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McGRATH INSTITUTE FOR
CHURCH LIFE

Mission Statement

The McGrath Institute for Church Life partners with Catholic dioceses, parishes and schools to address pastoral challenges with theological depth and rigor. By connecting the Catholic intellectual life to the life of the Church, we form faithful Catholic leaders for service to the Church and the world.

Science & Religion Seminars

Nourishing the Catholic Imagination of Teachers at the Intersection of Science and Religion

The Science & Religion Seminars equip teachers with approaches that expand the dialogue between the disciplines and challenges the notion that science and religion are in conflict.

Training Catholic Educators to Engage the Dialogue Between Science and Religion:

A Grant from the John Templeton Foundation

Project Leader(s)
John Cavadini

Grantee(s)
University of Notre Dame du Lac

Description
The purpose of this grant is fivefold: (1) to continue and expand the Science & Religion Initiative that began with the exploratory grant and was continued and extended by a second grant; (2) to introduce teachers in Catholic high schools to the dialogue between theology and science; (3) to assist them in incorporating that material into their courses; (4) to provide continuing education opportunities and pedagogical resources to teachers and administrators; and (5) to assess, develop, and share the results. We will accomplish these goals through a combination of seminar programming, media development, and the publication of educational material. Catholic schools constitute the largest private educational system in America and a large potential audience (1200 high schools with 579,605 students). We believe education should inspire wonder and foster inquiry into the mysteries of the world and this should be institutionalized in the entire school systems. Unfortunately, the academic and the spiritual have too often been separated, even within Catholic schools. Our program aims to rectify that. We have developed this program within the context of the church's 2000-year intellectual and spiritual tradition. The church encompasses numerous cultures, languages, and philosophical traditions, attempting to integrate them into a whole. Development of its tradition occurs slowly and discerningly, growing organically out of the historical tradition even while incorporating scientific and philosophical insights. Our initiative will bring elements of the tradition into dialogue with scientific research.

Foundations New Orleans Leadership Team

Dr. Chris Baglow (Director) - Chris is a Professor of Theology at Notre Dame Seminary and has directed programs of academic integration at two Catholic high schools, including the STREAM™ Program at St. Mary's Dominican H.S. in New Orleans, LA In 2011-2014 Baglow directed the Templeton-funded *Steno Learning Program in Faith and Science for Catholic Secondary Educators* (*SLP*), a week-long seminar experience for Catholic science and religion teachers. Baglow is the author of *Faith, Science and Reason: Theology on the Cutting Edge* (Midwest Theological Forum, 2009). Baglow's creative work includes the seminary course *Emergence of the Image: Human Evolution from Scientific, Philosophical and Theological Perspectives*.

Dr. Stephen Barr (Physics Lecturer, Co-Moderator) - Steve is a Professor of Particle Physics at the Bartol Research Institute and the Department of Physics and Astronomy at the University of Delaware. He has authored over 120 physics papers in journals such as *Physical Review* and *Physics Today*. He is a regular contributor on matters of science and religion to the journal *First Things*, and sits on the journal's editorial advisory board. He is the author of *Modern Physics and Ancient Faith* (University of Notre Dame Press, 2003) and *The Believing Scientist: Essays on Science and Religion* (Eerdmans, 2016). He is the founder and president of the Board of Directors of the Society of Catholic Scientists.

Dr. Tim Burgess (Physics Lab Instructor) - Tim is the Chair of the Science Department at McGill-Toolen Catholic H.S. (Mobile, AL) and a veteran high school science teacher with 34 years of experience. As Science Chair, he pioneered the successful *Physics First* Program that introduces students to physics first, followed by chemistry, and then culminating with biology.

Matthew Foss (Lab Coordinator) - Matt is the Chair of the Science Department at St. Mary's Dominican H.S. (New Orleans, LA). He has a B.S, and M.S. in Physics and has taught science for 15 years at Dominican, as well as math and robotics. He also has had a leading role in the planning of the labs in the new Gayle and Tom Benson Science and Technology Complex as well as in STREAM™ faculty development and curricular implementation.

Dr. Cory Hayes (Co-Moderator) - Cory is a Senior Professor of Philosophy and Theology at St. Joseph Seminary College in Covington, LA and served as Associate Director of the STREAM™ Program at St. Mary's Dominican H.S. A veteran seminar leader and a co-moderator in the *Steno Learning Program*, Hayes is also a clear and exciting instructor with a keen grasp of philosophy and the role it plays in the science and religion dialogue in the Catholic intellectual tradition.

Dr. Clare Kilbane (Implementation Director) - Clare is a Professor of Education at Otterbein University in Westerville, Ohio where she teaches courses focusing on technology, instruction, and assessment. Her work in Catholic education has included consultation with over 20 Catholic schools on projects related to 21st century skills, critical thinking, problem-solving, differentiated instruction, digital portfolios, and technology integration. Kilbane is a frequent speaker at NCEA conferences and has authored many books and other materials about innovative teaching.

Dr. Dan Kuebler – Dan is a Professor of Biology and the Chair of the Biology Department at Franciscan University in Steubenville, Ohio where he teaches courses on evolution, cell physiology and neurobiology, as well as maintaining an undergraduate research laboratory that investigates seizure disorders. Dan is the co-author of *The Evolution Controversy: A Survey of Competing Theories* (Baker Academic, 2007), a resource for cutting through the competing agendas to gain an unbiased understanding of the scientific issues involved in the debate surrounding evolution.

Dr. Stacy Trasancos (Chemistry Lab Instructor, Lecturer) - Stacy has a Ph.D. in Chemistry from Pennsylvania State University and a M.A. in Dogmatic Theology from Holy Apostles College and Seminary. She has served as a Senior Research Chemist for E. I. DuPont de Nemours & Co., Inc., and is the author of *Science Was Born of Christianity: The Teaching of Fr. Stanley L. Jaki* and *Particles of Faith: A Catholic Guide to Navigating Science* (Ave Maria Press, 2016).

Foundations New Orleans Seminar Working Schedule
June 24-29, 2018
(schedule subject to minor revisions if necessary)

Day 1, Sunday, June 24, 2018
3:00 – 5:00 p.m. Arrival/Check-In at Notre Dame Seminary (NDS)
5:30 – 6:15 p.m. Mass, Solemn Feast of *Corpus Christi*
6:15 – 7:30 p.m. Dinner
7:30 – 9:00 p.m. EVENING SESSION
Greetings and Orientation (NDS Pastoral Center)
Introduction to Seminar Team and Agenda (NDS Pastoral Center)
9:00 p.m. Social (NDS Student Center - Biblicum)

Day 2, Monday, June 25, 2018
7:00 – 7:30 a.m. Mass (NDS Chapel)
7:30 – 8:15 a.m. Breakfast (NDS Dining Room)
8:15 a.m. DEPART NDS FOR DHS AS A GROUP

Part One: Engaging the Great Conversation: Science, Philosophy and Faith
Morning Session at DHS Gayle and Tom Benson Science and Technology Complex from 8:30 a.m.-12:30 p.m.
PHYSICS LAB: Our Understanding of Light, the Photoelectric (PE) Effect and the Birth of Modern Physics (Instructors: T. Burgess & M. Foss)
Explanation: *FNO* begins with an explanation of how models of light were developed through 2000 years of observations, experiments and imagined explanations. Eventually the explanation arrived at the wave-particle duality model for light. Once developed, this explanation became foundational to all of modern Physics. Understanding this "duality" is required to consistently and coherently explain the "photoelectric effect" (PE).
Materials: *FNO Physics Lab Packet,* Pencils, Pens, Paper
8:30 – 9:45 a.m. Lecture: Introduction to the wave-particle duality of light (discussing history and experiments leading up to this model). Includes a diffraction/refraction demo. (T. Burgess & M. Foss)
9:45 - 10:00 a.m. Break
10:00 – 11:30 a.m. Teams will gather electron ejection energy as a function of incident light frequency. The data will be collected across all teams and groups for analysis in the Concluding Session. Teams will also explore the capabilities of the simulation of the PE effect and the different values that can be measured and observed. Teams will gather data with stated expectations. Possible interacting values include light frequency (color), light intensity (brightness), electrical current (amperes), stopping voltage (Volts) required to stop the flow of electrons from the surface (and so therefore electron ejection energy).
11:30 - 11:45 a.m. Break
11:45 a.m. – 12:30 p.m. Teams review, analyze and discuss data collected in the lab and computer simulations. Teams will generate a graph or representation of the data

and an explanation using the dual particle-wave model of light proposed by Albert Einstein in his Nobel Prize-winning 1905 paper on the PE effect.

