty and more beauty, this hunger for God" (*De vita Moysis* 1.10)."
 - 10 McGuckin, John, "'Perceiving Light fom Light in Light' (Oration 31.3). The Trinitarian Theology of Saint Gregory the Theologian," in: *GOTR*, Vol. 39, No. 1, 1994, 31. 32.

2. Trinitarian Paradigme of Communion and Communication

The Trinitarian understanding of the world as created *by the Father through the Son in the Holy Spirit* allows us to see everything marked by the wisdom of the divine Word and by the energetically presence of the Holy Spirit. The eternal and historical realities are fundamentally encoded with this *matrix of communication*. Like the eternal life that is communion and communication, biological existence depends on exchange of information:¹¹ “The dance of life in a biological cell involves a (...) complex and dynamic rationality, sustained by continual interactions between enzymes and proteins in processes of great intricacy”, said John Polkinghorne.¹²

*Maximus Confessor had the intuition of the fundamental character of relationality, confirmed nowadays in physical science.*¹³ There is a “holistic connectivity in the physical world” that cannot be explained by a “purely atomistic” view of the world.¹⁴ According to John Polkinghorne “it is not possible to describe the world of subatomic physics atomistically! Nature is intrinsically relational.”¹⁵ Due to this intrinsic relationality, “democritan atomism is definitely dead”.¹⁶

The *relational ontology* of the world is based on “*trinitarian relationality*”, i.e. on the “perichoretic exchange of mutually interpenetrating love between the three divine Persons”.¹⁷ “Trinitarian mutuality of perichoresis” means “unique relationship of (...) mutual interpenetration and exchange of love between the divine Persons”.¹⁸

11 One could speak about a *growing in knowledge and being*. Human communication is based like human life on biochemical and neuropsychological communication.

12 Polkinghorne, John, “The Demise of Democritus,” in: idem, (ed.), *The Trinity and an Entangled World*, 1f.

13 Ibid., “The Demise of Democritus,” 1f.

14 Ibid., “Introduction,” in: idem (ed.), *The Trinity and an Entangled World*, vii.

15 Ibid., “The Demise of Democritus,” 6.

16 Ibid., 11.

17 Ibid., “Introduction,” ix.

18 Ibid., “The Demise of Democritus,” 1.

3. “At its base, everything that ‘is,’ is light” – Cosmic Light as expression of Trinitarian Love

Dumitru Stăniloae, one of the major interpreters of Maximus Confessor, understood the divine fire in all things as creative *irradiance of God’s love*. Creation exists because the Trinitarian God as “supreme structure of love” wishes to share his overwhelming plenitude and fullness of existence with mankind. According to Stăniloae “love puts omnipotence in motion”.¹⁹ The entire Holy Trinity is at work in creation, salvation and sanctification. “The Holy Trinity is the supreme mystery of existence. It explains everything, and nothing can be explained without it”.²⁰

Creatio originalis, creatio continua and creatio nova are linked with each other and sustained by divine grace. As “unlimited plenitude” of Reason, of Love and of Light, God is the origin, the sustainer and the aim of creation. The causal existences such as we know it, comes from Creator, who is “force of goodness and harmony”²¹, the “ultimate meaning” that “fully satisfy the thirst of humans for ultimate fulfillment”.²² “Supreme existence is supreme goodness”.²³ “There was a light that had no beginning, which could bring all created lights into being through the words ‘Let there be light!’ All creation received existence in order to enhance the light, or the consciousness (...) At its base, everything that ‘is,’ is light”.²⁴ “Everything that exists has rationality or light in itself”.²⁵ From the light of Jesus Christ occurs a “moving force” that “attracts creation into the eschatological condition”.

The eternal source of rationality and light in creation is the Trinitarian God. Stăniloae refers to St. Gregory of Nazianzus who described the Holy Trinity as “a single intermingling of light, which exists in three mutually connected Suns”.²⁶ This patristic view is present also in St. John of Damascus, who understood the Holy Trinity as “three suns cleaving to each other without separation and giving out light mingled and conjoined into one”.²⁷

19 Stăniloae, Dumitru, *The Holy Trinity. In the Beginning There was Love* (Holy Cross Orthodox Press, 2012), 44.

20 Ibid., xi.

21 Ibid., 8.

22 Ibid., *The Experience of God. Orthodox Dogmatic Theology* (Continuum, 2002), 38.

23 Ibid., *The Holy Trinity*, 31.

24 Ibid., 5f.

25 Ibid., *Iisus Hristos, Lumina lumii și îndumnezeitorul omului* (Anastasia 1993), 28.

26 Ibidem.

27 Ibid., *The Holy Trinity*, 19f.

Creation is a sacrament of communion, of shared light, of embodied or materialized divine love. "Matter is capable of being formed through the spirit."²⁸

"It is equally miraculous how the body's organs are arranged out of collection of molecules: the heart, lungs, stomach, and the senses are all joined together in a body, and all serve the conscious purposes of the human subject. Through each of them flows the conscious unity of the same subject. (...) God must be present together with His handywork in this marvelous relationship."²⁹

For Stăniloae Creation has an eternal meaning, because it is based on the *divine fire of love, i.e. of Trinitarian intersubjectivity. Where love is there is meaning. Where eternal love is there is the eternal light of meaning too.*

In his cosmic Christology Stăniloae described *True Reason* as being *one with love*³⁰: "I am the light of the world. He who follows Me shall not walk in darkness, but have the light of life" (John 8:12). As power the Logos of God is also life and "as wisdom He is light and love".³¹ "I am the truth and the life" (John 14:6). The fullness of life is goodness and light of consciousness or of knowledge. *The entire material universe is imprinted by God's wisdom and sustained through His Holy Spirit*, who "was hovering over the face of the water" (Gen 1:2) at the beginning. There is a divine fire in all things, because the entire creation exists by the uncreated energies of the Holy Spirit. This is the reason why Stăniloae understood the Pentecost as ultimate purpose of Trinitarian salvation. The mater of the universe can be sanctified, penetrated or transfigured by divine light. Stăniloae called this a "mystical materialism" and a mystery of the resurrected body. *The mystery of salvation is the mystery of God's indwelling that transforms creation by the glory and beauty of his eternal interpersonal love. For an Orthodox Soteriology eschatologic pleroma means the living unity of interpersonal communion, common sharing of divine fire and light.*

4. The fire in creation as medium of divine revelation

In the Old Testament we have many witnesses about the relationship between theophany and lightning events. For Israel the fire was a sign of divine presence,

28 Ibid., 49.

29 Ibid., 51.

30 Ibid., 8.

31 Ibid., 15.

a main element of theophany, i.e. of divine holiness and splendor.³² Fire in OT is both a created element (Eccl. 43, 5.21) and a sign of divine presence as well. On the Mount Sinai Moses received the Ten Commandments accompanied by light-frightening phenomena:

Exodus 19, 18–19: “Now Mount Sinai was wrapped in smoke because the Lord had descended on it in fire. The smoke of it went up like the smoke of a kiln, and the whole mountain trembled greatly. And as the sound of the trumpet grew louder and louder, Moses spoke, and God answered him in thunder.”

Exodus 22, 18: “Now when all the people saw the *thunder* and the *flashes of lightning* and the sound of the trumpet and the mountain smoking, the people were afraid and trembled, and they stood far off.”

On the Mount Horeb Moses encountered God in the burning bush. God “appeared to him in a *flame of fire out of the midst of a bush*. (...) The bush war burning, yet it was not consumed” And Moses said, ‘I will turn aside to see this great sight, why the bush is not burned.’ When the Lord saw that he turned aside to see, God called to him out of the bush” (Exodus 3, 2–4).

The religious experience on *Mount Sinai* and on *Mount Horeb* became part of the cultural and religious memory of Israel, that God the Lord spoke to his people “out of the midst of the fire” (Deut. 4, 12.15). The fire of the Lord protected and helped Israel during the exodus from Egypt by the nightly guiding “in a pillar of fire”:

Exodus 13, 22: “And the Lord went before them by day in a *pillar of cloud* to lead them along the way, and by night in a *pillar of fire* to give them light, that they might travel by day and by night.”

The same fire of God can also be a destructive, devouring fire (Ps. 50, 3; 104, 4.32; 144, 5–6):

Exodus 24, 17: “Now the appearance of the glory of the Lord was like a devouring fire on the top of the mountain in the sight of the people of Israel”.

Psalms 18, 8: “Smoke went up from his nostrils, and *devouring fire from his mouth*; glowing coals flamed forth from him.”

Psalms 29, 7: “The voice of the Lord flashes forth flames of fire.”

Psalms 77, 19: “The crash of your thunder was in the whirlwind; your lightnings lighted up the world; the earth trembled and shook.”

The metaphor of *devouring fire* will become an eschatological motive of divine pedagogy (or terrorization of sinners) (Daniel 7, 9–12; Joel 1, 19–20; Joel 2, 3–5;

32 Gaillard, Art. Feu, 247.

Amos 4, 11; 5, 6; Isaiah 4, 5–6; Marc 9, 48: “where their worm does not die and the fire is not quenched”; 2 Thess 1,8; Hebr 12, 29: “for our God is a consuming fire”).

The fire of God can purify the prophets like Isaiah 6, 6. The experience of *divine glory* is described by Hezekiel like the *brightness of fire* (Hezekiel 1, 27; 8, 2; 9, 1–7).

5. Main Aspects of the Orthodox Spirituality as Spirituality of Light

Jesus Christ is called in Nicaenum Constantinopolitanum “God from God, *Light from Light*”. He came in the world in order “to cast fire on the earth” (Luke 12, 49). This fire is associated with the Holy Spirit, who as Spirit of Love, of Life and of Resurrection descended at Pentecost as “tongues of fire” (Act 2, 3–4). Saint John of the Cross calls the Holy Spirit “flame of love”.³³ The Holy Spirit is described in the hymn “Veni, Creator Spiritus” as “Fons vivus, ignis, caritas”.³⁴ He is called in the Orthodox Liturgy “Fire that proceeds from Fire” (πῦρ ἐκ πυρὸς προίόν).³⁵

According to the mystique of Hesychasm the human being is able to see the uncreated, taboric light and to become entirely like fire (γενοῦ ὅλος πῦρ), Apophthegmata Patrum, PG 65, 229c).³⁶ The pursuit of happiness consists in the inner longing to become theophor, i.e. a *burning bush of divine fire*, a personal bearer of divine love, beauty and wisdom, a “*flame of fire*” (Psalm 104, 4; Hebrews 1, 7). As *eikon tou Theou*, the human being was created with the ability to participate in divine glory (Chavod, Gloria resurrectionis).