12:30 – 1:30 p.m. Lunch (NDS Dining Room)

1:30 – 2:30 p.m. Physics Lab Presentations and Discussions: All teams will present data, analysis and explain results of simulation exploratory labs in terms of the wave-particle duality described by Einstein. Discussion regarding the consistency and coherence of the model will be generated. Clarifications will be offered. (NDS Pastoral Center)

2:30 - 3:30 p.m. Break

3:30 – 4:30 p.m. Seminar I: Chris Baglow, "Faith and Science at the Crossroads of the Human Spirit," "Science and Faith: Understanding and Correcting Models of Conflict," pp. 3-36 in *Foundations New Orleans Reader*

4:30 - 4:45 p.m. Break

4:45 – 5:45 p.m.Seminar II: Chris Baglow, "Bridging the Gap: A Wisdom Wider than Science," pp. 37-56 in *Foundations New Orleans Reader*

6:00 – 7:00 p.m. Dinner (NDS Dining Room)

Part Two: Faith and Science in the Catholic Intellectual Tradition

7:00 – 8:00 p.m. Lecture: "The Catholic Church and Modern Science: A Glorious History" (S. Barr) (Required pre-reading: Peter Hodgson, "The Bible and Modern Science," "The Judeo-Christian Origin of Modern Science," pp. 59-86 in *Foundations New Orleans Reader*; Stephen Barr, "Retelling the Story of Science," pp. 3-21 in *The Believeing Scientist*) (NDS Pastoral Center);

8:00 p.m. Social (NDS Student Center - Biblicum)

Day 3, Tuesday, June 26, 2018

7:00 – 7:30 a.m. Mass (NDS Chapel)

7:30 – 8:30 a.m. Breakfast (NDS Dining Room)

Morning Session at DHS Gayle and Tom Benson Science and Technology Complex from 8:45 – 11:45 a.m.

8:45 – 10:15 a.m. Seminar I: St. John Paul II, Discourses on Science and the Catholic Faith, pp. 87-142 in *Foundations New Orleans Reader* (DHS: Gayle and Tom Benson Science and Technology Complex, *Disputatio* Room)

10:15 - 10:30 a.m. Break

10:30 – 11:45 a.m. Seminar II: International Theological Commission, *Communion and Stewardship* Chap. 3, sec. 1, pp. 143-148 in *Foundations New Orleans Reader* (DHS: Gayle and Tom Benson Science and Technology Complex, *Disputatio* Room)

12:00 p.m. – 1:30 p.m. Lunch (NDS Dining Room)

1:30 – 2:45 p.m. Seminar I: Galileo Galilei, St. Robert Bellarmine, The Holy Office of the Inquisition, *The Essential Galileo*, pp. 103-109, 146-178 (NDS Pastoral Center)

2:45 – 3:00 p.m. Break

3:00 – 4:15 p.m. Seminar II: Galileo Galilei, St. Robert Bellarmine, The Holy Office of the Inquisition, *The Essential Galileo*, pp. 272-294 (NDS Pastoral Center)

4:15 - 4:45 p.m. Break

4:45 – 6:00 p.m. Implementation/Pedagogical Think-Tank: Introducing Faith/Science Dialogue and Instruction in Secondary Curricula (C. Kilbane) (NDS Pastoral Center)

6:00 – 7:00 p.m. Dinner (NDS Dining Room)
8:00 p.m. Social (NDS Student Center - Biblicum)

Day 4, Wednesday, June 27, 2018

Part Three: Physics, Chemistry and the Catholic Faith

7:00 – 7:30 a.m. Mass (NDS Chapel)
7:30 – 8:30 a.m. Breakfast (NDS Dining Room)
Morning Session at DHS Gayle and Tom Benson Science and Technology Complex from 8:45 a.m. - 12:00 p.m.
CHEMISTRY LAB: Flame Test for Metals (Instructor: S. Trasancos)
Explanation: This is a hands-on experience with an analytical technique to gather data for elemental analysis. The goal is to begin a discussion about atomic spectroscopy and electromagnetic radiation, which will lead into a deeper discussion about emission spectra, absorption spectra, and fluorescence spectra. This will lead to a deeper discussion about how the instruments in analytical labs and in astronomical labs are used to determine the elemental composition of substances for industry and of cosmic bodies. It will introduce concepts that tie the atomic realm to the cosmic realm, yet include the academic and industrial realm as well. In tying all of this together, the discussion will then lead to an appreciation of beauty and symmetry in the laws of nature as evidenced in a) the order in the periodic table; b) how each element known is unique in its number of protons, with no missing spots on the table; and c) how this profound yet simple order is responsible for the symmetry and/or asymmetry in ionic and molecular bonds.
Materials: Pencils, Paper (*FNO Chemistry Lab information will be given via PowerPoint*)
8:45 – 9:15 a.m. Lab Preparation and Explanation
9:15 – 10:15 a.m. Lab Activity: Flame Testing (Metal Salts)
10:15 - 10:30 a.m. Break
10:30 – 11:00 a.m. Participants present and discuss findings from testing.
11:00 – 11:45 a.m. Lab Activity: Flame Testing (Unknowns)
11:45 a.m. – 12:00 p.m. Participants present and discuss findings from testing.
12:00 – 1:30 p.m. Lunch (NDS Dining Room)
1:30 – 2:30 p.m. Lecture: "'These Thy Atoms': Beauty and Symmetry in Chemistry" (S. Trasancos) (NDS Pastoral Center)
2:30 – 3:00 p.m. Break
3:00 – 4:15 p.m. Seminar I: Stephen Barr, "Modern Physics, The Beginning and Creation," pp. 123-136 in *The Believing Scientist* (NDS Pastoral Center)
4:15 - 4:30 p.m. Break
4:30 – 5:45 p.m. Seminar II: Stephen Barr, "Fearful Symmetries" (pp. 159-167), "Does Quantum Mechanics Make It Easier to Believe in God?" (pp. 86-90) and "Faith and Quantum Theory" (pp. 91-100), in *The Believing Scientist* (NDS Pastoral Center)
6:00 – 7:00 p.m. Dinner (NDS Dining Room)

Part Four: Biology and the Catholic Faith

7:30 – 8:30 p.m. Lecture: "Evolutionary Theory: Terms and Concepts" (D. Kuebler) (NDS Pastoral Center)
8:30 p.m. Social (NDS Student Center - Biblicum)

Day 5, Thursday, June 28, 2018

7:00 – 7:30 a.m. Mass (NDS Chapel)
7:30 – 8:30 a.m. Breakfast (NDS Dining Room)
Morning Session at DHS Gayle and Tom Benson Science and Technology Complex from 8:30 a.m.-12:00 p.m.
BIOLOGY LAB: Classification and Evolution (Instructor: D. Kuebler)
Explanation: This lab was developed by evolutionary biologists Joseph H. Camin and Robert P. Gendron. Participants model evolution by classifying imaginary animals called "caminalcules." In this lab exercise the students first classify 14 "living caminalcule" species into genera, families, etc. Then they construct a phylogenetic (evolutionary) tree of the Caminalcules using an additional 57 "fossil" species. This illustrates how modern classification schemes attempt to reflect evolutionary history. In the process participants learn concepts such as convergent evolution and vestigial structures.
Equipment/Materials: *FNO Biology Lab Packet*, Pencils, Paper
8:30 – 9:15 a.m. Lab Preparation and Explanation
9:15 – 10:15 a.m. Lab Activity: Caminalcules: Classification and Phylogenetic Reconstruction
10:30 – 11:00 a.m. Participants present and discuss findings.
11:15 a.m. – 12:00 p.m. Lab Activity (cont.): Caminalcules: Classification and Phylogenetic Reconstruction
12:00 – 1:30 p.m. Lunch (NDS Dining Room)
1:30 – 3:00 p.m. Implementation/Pedagogical Think-Tank (C. Kilbane) (NDS Pastoral Center)
3:00 – 3:15 p.m. Break
3:15 – 4:15 p.m. Seminar I: Cory Hayes, "A Tour of the Cosmos," pp. 149-172 in *FNO Reader*) (NDS Pastoral Center)
4:15 - 4:30 p.m. Break
4:30 – 5:45 p.m. Seminar II: Nicanor Austriaco, *Thomistic Evolution*, pp.125-164 (NDS Pastoral Center)
6:00 p.m. Banquet (NDS Dining Room)
FREE NIGHT IN NEW ORLEANS

Day 6, Friday, June 29, 2018

6:00 - 7:30 a.m. Checkout (NDS Main Lobby)
7:00 – 7:30 a.m. Mass (NDS Chapel)
7:30 – 8:30 a.m. Breakfast (NDS Dining Room)

Part Five: The Emergence of the Image: Evolution from Scientific, Philosophical and Theological Perspectives

8:30 – 10:00 a.m. Seminar I: Nicanor Austriaco, *Thomistic Evolution*, pp.165-200 (NDS Pastoral Center)
10:00 - 10:15 a.m. Break
10:15 – 11:45 a.m. Seminar II: Nicanor Austriaco, *Thomistic Evolution*, pp.201-248 (NDS Pastoral Center)
12:00 p.m. – 1:15 p.m. Lunch: Concluding Remarks and Closing Prayer (NDS Dining Room)

1:30 p.m. Departure from Notre Dame Seminary

THE SEMINAR WAY

By

Patrick Powers, Ph.D.

THE VIRTUES

Moral, Theoretical and Theological

- **Be patient**, as you are one of over forty great minds who believe they should speak.
- **Be deferential** with your colleagues who want to speak, as your turn will come.
- **Be courageous** to speak up every now and then, not worrying what you will say.
- **Be honest** about whether or not you have done the entire assigned reading.
- **Be cautious** about judging when an author or colleague is talking rot or not.
- **Remember** to start with "first impressions," not the meaning or truth of an author.
- **Remember** to read what an author said, not what you think he or she should say. .
- **Remember** to listen to what an author or speaker intends to say and mean.
- **Remember** to listen to: What did he say? What did he mean? So what; is it true?
- **Remember** to heed these counsels before seizing the pulpit to speak your mind.
- **Remember** to ask questions as much as to make statements.
- **Be faithful** to your colleagues by trusting that the dialogue will unfold fruitfully
- **Be charitable** as your colleagues may not have as much to say as you.
- **Be hopeful** that Providence will guide you about when it is good to speak or not.
- **Be humble** about assuming that God has assigned you to save a messy seminar,

THE RULES

- **Inner and Outer Circles**: Participants are divided into two groups. For the first morning and afternoon sessions, the Alphas form a speaking inner circle at the table, and the Omegas form a listening outer circle around the Alphas. For the second morning and afternoon sessions, the Omegas form a speaking inner circle at the table, and the Alphas form a listening outer circle around the Omegas. Alphas include _____ through _____; Omegas include _____ through ____. The evening sessions are plenary, with no division between Alphas and Omegas.

- **The Moderators' Sign Language:**
  - Finger at you – you should speak.
  - Finger in the air – you have one minute.
  - Two fingers pinched – you have thirty seconds.
  - Two-handed T – take a break and come back later.
  - Hand across the throat – enough, stop now!
  - Thumb pointed back over shoulder – you're silenced!

"Blessed are the silent, for their way contributes to dialogue and is often the stuff of wisdom.

ENGAGING THE GREAT CONVERSATION:

THE COMPLEMENTARITY

OF

SCIENCE, PHILOSOPHY AND FAITH

Chris Baglow

1. **"Faith and Science at the Crossroads of the Human Spirit"** (Chapter One of *Faith Science and Reason: Theology on the Cutting Edge*, 2nd ed., publication pending)
2. "**Science and the Christian Faith: Understanding and Correcting Models of Conflict"** (Chapter Two of *Faith Science and Reason: Theology on the Cutting Edge*, 2nd ed., publication pending)
3. **"Bridging the Gap: A Wisdom Wider than Science"** (Chapter Three of *Faith Science and Reason: Theology on the Cutting Edge*, 2nd ed., publication pending)

Chapter One

Faith and Science
At the Crossroads of the Human Spirit

Why do we need both faith and science to understand the world?
How are science and faith related to each other?
How do faith and science come together in the human spirit?

> *"Faith and reason are like two wings on which the human spirit rises to the contemplation of truth; and God has placed in the human heart a desire to know the truth—in a word, to know himself—so that, by knowing and loving God, men and women may also come to the fullness of truth about themselves."*
>
> -St. John Paul II*, Fides et Ratio,* Prologue

With this beautiful image of the human spirit soaring in flight upon two wings, St. John Paul II (1920-2005 AD) began his famous 1997 letter on faith and reason. This course is about applying his vision of faith and reason in general to the scientific investigation of the universe—one important example of human reason—in order to bring faith and reason together in a coordinated vision of reality. Since I will refer to the concepts of faith and reason many times, let's define these terms.

Reason is not merely the ability to think clearly and come to correct answers about certain kinds of problems. Rather, it is the capacity for wisdom. In the words of Fr. James Brent, O.P., "Wisdom is an all-embracing understanding of reality as a whole in light of ultimate causes, especially in light of the end or goal of all things."[1] An act of reason may involve specific problems, but reason understood as wisdom is never limited to this or that intellectual activity. Physics, psychology, mathematics, etc.; these are all examples of reason in action. But wisdom is more than physics, more than psychology, more than mathematics. It is any authentic pursuit of truth and the openness to all things true. Modern science in all its forms counts as an authentic and often difficult application of human reason to the material world, and a true way of wisdom, but by no means the only one.

If reason is open to all things true but above all to the causes and goal of all things, then of course the question of the greatest truth, the Truth behind all truths, questions about God and the meaning of reality, can never be neglected by it. But because our capacity for reason is limited, we know that "the meaning of it all" is not accessible to our minds alone. ***Reason leads us to pose questions we could never use reason to answer.*** And it is here that a whole new kind of knowledge, the knowledge brought about by entrusting one's whole self to God, can give us answers beyond the

[1] Nicanor Austriaco, James Brent, Thomas Davenport and John Baptist Ku, *Thomistic Evolution: A Catholic Approach to Understanding Evolution in the Light of Faith* (Tacoma, WA: Cluny Media LLC, 2016), 15-16.

capacity of the human mind. This entrusting of one's whole self to God, and the new path of knowing it makes possible, is called *faith*. In the words of Joseph Ratzinger, who would later become Pope Benedict XVI, faith "is not an act of [reason] alone, not simply an act of the will, not just an act of feeling, but an act in which all the spiritual powers… are at work together. It is only because the depth of the soul—the heart—has been touched by God's Word that the whole structure of spiritual powers is set in motion and unites in the 'Yes' of believing."[2] The practice of faith in prayer, worship and daily life is called *religion*—faith is an act and disposition of the mind and will, religion is the practice of life and worship in the light of faith. The two terms are often used interchangeably, as they will be here.

St. John Paul II not only extolled faith and reason in general as both necessary and harmonious, but he also applied this vision to the scientific investigation of the universe. In 1988, he declared that "Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes. Each can bring the other into a wider world, a world where both may flourish."[3] Since scientific discovery is such a powerful work of reason, the specific relationship between faith and science will be our focus in this book. Many struggle with believing in God because of what they think science says, and many others struggle with accepting the discoveries of modern science because they fear that it leads away from God. Perhaps looking at them together, as St. John Paul II recommended, can help us embrace both.

To investigate this, let's begin by considering the two perspectives—science and faith—and what they show us about reality. Seeing these perspectives side-by-side goes a long way toward understanding how much science and faith are different, what they have in common, and how they can complete each other.