Humans are defined to become a “living icon of the Holy Trinity”³⁷ an embodied presence of Trinitarian love. This is possible only by a mutual indwelling, by a perichoresis with the divine fire: “like the iron, that in contact with fire, becomes itself fire” (Nicolas Cabasilas).³⁸ Gregory of Nyssa spoke about a bright,

33 Ibid., Art. Feu, 259.

34 Ibid., 258.

35 Ibid., 258.

36 Ibid., 265.

37 Metropolitan Kallistos Ware, “The Holy Trinity: Model for Personhood-in-Relation,” in: Polkinghorne (ed.), *The Trinity and an Entangled World*, 128.

38 Gaillard, Art. Feu, 267

luminous and *brilliant darkness* ἀρχή ἄναρχος.³⁹ Human being can participate in the uncreated light of God, i.e. to touch the glowing and interpersonal infinity of God. There is a “burning vibration” in creation that seeks for the everlasting inhabitation of God as source of life and happiness. By inhabitation of God in creation the ocean⁴⁰ of divine love and glory (doxa) becomes more and more visible. God’s Glory, said Maximus, is a deifying fire.⁴¹

A fascinating image about the *cosmic fire in every living being* can be found in John Polkinghorne description of the “*stellar nucleogenesis*”: “Every atom of carbon in every living being was once inside a star, since the interior nuclear furnaces of the stars are the only place in the universe where this element can be made.”⁴²

6. Fire as symbol of an intrinsic rationality and dynamic complexity of the universe

Maximus Confessor understood God as “the beginning, the middle and the end of all things as their energy, for He is as Creator their beginning without beginning (ἀρχή ἄναρχος), their middle (μεσότης) as their Providence (προνοητής), and the end (τέλος) of all as their boundary (περιγραφή).”⁴³ There is dynamic presence of God in his creation through his “logoi” of creation. Everything that is, lives in the field of resonance of the divine Logos through the architectural work of the Holy Spirit. We can know and see God through the logoi of creation. God exists in all “logoi” of creation as supreme Love. The logoi are divine purposes and wills in all beings and things. The Logos of God is the plenitude and fulfillment of all logoi of creation⁴⁴, the “sun of righteousness” and savior of all thing.⁴⁵ In

39 Daley, Brian E., S. J., “‘Bright Darkness’ and Christian Transformation. Gregory of Nyssa on the Dynamics of Mystical Union,” in: Himes, Michael J. and Pope, Stephen J. (ed.), *Finding God in All Things. Essay in honor of Michael J. Buckley, S.J.* (Crossroad, 1996), 215f.

40 See Stăniloae, “Dumnezeu este lumina (1 Ioan 1, 5),” in: Ortodoxia, XXVI, 1/1974, 76: Stăniloae speaks of God as “ocean of love and light”.

41 S. Maximi Confessoris, *Ambiguorum Liber*, 1124 A; see Louth, 103.

42 Polkinghorne, *Science and Religion in Quest of Truth*, 55.

43 Maximus Confessor, ThEc I, 10, 1085–1088D; see Constantine N. Tsirpanlis, Constantine N., *Introduction to Eastern Patristic Thought and Orthodox Theology* (Liturgical Press, 1991), 35.

44 Ibid., 33.

45 Maximus Confessor, *Questions à Thalassios*, Tome II (Questions 41 à 55), trad. par Francoise Vinel, *Sources Chrétiennes*, No. 554, Paris: Les Édition du Cerf, 2012, 181.

the incarnated Logos “sont comprises la generation des temps et des réalités qui sont dans le temps ainsi que le prolongement à l’infini de la vie des réalités qui par grâce sont au-delà des temps”.⁴⁶

Hans Urs von Balthasar showed that for Maximus Confessor “Ontology and Cosmology are extended Christology, insofar as the hypostatical synthesis is the last and the first thought of God about Creation”.⁴⁷

For Maximus Confessor the material universe is based on divine rationality (logoi) and permeated by the Spirit of God, who is present in everything, so that nothing is empty of the Holy Spirit: “ἐν πᾶσιν ἀπλῶς ἐστι τὸ πνεῦμα τὸ ἅγιον”.⁴⁸

6.1 St. Gregory Palamas as Theologian of divine Light

As one of the main representatives of the hesychast spirituality, Palama is a theologian of light. For him the human being was created in order to participate in the uncreated light and glory of God. Knowledge of God means for him participation in the transformative, uncreated light of the Trinity, a movement accompanied by the inhabitation of the Trinity.⁴⁹ Palamas understood salvation as “divine illumination” (θεῖος φωτισμός)⁵⁰, i.e. as immediate union with God: “through the Spirit, in the light of the Father, we see the Son as light”⁵¹ and becomes united with his light and wisdom, “deviant tout entire lumière”⁵², “children of light” (Ephesians 5, 8).⁵³ God is like a source of light: “πηγὴ φωτός”⁵⁴, “who dwells in unapproachable light” (1 Timothy 6, 16).⁵⁵

According to his theology, the material universe is based on the “creative beauty” and “divine light”. This light is deifying (τὸ θεουργὸν φῶς), because it is an irradiation of the eternal, Trinitarian love.⁵⁶ Palamas spoke about *divine light*

46 Ibid., 227.

47 von Balthasar, *Kosmische Liturgie. Das Weltbild Maximus’ des Bekenners*, (Einsiedeln 1961), 204.