A. Science and Faith, How and Why: Different Perspectives on the One Universe

Both science and faith involve encountering and understanding the same universe, but they do so in unique ways. The word *universe* is derived from the Latin phrase *unum in diversis*, or "a diverse unity," a complex collection of very different things that are all connected in some real way, the sum total of all beings that are changeable and material.[4] It includes things as different from each other as subatomic particles and animals, including human beings. No catalog of everything in the universe can be made, as the universe is far too vast to ever be accounted for in its entirety. But we can come to understand it, and science and faith are two very different ways of doing so; so different that despite all of the claims to the contrary, they can never be in any real conflict. In the

[2] Joseph Ratzinger, "Faith and Theology," in *Pilgrim Fellowship of Faith: The Church as Communion* (San Francisco: Ignatius Press, 2005), 24.
[3] John Paul II, Message to the Reverend George V. Coyne, S.J., Director of the Vatican Observatory, 1 June 1988, http://inters.org/John-Paul-II-Coyne-Vatican-Observatory.
[4] Juan José Sanguineti, *Interdisciplinary Encyclopedia on Science and Religion*, "Universe," http://inters.org/universe.

words of Rabbi Jonathan Sacks, "Science takes things apart to see how they work; religion brings things together to see what they mean."[5]

To make the difference between the two even clearer, Sacks provides a thought experiment, which I have reimagined as the appearance of aliens at a music festival. Imagine enjoying the finale of an incredible set from a favorite band on a sunny afternoon. Afterwards an alien spacecraft lands and an alien (who strangely can understand and speak English) approaches you and asks about the noise that had been coming from the stage. You begin by explaining what the music being played is called (blues, folk, rock n' roll), and you go through the type of music it is, the instruments it involves, a little music theory about harmony, keys and octaves, etc. Once you have said enough for the alien to understand, he responds: "Now I understand *how* the music is played. But I don't understand *why* everyone here is so excited about it." At that moment you realize that the alien still has no idea about *why* music is composed and performed and what *meaning* it has to you and the other fans.

Now you have an entirely different task of explanation. Ultimately, you might say that people love music because it moves them by putting the experience of being human into beautiful sounds--music is about experiencing your ordinary life from a new perspective. Or you might say that it unites the music fans into a common experience—music is about relationships. Or you might say that, through the poetry and musical artistry, you are drawn out of ordinary life and your own experience for a moment--music is about transcendence.

Notice that in order to explain the music festival, you have two choices. You can explain the internal logic of the music, describing *how* it is composed and played. But in order to explain the *meaning* of music to those who play it or enjoy watching it, you have to go beyond how it is played and answer *why* questions about it. And in this analogy we have a helpful way of thinking about science and faith. Science approaches the universe according to its internal rules and patterns, telling us *how* it all works, like your first explanation of music. Faith approaches the universe according to what the whole system of the universe means: *why* it exists, its role in human happiness, and questions about its Creator and his intentions for it, like your second explanation of music. Just as they are in understanding music, why questions and how questions about the universe are very different and serve together to provide a total picture, a deeper understanding.

With this important distinction in mind, let's consider two individuals who embody each perspective; then let's think about the universe from each perspective.

B. Two Lives: Awe and Wonder in Science and Faith

1. *Dirty Bandages and DNA – A Scientist in Search of Answers to How Questions*

Science can be, indeed often is, very hard work, and some scientists have given whole lifetimes to the difficult, frustrating pursuit of scientific discovery, often suffering great hardship. The life of Friedrich Miescher is a telling example.

[5] Jonathan Sacks, *The Great Partnership: Science, Religion and the Search for Meaning* (New York, Schocken Books, 2011), 2.

Friedrich Miescher (1844-1895 AD) was a 19th century pioneer in the field of cell biology. The center of his scientific curiosity was the center of the cell—the nucleus. In his day, no one knew what was in the cell nucleus, nor what purpose it served. In 1869 his lab assigned him to the study of white blood cells, and he focused on the nuclei of these cells. White blood cells are very common in pus, so much of his time was spent collecting bandages from a nearby hospital and going through the difficult process of collecting the cells and then extracting their nuclei, using painstaking and tedious applications of chemicals that took weeks. Ultimately he extracted a gray chemical compound "not comparable" to any other known. It wasn't a protein, the most common kind of compound found within cells, so Miescher was aware that it was something unique. He named it "nuclein." For this discovery he received the honor of publishing perhaps the most unattractively titled article one can imagine: "On the chemical composition of pus."

Later in his career, Miescher discovered that nuclein could be found in high quantities in animal sperm. At last he had found a clue about the function of nuclein, at one point suggesting that it might have something to do with heredity: ""if ... a specific substance is the cause of fertilization, one would without doubt have to think of the nuclein." Yet he was never able to obtain conclusive evidence of the function of nuclein, despite spending almost all of his time in his lab. After stressing himself through overwork in extremely cold lab conditions, he developed tuberculosis and died of pneumonia at the age of 51. Only after his death would "nuclein" be renamed deoxyribonucleic acid, or DNA for short, and only a half-century later would Miescher's discovery become the chemical foundation of all modern genetics. All we now understand about heredity we owe to DNA studies, of which Miescher's was the first and perhaps most difficult to accomplish.[6]

Miescher's tireless dedication and sacrifice highlights the awe and wonder that characterizes the scientific endeavor for so many scientists. Astronomers peer deep into the sky, paleontologists dig deep into the earth, and microbiologists dig deep into cells. Miescher spent the large part of his scientific career discovering and studying a substance that brought him no acclaim, and did not even gain the satisfaction of discovering its function, and yet his wonder drove him to continue. Without knowing it, he was serving to provide an answer to the questions, "How does the cell work?" and "How does animal reproduction work?" He ultimately was able to advance science, but only based upon the work of others who took his discovery further than he was able. But the lack of reward did not stop him--the pursuit of the truth about the nucleus and its function was sufficient. Somewhat like the music theorist who tells us how, but not why, music is composed, Miescher had to go to the parts of the cell and break them down to gain insight, and from this he achieved a valuable scientific breakthrough.

[6] Florian Maderspacher, "Rags before the riches: Friedrich Miescher and the discovery of DNA, " *Current Biology* 14, no. 15 (10, August 2004), R608.

2. For the Greater Glory of God - A Spiritual Seeker in Search of Answers to Why Questions

Unlike Friedrich Miescher, who from an early age knew he would be a scientist, the young Ignatius of Loyola (1491-1556 AD) certainly never dreamed he would be a man of faith, the founder of a religious order and one of the most renowned saints in history. His passion for military fame led him to a life of a warrior, fighting many duels and becoming a successful soldier. At the age of 30, during the Battle of Pamplona in 1521, a cannonball wounded his legs, fracturing his left leg in multiple places. Ignatius underwent several operations, all without anesthesia, leaving his left leg shorter than the other and ending his military career for good. His pursuit of personal glory on the battlefield, in the hearts of beautiful women and in the eyes of his peers was over.

This began a complete change of heart for Ignatius, and a long process of spiritual searching which brought him to the small town of Manresa in Spain. Wounded in body but still having the stubborn perseverance of a soldier, he put himself through tireless efforts to find God, attending daily mass, praying seven hours a day, and living as a beggar. One day while he was walking to a nearby church to pray, he stopped to gaze at the river Cardoner that ran near the path, and had the following experience:

> While he was seated there, the eyes of his understanding began to be opened; though he did not see any vision, he understood and knew many things, both spiritual things and matters of faith and learning, and this was with so great an enlightenment that everything seemed new to him. It was as if he were a new man with a new intellect.

Later he would name this experience as the greatest gift he was ever given by God—the ability to see the world in a new way, with a new understanding. Notice that it was not this or that thing that he came to understand. In this moment of encounter with God he was given a new perspective on *everything*--truths of faith *and* of reason. He became such an inspiring religious leader that his order, the Society of Jesus (the Jesuits) went from a few friends to 1,000 priests in his own lifetime, spread out across four continents, and continues to this day. The path of Christian prayer and growth he mapped out, the *Spiritual Exercises*, has inspired millions.

The *Spiritual Exercises* would take far too long to summarize here, but when we consider its beginning, which Ignatius called "the First Principle and Foundation," we can see that his Cardoner experience was all about answering the question "Why?" about his life: "The human being is created to praise, reverence, and serve God our Lord, and by this means to save his soul… And the other things on the face of the earth are created for the human being that they may help him in achieving the goal for which he is created." These are not the words of a theorist, who sees a part of a whole and tells us how it works. These are the words of a prophet, whose perspective on the whole is different from, *and not in competition with*, the "How?" perspective of the scientist.