48 <http://www.ellopos.net/elpenor/greek-texts/fathers/maximus-holy-spirit.asp?pg=2>.

49 Palamas, Grégoire, *Défense de saints hésychastes*, 2 vols. ed. Meyendorff, John, (Spicilegium Sacrum Lovaniense, Études et documents Fascicule 30, Louvain 1959), 74.

50 Ibid., 106f.358.

51 Ibid., 440.

52 Ibid., 458.

53 Ibid., 482.

54 Ibid., 550.

55 Ibid., 580.

56 Ibid., 116f.154.600.

as *divine, immaterial fire* that is at the very essence of things.⁵⁷ The "Fire of divine love"⁵⁸ is as a matter of fact the foundation and the reason of creation and salvation: "At the beginning of creation God said and light occurred; today he didn't say but he become himself our light".⁵⁹ Incarnation is connected in this view with the transformation of the world by divine glory, revealed on the mountain Tabor. "God is light, and in him is no darkness at all" (1 John 1, 5). The supracosmic "sun of justice" (Maleachi 4, 2) became light of the world, a light that is at the same time eschatological and transcends the universe.⁶⁰ "For God, who said, 'Let light shine out of darkness,' has shone in our hearts to give the light of the knowledge of the glory of God in the face of Jesus Christ." (1 Cor 4, 6).

Humans can become illuminated by divine wisdom, by the tongues of fire as tongues of the Holy Spirit. This *mysterious union* with God through his eternal light (τὸ ὑπερ αἰσθησιν φῶς) (*énergie lumineuse*)⁶¹ is beyond imagination and transforms us in a "visible theophany" and makes us Christus-like (*Hristoeidésin*).⁶² "Lumière mystérieuse, inaccessible, immatérielle, créée, déifiante, éternelle, éclat de la nature divine, gloire de la Divinité, beauté du Royaume celeste, (...) lumière du siècle à venir".⁶³

6.2 Creation and Information

The relationship between *creation and information* can be perceived as a bridge for theology and science dialogue. In our western society as *information society* the information has an enormous influence. Information is nowadays described as a "hinge category between science and theology".⁶⁴ The evolutionary success of mankind is partly explained by "the capability to handle information in an adequate way".⁶⁵ The *informational worldview*, which is "centered on the more

57 Ibid., 636.

58 Ibid., 158.502: "Ténebre supralumineuse (*hypérfoton gnófon*)".

59 Ibid., 120.

60 Ibid., 178.

61 Ibid., 624.

62 Ibid., 436.576.

63 Ibid., 598f.

64 J. C. A. van der Lubbe, J. W. A. Laurent, "Information as a hinge category between science and theology and its impact on the idea of God," in: Wassermann, Christoph, Kirby, Richard and Rordorf, Bernard (eds.), *The Science and Theology of Information*. Proceedings of the Third European Conference on Science and Theology, Geneva, March 29 to April 1, 1990, Genève: Editions Labor et Fides, 1992, 83f.

65 Ibid., 85.

dynamic aspects of information” overcomes the “mainly object-oriented” mechanistic worldview.⁶⁶ The concept of information can also be helpful in bridging dichotomies like subject and object, mind and matter.⁶⁷

From a theological point of view information indwells creation as a divine input. The world was created through God’s Word and is as such based on divine communication and information. The latin *informo, informare* means “to give shape or form to”.⁶⁸ As living creature (*nephesh hayah*) with divine dignity – *imago Dei* the human being is able to share and transform information, i.e. to participate in the *dynamism of divine creativity*. For the Dutch scientist and theologian Cornelis Johannes Dippel (1902–1971), God is the sublime “Informaticus” or “Informer” of matter, the ultimate source of all information “by which man, matter, mind, energy, all visible and invisible things” are.⁶⁹ Karl Rahner defined matter as “frozen spirit”, whereas Dippel spoke about matter as “solidified information”, so that the material world is always marked by the *divine information*.⁷⁰

Based on this creation exists due to an *intentionality of communicative information*. God is source of life, of information and the eternal light in which the information, the symbolic encoded world should be understood. The human being is able to hear the Word of God (“Hörer des Wortes” – Karl Rahner). Without such an ability of perceiving human and divine information, information is meaningless. Humans are able to receive, to decode and to understand the divine information. By seeing the world in the light of divine wisdom, the biosphere becomes a semiosphere:

“In the *biosemiotic vision* natural entities and processes are seen as interconnected webs of relations, shaking hands so to say between levels in the hierarchical scale, stretching along the spatial dimension from the single cell to the biosphere or, along the semantic dimension, from pheromone-signaling to the human psycho-neuro-immuno-endocrine system”.⁷¹

66 Ibid., 85.

67 Ibid., 85.

68 Puddelfoot, John C., “Information and Creation,” in: Wassermann, Kirby and Rordorf (eds.), *The Science and Theology of Information*, 15.