"Science takes things apart to see how they work; religion brings things together to see what they mean" - the lives of Friedrich Miescher and Ignatius show us the truth of this foundational principle for relating faith and reason. Interestingly, Ignatius' Jesuits

would produce an impressive number of priest-scientists in the centuries to come, men who would make fundamental contributions to astronomy, physics and numerous other sciences, while at the same time living the *Spiritual Exercise*s as men of faith. These Jesuits show that "how" questions and "why" questions can go together as long as we know how to unite them correctly.

But different though they may be, science and religion are both perspectives on the same universe; therefore, there should be some commonalities between them. Let's consider, then, what science shows us about the universe, and what faith shows us about the universe. The perspectives are very different, but in some important ways we can see how they can be brought together. We begin with science.

C. Order and Openness: The Universe from the Scientific Point-of-View

Science, applying its particular method through disciplined and thorough processes of investigation, has made characteristics of the universe accessible to us in ways unimaginable before the modern age. Common-sense notions that things are exactly as they seem to us have often been overturned. Our sense experience tells us that the sun moves around the earth and suggests that the kinds of animals we see are the only kind possible and have always been the same. But both of these positions have been shown to be false by modern science. Scientific investigation very often shows us that our everyday thinking is NOT the measure of reality, that the universe is often different than we expect.

The power of science to reveal the way the universe works comes from its careful self-restriction to focus on material things and their interactions, the way the action of material thing A causes the material effect B. It begins with material things and it ends with material things. It formulates questions, carries out investigations, analyzes and interprets data collected, and constructs explanations on this basis.[7] An explanation to be tested and possibly disproved is called a *hypothesis*; when it survives many challenges and becomes well-tested and well-developed as an explanation of material realities, it begins to be called a *theory*.

The hallmarks of scientific investigation include observing patterns, thinking about material causes and effects, measuring size, proportions and quantities, modeling systems of interactions, tracking energy and matter as they change within systems, detecting the functions of material structures, and observing rates of stability and change.[8] Through the various applications of these methods over centuries, a picture of the universe has emerged, one of order and openness. In almost any area of scientific inquiry, both can be seen.

[7] Board on Science Education, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (Washington, D.C.: National Academies Press, 2012), 50-53.
[8] Board on Science Education, *A Framework for K-12 Science Education*, 84-85.

1. Order – A Universe of Patterns

"The eternal mystery of the world is its comprehensibility... The fact that it is comprehensible is a miracle."[9] These famous words of Albert Einstein (1879-1955 AD) lead us to the first characteristic of the universe, that within it we find regular, predictable patterns that can be understood and described with laws, laws that can be formulated in mathematical terms. The great moments of scientific discovery in history have usually been the discovery of these regular patterns, such as the discovery of the laws of genetics by the Augustinian monk Gregor Mendel and the law of gravity by Sir Isaac Newton. The assumption that the universe is orderly and patterned is foundational to science, and again and again that assumption has been confirmed. The words of the German physicist Carsten Bresch capture this hallmark of the universe:

> If we were to describe the fundamental property of the matter of the universe in a single sentence, we would have to say that matter is formed—or created—so as to show continuously accelerating growth of patterns… Everything around us consists of patterns. Matter is patterned, atomically and molecularly. Organisms are enormous patterns of cells, each of which in turn consists of a wealth of biological patterns…We are so used to being surrounded by patterns that we do not give a thought to this fundamental property of our world. But it is matter *and* pattern (structure, form) that determine the properties of an object.[10]

The assumption of order by science has been a large factor in its success in understanding the physical universe, and at times has helped scientists even predict certain discoveries in advance of experimentation. For example, the physicist Murray Gell-Mann was able to accurately predict the existence of a subatomic particle based upon the incomplete pattern created by already discovered particles, a pattern that it would complete. In 1961 he predicted that the particle did exist, and what its exact properties would be. In 1964 the particle, the "Omega minus baryon," was discovered and its characteristics fit his prediction perfectly. The particle pattern formed a triangle without a point, and Gell-Mann realized that something was missing. Science again and again confirms our suspicion that the universe has a real and profound order to it.

The presence of order throughout the universe has been so impressive to scientists that some have gone as far as to assume that the universe is so orderly, so thoroughly law-governed, that the laws of the universe absolutely predetermine everything that happens within it. This belief is called *physical determinism*. According to this idea, if someone knew all of the laws of the universe as well as everything going on in the universe at some point in time, she could predict exactly all the events that would later

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[9] Albert Einstein, translated by Sonja Bargmann, *Ideas and Opinions* (New York: Crown Publishers, 1954), 292.

[10] Carsten Bresch, "What is Evolution?" in *Evolution and Creation*, ed. Svend Andersen and Arthur Peacocke (Aarhus, Aarhus University Press, 1987), 36-37, as quoted in Mariano Artigas, *The Mind of the Universe: Understanding Science and Religion* (Radnor, PA: Templeton Foundation Press, 2000), 65.

happen in the universe. (Of course, she would have to have a mind of infinite power to do the calculations.) This is often called the "billiard ball" hypothesis because it makes the whole universe like an enormous pool table – as long as you know the data about the balls (size, mass, position, relative distance, etc.), you know exactly what will happen when this one hits that one, and when that one hits the next one, etc.

However, the progress of science has demonstrated a picture that is not so rigid. The intrinsic order that we see is real, but the universe is also characterized by a significant amount of intrinsic unpredictability. This brings us to the second hallmark of the universe.

2. Openness—A Universe of Emergence

When the great discoveries of modern science were being made, it brought many to conclude that determinism best described the way the universe works. Over time, however, it became clear that many things in the universe are not the simple result of all that went before. The universe is full of examples of order that are not fully explained by prior events and full of systems that are not reducible to the sum of their parts. For example, the water molecule profoundly affects the properties of the hydrogen and oxygen of which it consists—water has physical properties that are entirely unlike the physical properties of hydrogen gas and oxygen gas. This kind of newness is especially true of living things, which exhibit a control over their individual parts, ordering those parts in new ways not seen in the non-living universe. When new entities occur that cannot be explained simply as the sum of their parts, and that must be understood by beginning with the whole and working down to the parts, scientists call this phenomenon *emergence*. Water is emergent from hydrogen and oxygen; life is emergent from non-living chemicals, and so on.

In the fields of science that study emergence, the words *random* and *chance* are very often used to describe the process of emergence. These words are easily misunderstood by non-scientists. For scientists, however, they simply mean that these emergent realities are not the strict outcome of rigidly uniform processes. They are surprising and not able to be predicted just by knowing the laws of the universe and the initial conditions in a physical system.

For the purpose of characterizing the universe revealed by science, what such emergent realities do show us is a universe of *openness*. Science implies that the universe is full of novel possibilities, and that these become realities through surprising events in which causes merge to bring about novelties in unexpected ways, new things that exhibit whole new levels of order.[11] For example, about 300,000 years after the Big Bang, matter was spread smoothly throughout the universe, but with some "lumpy" regions randomly distributed throughout. Thanks to gravity, these lumps became the galaxies, including our own.[12] The *placenta*, the key to the protection and nourishment of embryos in the wombs of most mammals, has features that indicate that it evolved through the insertion of viral

[11] Artigas, *Mind,* 101-103.
[12] Stephen M. Barr, *The Believing Scientist: Essays on Science and Religion* (Grand Rapids, MI: Eerdmans, 2016), 54-55.

DNA within the genome of the ancestors of mammals millions of years ago.[13] Viruses bring disorder and death, and yet in this case and others, viral DNA became a key source of order and life. Emergent systems, arising from things much simpler and displaying new levels of complexity, distinguish our universe as one that is not closed and clocklike but open and surprising.

In short, the universe is a balance of order and openness, law and flexibility, symmetry and surprises. A fundamental order exists, but that order is flexible in ways that are open to the emergence of new levels of order that are not simply the result of simpler levels.

D. Traces of the Divine: The Universe from the Point-of-View of Faith

As we have seen, science is a process of investigation in which various proposals (hypotheses) are made and then become subject to rigorous processes of testing. In science, thinking about things with calm objectivity comes first, and only when a discovery is made, confirmed and reconfirmed does the scientific community assent to this or that scientific claim as true, and then build upon that truth (theory). Consider Miescher's musing over nuclein. He speculated that it might have to do with heredity, but stopped short of affirming this because he had no way to test his hypothesis.

But as the story of Ignatius reveals, faith is about our response to God, the source of all reality who is Truth. This means that faith involves assenting to what God has revealed even prior to our total understanding of it. Faith follows its own "method" that is different than science because it is not about answering science's "how" questions. God's self-revelation in Scripture and in Church Tradition requires the *obedience of faith*, which is "a personal adherence of the whole man to God…an assent of intellect and will to the self-revelation God has made through his deeds and words."[14] God approaches us not as a problem to be solved, but personally, as a loving Father, and we respond with personal trust. Of course we do not do so without any thinking at all; there are many indications in life and experience that there must be some cause that is the source of all things.

Although we assent to God's personal invitation prior to a complete understanding, faith is not blind; our assent to God's Truth still leaves us with questions, especially when there seems to be a disagreement between what we experience and what God has revealed. According to Joseph Ratzinger, the man who became Pope Benedict XVI and the greatest Catholic theologian of our day, in faith "struggling and questioning thought remains present, which ever and again has to seek its light from that essential light which shines into the heart from the Word of God."[15] In addition, the infinite richness of the knowledge of God made available through faith summons our reason to explore those riches. As St. John Paul II made clear with his image of two wings, acts of

[13] Jamie Henzy, "Retroviruses, the Placenta and the Genomic Junk Drawer," http://schaechter.asmblog.org/schaechter/2014/06/retroviruses-the-placenta-and-the-genomic-junk-drawer.html.
[14] *Catechism of the Catholic Church*, no. 476.
[15] Ratzinger, "Faith and Theology," 25.

faith contrary to reason should be rejected. Faith is not on the side of the irrational. We are obligated as Christians to question and engage faith critically and rationally.

Therefore faith, like science, seeks deeper knowledge. According to the great bishop and theologian St. Anselm of Canterbury (c. 1033-1109), *theology* is "faith seeking understanding," the study of God and his Revelation using human reason in order to understand it more deeply and live in accord with it more fully. Theology is what faith looks like when it turns to thinking about what is believed. This use of reason never rejects God or his truth, but takes God and his revealed truth as its basis, its first principles, the fundamental "concepts" that make all theological thinking possible. Much like a chemist relies upon the periodic table of the elements without going back to reinvestigate it, theology relies on what God has revealed in the quest for understanding Him.

While taking God's revelation as certain, theology can and must inquire into the relationship between the knowledge given through faith and the knowledge acquired through reason and experience, including scientific knowledge. What perspectives do the "how" insights of science and the "why" insights of faith share? To answer, let's consider the hallmarks of the universe from the point-of-view of faith, just as we did from the point-of-view of science.

1. Divine Order: The Son "through Whom all Things were Made"

The central doctrine of the Christian Faith is the doctrine of the Trinity, that there is only one eternal God in three divine persons, Father, Son and Holy Spirit, who all completely are the one God, the Three-in-One. In their perfect, divine life the Son is eternally begotten of the Father and the Spirit proceeds from them as the Love they share. This is not something that could be known by the human mind unless revealed by God, whose inner life is not accessible to us. Furthermore, the three persons act as one in bringing the universe into existence, and so ours is a universe willed by God that reflects something of his inner life and the divine persons who create the universe.

The second person of the Trinity, the Son, is given a special name in Scripture—he is called the *Logos*, a Greek word which literally means "Mind" or "Reason." Now we see that the Christian Faith begins with placing faith in the Reason of God--no wonder John Paul II calls upon believers to use their minds! Of the Divine *Logos*, we are told that "all things were created through him," (Jn 1:3) and "in him all things hold together" (Col 1:17). Like the scientific perspective, then, the perspective of faith on the universe begins with a vision of orderliness. Faith reveals that from all eternity the Son is God's perfect wisdom, and so the universe is lawful, full of patterns that are intelligible. Scientists like Murray Gell-Mann marvel at the effectiveness of mathematics for describing the universe—why should mathematical order be the foundational characteristic of reality? The theologian responds, "because God is Truth, and so the universe reflects His wisdom"; in the words of Psalm 104: "How varied are your works, O Lord! In wisdom you have made them all…" (v. 24).

The primary concern of faith is the coming of the Son-Logos into the universe and human history as a human being for the sake of our salvation, the mystery we call the Incarnation. Fully coming in the flesh 2,000 years ago, Jesus Christ, the Son-Logos,

began his work of salvation long before, primarily in the history of the Jewish people but starting with the very creation of the universe. God was always speaking through his Son-Logos, and so we see God establishing an order for his people in the Law he gave through Moses and in the moral teachings of the prophets he sent over the centuries. Over time and much reflection, that people came to realize that this order God gave to their lives had a perfection about it that reflected the order they saw in the sky and on the earth. They recognized with God's guidance that he was not simply one god among the many pagan gods, or even the greatest of the gods, but the Lord who made all things, the one Creator, the only God. The ancient Jews were not a scientific people, but neither were they blind to the order that science investigates. When the time of the Incarnation had come the final prophet and greatest of them all, St. John the Baptist, called the people to repent and return to the law that had been given them, the order that the Lord has established for them. The Son-Logos, the Lawgiver, had come into the world, and to return to life according to God's order was required in order to receive him.

Faith, then, reflects upon the orderliness of the universe just as science does. The more science understands the universe and its laws, the more the certainty of faith in the Son-Logos as the very source of reality is reaffirmed. The universe begins in divine thought and so can be understood, feebly and incompletely but really, by human thought. In this way faith cherishes as a gift from God the same assumption of order that fuels scientific investigation.

But this picture of order that animates faith is an incomplete picture. When the Son-Logos became man, he announced new things, even while fulfilling the Law and the prophets. He corrected those who were not open to new things, commanding and announcing things that transcended the Law. We call the announcement of these new things the *Gospel*, the announcement of salvation through Jesus' life, death and resurrection, which included mercy for those who had rejected and broken the Law, and salvation for those outside of the Jewish people, the Gentiles. While pointing back to what had been given and what God had done in the past, Jesus interpreted the past in new ways. Faith sees not only order but openness to an unheard of future; faith is filled with *hope*.

The Lord is *Logos*, Mind, and so the universe's order is affirmed. But how does faith affirm the amazing and unexpected openness that science also sees? To answer this we must remember the Trinity, where with the eyes of faith we see a third divine person at work in the world.

2. Divine Openness: The Holy Spirit, "the Giver of Life"

A few verses after Psalm 104 celebrates the universe being made in wisdom, the same song makes a prayerful plea: "Lord, send out your Spirit, and renew the face of the earth." (v. 30) This idea of the renewal of the earth is a vision of openness and newness that is associated with the third divine person of the Trinity, the Holy Spirit. Here we can see that faith has its own vision of "emergence" that corresponds to the universe's openness that science also recognizes.

This third person of the Trinity is often referred to in Sacred Scripture as a gift given by the Son through his death and resurrection. In the words of John Paul II,

"through the Holy Spirit God exists in the mode of gift."[16] Gifts are unmerited and involve the unexpected and unpredictable. The Spirit is also associated with love; as the Apostle Paul writes: "God's love has been poured into our hearts through the Holy Spirit which has been given to us." (Rom 5:5). Love, which is something freely given, is surprising when it is directed toward us by another, and has the capacity to change our lives in new and unpredictable ways. The Holy Spirit, the divine person who is Gift-Love, is always associated with the new and surprising in God's work in history, when old patterns become taken up and are brought to whole new levels not reducible to what went before. At the beginning of the universe, the Spirit is depicted as moving "over the waters" as new things are to be brought forth (Gen 1:1); and so the very order of creation comes into existence whereas before there was none. The Incarnation of the divine Son is a new event, expected by no one, not even by his own mother, who receives the Holy Spirit in order to conceive him in her womb: "The Holy Spirit will come upon you, and the power of the Most High will overshadow you: therefore the child to be born will be called holy, the Son of God." (Luke 1:34) And so through Mary's "yes" to God a whole new way of being human is revealed in the life, death and resurrection of her son.