69 Cf. van der Lubbe and Laurent, “Information as a hinge category,” 87.

70 van Dijk, Pieter, “Revelation and Information,” in: Wassermann, Kirby and Rordorf (eds.), *The Science and Theology of Information*, 92f.

71 Marais, Mario A., *The use of information concepts in the dialogue between science and theology*, dissertation, University of South Africa, electronic version: <http://uir.unisa.ac.za/handle/10500/1101>, 15, cites Hoffmeyern.

In his book “The Beauty of the Infinite. The Aesthetics of Christian Truth”, David Bentley Hart describes the recapitulation of creation in Christ as semiotic process of restauration: “Christ’s miracles – as do all the aspect of his life and ministry – constitute a *semeiosis* (...) that restores the original *semeiosis* of the world, the language of divine glory, and that reorients all the signs of creation toward the everlasting sign of God, who walks among them. (...) all the signs of created being (...) speak of him”. Each attempt to understand Christ is “an *epektasis* of words, in and toward the Word”.⁷²

7. Criteria for Theology and Science Dialogue

1. The common sphere of the *one*⁷³, *intelligible world*⁷⁴, i.e. of the one complex reality – open and complementary hermeneutics of the one reality – Reality/information, cultural/traditional medium of experience, knowledge. *Theology and Science can be understood as an attempt to understand and to participate in the mystery of life and light*. Theology and Science have a common realm of reality, of information, of biological life, traditions, perspectives’ – anthropological constant or *knowledge in the realm of historical conditio humana*. An *anthropology of communication* could be fruitful for the interdisciplinary dialogue – homo communicans, the human being as information sharing being.
2. *Pneumatological dimension of knowledge and being*: “The Holy Spirit is present in all creatures and most of all in those who have participated in any way to reason. Because He is who holds and unites the knowledge of all creatures, since He is God and God’s Spirit, going into everything according to the potentiality that He foresees, and He enlivens and moves the natural reason of all, this way leading him, who senses and has his will ready to receive the correct and natural thoughts, to feel those of his acts that don’t comply completely with the customs of nature”.⁷⁵

72 Hart, *The Beauty of the Infinite*, 327f.

73 Polkinghorne, *One World. The Interaction of Science and Theology* (Princeton University Press, 1987).

74 See Coyne, Georg V. and Heller, Michael, *A Comprehensible Universe. The Interplay of Science and Theology*, New York: Springer Verlag, 2008, 3f.

75 Maximus Confessor, *Questiones ad Thalassium* 15, “Τὸ πνεῦμα τὸ ἅγιον οὐδενὸς ἄπεισι τῶν ὄντων καὶ μάλιστα τῶν λόγου καθοτιοῦν μετειληφόντων”; see: <http://www.ellospos.net/elpenor/greek-texts/fathers/maximus-holy-spirit.asp>

3. *Fragmentarity of knowledge and relativity of paradigms*: “Aware that there is no such thing as objective, or value neutral information, the paradigms within which we observe, understand, communicate and make decisions, will influence the future direction of the world. Our interpretive models, paradigms and languages are in continuous change over time, often through interaction, sometimes by re-seeing something in a different perspective”.⁷⁶ Scientific knowledge is limited⁷⁷ because it depends on the quality of instruments and of the interpretative observer as well. The *subjectivity of human knowledge* is clear in the process of observation that depends on the observer. Michael Welker showed in a constructive way that only a *multidimensional and multiperspectival approach* can lead the Theology and Science Discourse on a new plurisignificative level⁷⁸.
4. *Culture of kenosis or humility* as way of reconciliation of the multiplicity of paradigms. “We think in culturally and linguistically determined models and metaphors. However, we continue to change, responding to new information, new experiences and new interpretations”.⁷⁹ The culture of kenosis is the way of overcoming intolerance and idolatry of discourses by the creative challenge of difference.
5. *Recognition of the gnostic intellect*. “The gnostic intellect (ὁ γνωστικός νοῦς) is a friend of God (θεοφιλής), because in his searching for the truth (...) inflames the fire of knowledge (τὸ πῦρ ἐξάπτων τῆς γνώσεως)”.⁸⁰ “For all the things of God, which we contemplate (...) with the help of the appropriate science (...) tells us in a hidden way about how they were made. Through them we learn of God’s purposes in every created thing. (...) Through the wise contemplation of creation, we discern the Reason which sheds light on the Holy Trinity”.⁸¹
6. Universe of divine intentionality of communion.

76 Rajotte, F., “Models and Metaphors as Informations Carriers,” in: Wassermann, Kirby and Rordorf (eds.), *The Science and Theology of Information*, 124f.

77 See Buxhoeveden, Daniel, “Limitations of Scientific Knowledge and Orthodox Religious Experience,” in: *ibid.* and Woloshak, Gayle (eds.), *Science and the Eastern Orthodox Church*, Burlington: Ashgate, 2011, 91f.

78 Welker, Michael, *The Theology and Science Dialogue. What can Theology Contribute*. Expanded Version of the Taylor Lectures Yale Divinity School 2009 (Neukirchner, 2012), 18.37f.