Wherever faith sees order, it also sees that this order exists to make possible a new level of "complexity," an even more marvelous and surprising order. The law given by Moses is not thrown out when Jesus, the new Lawgiver, comes. Rather the Holy Spirit is offered by him to take that law to a whole new level, correcting its imperfections and plumbing the depths of its possibilities. "Thou shall not kill" becomes deeper: "Thou shall not hate." The Gift-Love, the Holy Spirit, takes what is old and makes new patterns. He even takes what is broken and transforms it, as he does when the tragedy of the crucifixion of Jesus becomes the source of new life, in fact eternal life, for all who believe. Here we see that the Son-Logos and the Gift-Love always work together. Faith sees all reality as coming from God in a way that the Son and Spirit can be distinguished in their work, but never separated. In faith as in science, there is no order without openness, and no openness that leaves behind order.

Through the Son and the Holy Spirit, God the Father both creates and redeems the universe. The Trinity, the Three-in-One, is a mystery, which means it is beyond full human comprehension, ultimately unfathomable to us. It is a paradox, a truth made up of two truths (God is One, God is Three) that seem irreconcilable to the human mind. There are many who claim that this is why the Christian Faith ought to be rejected by reasonable people; science, they would claim, is about removing mystery and resolving paradox. Perhaps this is where science and religion part ways and become irreconcilable perspectives – science clarifies, faith mystifies. Let's explore this dilemma.

E. Paradox and Mystery: Uniting the Perspectives of Science and Faith

"Ridicule is the only weapon which can be used against unintelligible propositions. Ideas must be distinct before reason can act upon them; and no man ever had a distinct idea of the trinity. It is the mere Abracadabra of the [tricksters] calling

[16] John Paul II, *Encyclical* Dominum et vivificantem *on the Holy Spirit*, no. 10.

themselves the priests of Jesus."[17] With these words Thomas Jefferson (1743-1826 AD) derided and rejected the central doctrine of the Christian Faith. His logic was that, since we cannot comprehend how God is both one and three, it simply cannot be true. In other words, he rejected this article of faith because of its paradoxical nature. If something cannot be resolved into distinct ideas in the human mind, then it must be a trick, an "Abracadabra."

If you think about the teachings of Christianity, you will see that paradoxes abound. Jesus Christ, we believe, is both God and man; the Eucharist is really the Body and Blood of Christ although it has all the chemical properties of bread and wine; salvation is a pure gift of grace, but we must work it out "in fear and trembling" (Phil 2:12). None of these can be easily resolved into distinct ideas; in each case, two seemingly irreconcilable assertions are being made, assertions that cannot be simply reconciled. Again and again traditional Christianity failed Jefferson's personal "smell test" of truth and falsehood; it is not surprising that he rejected many of Christianity's central doctrines, such as the miracles of Jesus (which he actually cut out of his Bible). What is surprising is that much of what science has discovered about the universe fails Jefferson's test also. It turns out that the material universe contains its own paradoxes.

For example, consider the science of light, an important branch of modern physics. Over centuries many scientists developed distinct ideas about light, ideas that would've passed Jefferson's truth test. Sir Isaac Newton (1642-1727 AD), following the position of the Catholic priest and astronomer Pierre Gassendi (1592-1655 AD), thought that light was a particle, which would explain why light can knock electrons off of metal plates. But light also flows around objects and reforms its patterns, which is what waves do; so Francesco Grimaldi (1618-1663 AD), who was also a priest, and a Jesuit, theorized that light was a wave, a transfer of energy. The debate lasted for centuries until, in 1905, Albert Einstein resolved the issue by demonstrating that light is a "wavelike particle" called a *photon*. Later he explained the "wave-particle" paradox of light this way:

> But what is light really? Is it a wave or a shower of photons?... It seems as though we must use sometimes the one theory and sometimes the other, while at times we may use either. We are faced with a new kind of difficulty. *We have two contradictory pictures of reality; separately neither of them fully explains the phenomena of light, but together they do*.[18]

Light cannot be fully imagined; it presents us with a natural paradox. But this is because the nature of light is richer than our minds can handle. The same is true of the Trinity, the Incarnation, the Eucharist and many other articles of faith.

Since Einstein, many other natural paradoxes have been discovered by scientists, leading the physicist Neils Bohr (1885-1962 AD) to introduce a scientific principle he

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[17] Thomas Jefferson, "Letter to Francis Adrian Van der Kemp," 30 July 1816, https://founders.archives.gov/documents/Jefferson/03-10-02-0167.

[18] Albert Einstein and Leopold Infeld, *The Evolution of Physics*, 18th print ed. (New York: Touchstone, 1967), 262-263.

called *complementarity*, i.e. that objects have properties which cannot be observed all at once because of the limitation of our point-of-view. Interestingly, he used a theological example to illustrate his scientific principle: the paradox that God is perfectly just and perfectly merciful.[19]

Notice that Einstein's explanation of light would not satisfy Thomas Jefferson, but considering that Einstein's insight is foundational to all modern physics shows that Jefferson had a far too narrow "smell-test" for truth. Reality is bigger than the human mind, even a mind as great as Jefferson's.[20] Both the wave and particle models of light are necessary to explain what light is, in a way similar to how we must hold in faith God to be both one and three, Jesus to be both human and divine, etc. In the words of Joseph Ratzinger,

> We can only speak rightly about [God] if we renounce the attempt to comprehend and leave him as the uncomprehended… What is true [of light] here in the physical realm as the result of the deficiencies in our vision is true in an incomparably greater degree of the spiritual realities and of God… Only by circling around, by looking and describing from different, apparently contrary angles can we succeed in alluding to the truth, which is never visible to us in its totality."[21]

Science not only clarifies, and makes the complex simple. When the truth requires it, it also reveals the complexity of physical reality, its paradoxes and mysteries. This is not so different than faith which, by recognizing the mysteries of God, clarifies the meaning of life, as it did for St. Ignatius Loyola at the Cardoner River. In the words of C.S Lewis (1898-1963 AD), "I believe in Christianity as I believe that the sun has risen: not only because I see it, but because by it I see everything else."[22]

F. Looking Forward: *Faith, Science and Reason* in Outline

In this chapter we have laid out some general themes and a very broad picture of the relationship between modern science and the Christian Faith. The rest of this text will focus on completing that picture, applying these themes, adding other important perspectives and principles and treating major issues in a more thorough fashion. The contents have been inspired by the most common questions and misunderstandings that I have encountered in conversations and news stories, in questions from my own students and attendees at public presentations. Above all, the contents have arisen from my own personal quest to seek understanding of the Catholic Faith in a way that thoroughly embraces scientific insights, allowing those insights to, in the words of John Paul II, draw

[19] Joseph Ratzinger, trans. By J.R. Foster and Michael J. Miller, *Introduction to Christianity* (San Francisco: Ignatius Press, 2004), 173 n. 5.
[20] That he had a much better grasp on political philosophy than he did on Trinitarian faith should be obvious to all Americans.
[21] Ratzinger, *Introduction to Christianity,* 174.
[22] C.S Lewis, "Is Theology Poetry?" (Samizdat, 2014), 15.

me "into a wider world" where science is allowed to purify and strengthen my vision of the faith and my understanding of God.