79 Rajotte, “Models and Metaphors,” 126.

80 Maxime le Confesseur, *Questions à Thalassios*, Tome II, 151.

81 See Stăniloae, *The Holy Trinity*, 7.

7. *Sharing the same information with different hermeneutics.* One significant step in Theology and Science Discourse would be the question about an *interdisciplinary hermeneutics*. This hermeneutics of creation as *hermeneutics of complementarity* towards a better understanding could build the bridge for a deeply encounter between these both "truth-seeking" communities. A hermeneutics of complementarity is a cognitive and cultural invitation to search together, to share with each other the results of our understanding and discoveries, to open together "new windows" into visible and invisible realities. I understand a hermeneutic of complementarity as an attempt of integrative knowledge without reductionism and academically collapse of competence and concentration on specific topics, as Welker expressed it by quoting a brilliant questions (of Beckett): "Are you merely interested in everything – or also in something specific?"⁸²
8. *Creative love as participation in divine creativity.* Theological knowledge is doxological, i.e. not exclusivist but participatory openness to the divine light, wisdom and love. Openness for the discourse of the other is an openness or an ability to be "illuminated" by *the embodied fire of the other*. Multiliguallity and multiperspectivity are a challenge but also a necessity, in order to overcome each sort of violence of *univocalist contaminated discourses*. Without a dynamic of self-transcendence there is no Science and Theology Discourse.
9. *Responsible, interdisciplinary dialogue as ecological-ecumenical task.* In dialogue we can understand us a "part of the total interdependent created order. The sickness of the earth is inextricably bound up with the sickness of people"⁸³
10. *Vivid dialogue marked by the same passion for the "breath-taking complexity" of the world.* I understand this *sincere passion for knowledge* as an inner longing for understanding, and for participation in the deep meaning of the universe. There is in my opinion always a "liturgical logic" and "liturgical ethos" in any scientifically and theological seeking of truth. "Truth-seeking communities are communities which do not claim to possess the truth, but rather raise truth-claims and develop agreed modes to test these claims". Truth-seeking communities "seek to enhance topical insight and the coherence of knowledge"⁸⁴

82 Welker, *The Theology and Science Dialogue*, 21.

83 Rajotte, "Models and Metaphors," 129.

84 Welker, *The Theology and Science Dialogue*, 74.

11. *Science and Theology Discourse as Contribution to the welfare of future generations.* The search for authentic information can be seen as search for divine, eternal rationality/information.⁸⁵ Scientists and Theologians are responsibility for discourse as *transfer of information* and *formation of future cultural identity* (that is connected in my opinion with a correspondent ethics/activity). Theology and Science dialogue can lead to transformative impulses, to a *humanization of the world by dialogue, communication, self-transcendence, trust and philanthropy.*

85 M. Glodz, "Search for 'Eternal Informations' in Science – two perspectives," in: Wassermann, Kirby and Rordorf (eds.), *The Science and Theology of Information*, 333ff.

Eva Harasta

God's Spirituality. The Trinitarian Dynamics of Prayer

This paper has two objectives: First, I present the theological interpretation of prayer as developed in my dissertation (which received the John Templeton Award for Theological Promise in 2007). Second, I develop this interpretation of prayer further by locating it in the wider horizon of a theological interpretation of the human mind. I conclude by using my argument as a starting point for a dogmatic hermeneutics to the science and religion dialogue.

1. The Embodiment of Prayer: Praise, Petition, Lament and Thanksgiving

Prayer articulates the community between God and human: In prayer, faith becomes word. In my dissertation, I delineated the grammar of prayer as interplay of praise, petition, thanksgiving and lament on the basis of the Biblical prayer traditions (especially the Psalms and the Lord's Prayer).¹ In short, my systematic-theological interpretation of prayer amounts to the following: Praise, petition, thanksgiving and lament are not isolated from each other, but are interconnected and together form the grammar of Christian prayer. Their specific configuration is rooted in the specific community with God – and in the specific situation of the praying person. Every individually spoken prayer is rooted in this specific configuration of petition, praise, lament, and thanksgiving, but of course it applies the four elements to the given situation of the praying person. Individual prayer moves within the deep framework of the Biblical prayer traditions – and uses this Biblical framework to express the unique situation of the praying person. Thus the praying believer finds him- or herself in a wider context of prayer, and is strengthened as well as guided by the community of other praying persons

1 Harasta, Eva, *Lob und Bitte. Eine systematisch-theologische Untersuchung über das Gebet* (Neukirchen-Vluyn, 2005). For a short English summary of my thought about prayer and an investigation into the Christological context of this approach cf. Harasta, "Crucified Praise and Resurrected Lament," in: Ibid./Brock, Brian (eds), *Evo-king Lament: A Theological Discussion* (London, 2009), 204–217.

and by a tradition of an ongoing relationship of trust between God and his believers.

Praise, petition, thanksgiving and lament are forms of relating to God, and they are connected in a specific pattern. The pattern is determined by the way faith receives and perceives God's relationship to the believers, and their relationship to God. Praise and petition together form the backbone of prayer. – Here, I combine two established perspectives on prayer, the doxological perspective and the petitionary perspective. John Calvin is a prominent exponent of the doxological perspective, while Karl Barth is a prominent exponent of the petitionary perspective. Calvin stresses that all human life in essence ought to glorify God, and within this wider doxological context prayer is assigned its theological place and sense as well. For Calvin, even petitions ought to be instruments of praise; the aim of the pleading person should be to ask only for those gifts that align with God's glory. Barth – an exponent of the petitionary perspective on prayer – stresses that all human life in essence ought to be obedient to God's will. The purest form of prayer, in this perspective, is the petition "Your will be done, on earth as it is in heaven."

In my dissertation, I argued that the two perspectives – petition and praise – belong together and that their interrelationship influences the understanding and role of thanksgiving and lament within (Christian) prayer. Praise and petition together form the heart of Christian prayer, and both need to be equally present in liturgy and private prayer. Otherwise prayer atrophies, losing either the dimension of thanksgiving or the dimension of lament. The particularly noticeable loss of lament in Christian liturgy and prayer can be traced back to an overly petitionary stance on prayer: From the perspective of petition, lament looks like disobedience. But from the perspective of praise, lament becomes the acknowledgment of the unpraiseworthy.

The configuration of praise, petition, thanksgiving and lament expresses the deepest structure of faithful life: The grammar of prayer can be regarded as the grammar of faithful existence (in the "world"). By saying this, I do not want to turn my back on other ways of interpreting Christian existence, for example by way of the duality of Christian obedience and Christian freedom, or by way of the duality between existence *coram mundo* and existence *coram Deo*. But I do want to argue that the grammar of praise, petition, thanksgiving and lament offers a fresh perspective on Christian existence as a whole.

If the grammar of prayer may be read as a grammar of faithful existence, as a standing point for looking into the deepest structure of faithful life "in the world", then it can be further delineated in terms of the image of God in human

life. What does the specific configuration of praise, petition, lament and thanksgiving tell us about the image of God in human life?

2. The Relationality of Prayer: *Imago Dei*

The image of God in human life – this expression leads into the theological interpretation of the human being as *imago Dei* (Gen 1,27). In my approach to this problem, I draw on Augustine.² In his work *De trinitate*, Augustine offers a Trinitarian interpretation of the human being as the image of God. For Augustine, any “true image of God” can only be Trinitarian, because God is the living unity of Father, Son and Holy Spirit. Here, I cannot go into detail with regard to Augustine’s quest for images of the trinity in the human mind.³ I simply want to draw on one Augustinian motive in order to further my present argument. This Augustinian motive is the following idea: The life of the human mind is the interaction between memory, intelligence and will (*memoria, intelligentia, voluntas*). These interactions occur whenever the mind is at work. But only when the mind is moved by the love of God, it becomes the living image of God.⁴ Only when the mind receives the Holy Spirit, the “bond of love” (*vinculum amoris*), the human mind becomes the true image of God. When the mind is moved by the love of God, memory, intelligence and will interact in a specific manner: loving God and loving the neighbor. For Augustine, this is an eschatological occurrence; he is quite pessimistic regarding the present capability of the believers

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- 2 A more detailed account of my interpretation of Augustine’s thought on the *imago Dei* can be found in the following article: Harasta, “Glaube, Liebe, Geist. Zur Unterscheidung zwischen fides qua creditur und fides quae creditur,” *EvTh* 65 (2005): 428–443. In many ways, I agree with Rowan Williams; cf. Williams, Rowan, *De trinitate*, in: Fitzgerald, Allan D. et al. (eds), *Augustine Through the Ages* (Grand Rapids, 1999): 845–851, and *ibid.*, “‘Sapientia’ and the Trinity. Reflections on the *De Trinitate*,” *Aug(L)* 40 (1990): 317–332.
 - 3 A short overview of Augustine’s Trinitarian theology from my perspective: Harasta, “Augustinus: *De trinitate*,” in: Klein, Rebekka A./Polke, Christian/Wendte, Martin (eds), *Hauptwerke der Systematischen Theologie. Ein Studienbuch* (Tübingen, 2009), 31–48.
 - 4 *De trinitate* (abbr.: *trin.*) XIV,12,15; CChr.SL 50A,442,1–443,5. The „trinity“ of memory, intelligence and will: *trin.* X,10,13; CChr.SL 50,327,20–25. On the “Trinitarian” dynamics of love: *trin.* VIII (as a whole), esp. *trin.* VIII,8,12; CChr.SL 50,286,1–7 (which culminates in the invitation: “*Amplexere dilectionem deum et dilectione amplexere deum.*” – “Embrace God as love and embrace God in love.”).

to live according to their own being as images of God.⁵ But still: By the presence of the Holy Spirit, the believing mind may perceive the Trinitarian relationality within God, and by the presence of the Holy Spirit, the relationships between the Father, the Son and the Spirit open themselves up. John Calvin has described this “opening” of the Trinitarian relationality by re-interpreting Augustine’s notion of the Holy Spirit as “bond of love”: For Calvin, the “bond of love” lies between the believers and God, it is the presence of the Holy Spirit that enables faith.⁶

3. God’s Spirituality: Trinitarian Involvement

After delineating the configuration of lament, praise, petition and prayer as the “grammar” of prayer, I identified two approaches to prayer, the doxological and the petitionary approach and argued for combining the two approaches. The resulting grammar of prayer in the interplay of praise, petition, thanksgiving and lament emerged as the basic grammar of the Christian existence as a whole.

Then I sketched a Trinitarian interpretation of the Christian existence in terms of the *imago Dei*, taking my cue from Augustine’s interpretation of the believing mind, but re-interpreting his position from a protestant perspective. This resulted in the following notion: The human mind becomes the living image of God by being “endowed” with God’s love. This endowment is the presence of the Holy Spirit in the believer. By this love, memory, intelligence and will within the human being begin to interact in a new way, living out the image of God in love of God and love of neighbor. By being drawn into the presence of the Holy Spirit, the believers are also drawn into the Trinitarian relationality – never on the strength of their own endeavors (no *theosis*), but only through the mediation of the Holy Spirit.

Now I want to combine the two steps of my argument in order to use the grammar of prayer as a hermeneutics to the interpretation of the Christian existence.

I understand praise and petition as human responses to the presence of the Holy Spirit; these responses are not independent of the Holy Spirit, but “filled” with it. Praise, then, is the human response to being drawn (by the Holy Spirit) into the Trinitarian dynamic of “love of God”. And petition is the human response

5 Augustine’s eschatological skepticism with regard to the realization of the *imago Dei*: trin. XIV,15,21; CChr.SL 50A,449,7–16 (citing 1 Cor 4.7); cf. trin. XV,17,31; CChr.SL 50A,506,130–131.

6 Calvin, John, *Institutio christianae religionis* (1559), III,1,1; CR 30 (CO 2), 393f.

to being drawn (by the Holy Spirit) into the Trinitarian dynamic of "love of neighbor".

Praise realizes the reciprocity of love between God and the believer; praise is the awareness that the Holy Spirit is the opening of the community of love between the Father and the Son. The counterpart of praise is lament. Lament realizes the loneliness between God and the believer; lament is the awareness of Christ's cry of abandonment on the Cross. Praise and lament are introductions into the relationship between Father and Christ, the Son.

Petition – the human response to being drawn (by the Holy Spirit) into the Trinitarian dynamic of "love of neighbor" – realizes that God's love is kenotic, because it is the love of Christ. As such, the love of God leads into love of neighbor; it leads into the community of believers and it leads into community with "the world". In this perspective, *intercession* may be the purest form of petition. The counterpart of petition is thanksgiving. Thanksgiving is the awareness of received gifts, that is, it is the awareness of the Holy Spirit's work on the believer and on the believing community. Petition and thanksgiving are introductions into the relationship between the Holy Spirit and Christ.

Yet the introduction of Augustine's interpretation of the human *imago Dei* leads into a different context as well: How can praise, petition, thanksgiving and lament be interpreted in terms of the interplay of memory, intelligence and will? Here lies an important dogmatic-theological reason to engage with *scientific* interpretations of the human mind, for this question can only be answered by looking into different theories of memory, intelligence and will. But by referring to the Trinitarian dynamics of the true *imago Dei*, this reasoning remains true to the "otherness" of the faith discourse, that is: to the fundamental theological distinction between creation and creator.

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Prof. Dr. Thomas Pfeiffer, former Vice-Rector of the University of Heidelberg; Professor at the Faculty of Law, University of Heidelberg; Executive Director at the “Institut für ausländisches und internationales Privat- und Wirtschaftsrecht”.

Prof. Dr. Ted F. Peters, *Distinguished Research Professor of Systematic Theology at the Graduate Theological Union, Pacific Lutheran Theological Seminary.*

Rev. Prof. Dr. Dr. h.c. mult. John Polkinhorne, FRS, KBE, Professor of mathematical physics emeritus at the University of Cambridge and former president of Queens' College, Cambridge.

Prof. Dr. Stephen Post, Professor of Preventive Medicine; Director at Center for Medical Humanities, Compassionate Care and Bioethics, Stony Brook University.

Prof. Dr. Robert J. Russell, Founder and Director of the Center for Theology and the Natural Sciences (CTNS); Ian G. Barbour Professor of Theology and Science in Residence at the Graduate Theological Union (GTU), Berkeley.

Prof. Dr. Dr. h.c. William Schweiker, Edward L. Ryerson Distinguished Service Professor of Theological Ethics at Divinity School, University of Chicago; Director of the Martin Marty Center for the Advanced Study of Religion.

Prof. Dr. Jan Stievernann, Professor of the History of Christianity in North America, University of Heidelberg.

Dr. John M. Templeton, Jr., Chairman and President of the John Templeton Foundation.

Prof. Dr. Dr. h.c. Wentzel van Huyssteen, *James I. McCord Professor of Theology and Science, Princeton Theological Seminary.*

Prof. Dr. Gunter Wagner, Alison Richard Professor of Ecology and Evolutionary Biology at the Department of Biological and Biomedical Sciences, Yale University; Head of the Wagner Lab.

Prof. Dr. Dr. Dres. h.c. Michael Welker, Seniorprofessor for Systematic Theology, University of Heidelberg; Executive Director of the Research Center for International and Interdisciplinary Theology (FIIT), Heidelberg.