The book has three parts. Part One (A Friendly Reunion: The Relationship between Natural Science and Supernatural Faith) is the longest part and is about creating a strong foundation:

- Chapter Two dispels misconceptions of the relationship between faith and science and offers a better way of framing the relationship (Science and the Christian Faith: Understanding and Correcting Models of Conflict)
- Chapter Three introduces and explains important philosophical concepts and principles that are essential to understanding God's relationship to the universe, concluding with the Christian doctrine of creation (Bridging the Gap: A Wisdom Wider than Science)
- Chapter Four explains the relationship between Genesis 1 and modern science, using Catholic principles of biblical interpretation and an exploration of the pagan context in which Genesis 1 was written (The First Creation Account and Modern Science: Uniting Perspectives)
- Chapter Five lays out the broad historical picture of the Catholic Church's role in the advance of science, including the tragic case of Galileo as the exception to an otherwise glorious history (Patroness or Persecutor? The Tradition of the Church and Scientific Discovery)
- Chapter Six applies the principles explained in Chapter Three to three special questions: the problem of evil, the necessity of prayer and the possibility of miracles (Evil, Prayer and Miracles: Three Key Questions for Faith in the Light of Science)

Part Two (God and Science: The Credibility of the Creator) has three chapters, all of which approach the discoveries of modern science from the perspective of God's relationship to the universe, beginning with the discoveries of modern physics and then proceeding to the issue of biological evolution:

- Chapter Seven investigates important advances in modern physics (the Big Bang theory, discoveries of "fine-tuning" of the universe for life and of symmetry and beauty in the laws of nature) and explains how to relate them to our faith in God as Creator (Modern Physics and Creation);
- Chapter Eight investigates the contemporary theory of the evolution of life and both theological and scientific misunderstandings of evolution in order to reflect upon evolution in the light of faith (Going "Deeper than Darwin": God and the Evolution of Living Creatures);
- Chapter Nine sharpens the focus of Chapter Eight to consider what science has shown about the origins of our species, *Homo sapiens sapiens*, through investigating the evolutionary process. Genesis 2 will then be explored as the divine perspective on this natural process, as well as reflecting on how human evolution should be understood theologically (The Emergence of the Image: God and the Science of Human Origins)

Like Part Two, Part Three (In His Image: The Human Person from the Divine Perspective) also has three chapters, all of which engage science to better understand the Christian doctrine of the human person as created in the image of God:

- Chapter Ten further explains our evolutionary relationship to the other animals, focusing on the amazing capacities of the higher animals and our hominid ancestors that we also share. It then considers related questions: what makes humans different than the other animals? How does our animality affect our morality? What is the relationship between love of self and love of others? It then returns to Genesis 2 to complete the theological picture (Dependent and Rational: The Human Animal in the Light of Science and Faith)
- Chapter Eleven incorporates the findings of molecular biology, paleoanthropology and philosophical anthropology to deepen our understanding of how humans image God (The Embodied Image: Science and the Human Ways of Imaging God)
- Chapter Twelve returns to the problem of evil, considering the problem of human evolution from the perspective of our inherited tendencies toward sin and death. It completes the theological picture by considering how Jesus Christ gives humanity a new origin, and what the final destiny of humanity is in God's plan (Evolution and Resurrection: Jesus Christ, the True Origin of Humanity)

Chapter Two

Science and the Christian Faith: Understanding and Correcting Models of Conflict

Why do so many people today think that science and faith are in conflict? When did this rumor of conflict begin?
Are there better ways of thinking about the relationship between science and faith?
What false ideas keep the rumor of conflict alive today?

A. New Rumors about an Old Friendship

Have you ever encountered a rumor that you and an old friend are no longer on speaking terms? Perhaps someone heard about a disagreement between you and your friend, one that was settled weeks or even months ago. The person or persons at the source of the rumor concluded that what was a momentary, real conflict has actually become the status quo, and that you and your friend have actually become enemies for good.

If you have had this experience, then you have a solid insight into a misconception of the relationship between natural science and *the Christian Faith*, the truth God has revealed in Sacred Scripture, Sacred Tradition, and the teaching of the Church. This is often called the *warfare* or *conflict model* of science and faith. According to this model, science and religion hold no possibility of harmony because it is assumed that they are rival ways of explaining the universe, and that their practitioners are both aware of this and are actively fighting each other for supremacy. Many now believe that to gain scientific knowledge is a process that moves a person further away from belief in God. They assume that to be friendly with science means to lose one's acquaintance with religion. Many also assume that belief in God, especially as he is revealed in Sacred Scripture and in the teaching of the Church, somehow replaces a scientific, rationally informed picture of reality, or at least makes it unnecessary.

The warfare model has become a deeply rooted assumption in the minds of many Americans, and recent research reveals that the perspective of many young American Catholics today has been shaped by it. A 2014 study from the Center for the Study of Religion and Society and the National Study of Youth and Religion (NSYR) by sociologist Christian Smith discovered the following:

- 72 percent of all Roman Catholic emerging adults in the study adopted the "inherent warfare" model of science and religion; that is, they saw the two as contradictory and incompatible.
- 62 percent of Roman Catholic emerging adults in the study said that their own views about religion have *not* been strengthened by the discoveries of science.

- 78 percent of Roman Catholic emerging adults in the study who have stopped practicing their faith cited the "conflict" of science and religion as one of the reasons why they no longer practice their faith.[1]

These findings were reinforced by a study released in 2016 by the Center for Applied Research in the Apostolate (CARA). The study focused on roughly the same age group as the NSYR, and identified the assumption of conflict between science and religion as the most common reason given by young people for no longer practicing their Catholic Faith. A significant segment of these youth described the faith as "incompatible" with what they learned or are learning in high school and university science education. Typical responses to questions were: "It [the Catholic Faith] no longer fits what I understand of the universe"; and "As I learn more about the world around me and understand things that I once did not, I find the thought of an all-powerful being to be less and less believable."[2]

Many scientists have arrived at the conclusion that to be scientific necessarily excludes any kind of faith. One example is the famous biologist E.O. Wilson, who left behind his Baptist upbringing as soon as he discovered evolution in his scientific studies in college. "I knew the healing power of Redemption," he tells his readers in his book *Consilience*. "But… I chose to doubt."[3] Doubt about God, not faith in him, Wilson tells us, made it possible for him to arrive at a "truly scientific" outlook on the world.

It should not surprise anyone that, just as Wilson rejected faith in his quest to be scientific, so others have rejected contemporary science in an attempt to maintain a religious outlook. Debates have long raged over how much of the findings of modern science can be accepted by a genuine believer, especially in the area of biological evolution. Some believers have thrown doubt on scientific findings that seem to them to threaten what they find in the pages of the Bible. Some try to use *miracles* (that is, direct interventions by God in the universe) to explain gaps in scientific data. Other believers have pointed to the inability of science to achieve absolute certainty as a sign that science is on shaky ground in all cases. One example is the Discovery Institute, an organization that promotes Intelligent Design Theory (ID). ID is an attack upon evolutionary biology that claims that the intervention of an intelligent designer was necessary for some features of living organisms, such as the human eye or the bacterial flagellum.

The warfare/conflict model has become a rarely challenged principle in our society, one that powerfully shapes attitudes toward religion and faith, even among Catholics. However, it has no foundation in history, and is largely the product of propaganda; in the words of Lawrence Principe, a chemist and eminent historian of

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[1] This presentation was given on February 14, 2014 at a symposium for diocesan bishops and diocesan superintendents of Catholic education entitled "Science and Human Dignity" and cosponsored by the USCCB and the Institute for Church Life, University of Notre Dame, South Bend, IN. The video of the presentation is available at: https://youtu.be/OaS1SV7xwWQ.

[2] Mark Gray, "Young People Are Leaving the Faith. Here's Why," *Our Sunday Visitor Newsweekly* (August 27, 2016), available at: https://www.osv.com/OSVNewsweekly/Article/TabId/535/ArtMID/13567/ArticleID/20512/Young-people-are-leaving-the-faith-Heres-why.aspx.

[3] E.O. Wilson, *Consilience: The Unity of Knowledge* (New York: Knopf, 1998), 6.

science, "The idea that scientific and religious camps have historically been separate and antagonistic is rejected by *all* modern historians of science."[4] Why, then, are so many convinced that these two old friends, science and the Christian Faith, are actually enemies? In order to discover the source of the warfare "rumor" we have to go no further than the late 19th century and the work of two American scholars, one a scientist, the other a historian. To understand why their promotion of the warfare model was so successful, we should begin by understanding the times in which they lived.

1. The Warfare Model in Its Historical Context

The warfare model of science and faith emerged when three historical developments were unfolding at the same time in Europe and the United States. First, the various areas of study to which we now refer with the umbrella term "science," such as physics, chemistry, biology, etc. were being professionalized, taking on a whole new level of respectability and exciting popular enthusiasm through the benefits they were producing in the new technologies of the Industrial Revolution such as steam engines and textile machines. The methodical study of the natural world through observation and experiment was gaining its reputation as the cutting edge of human knowledge, which it has kept ever since.

As a result, science as we define it today began to stand out as a specific and separate pursuit, a status it had never enjoyed in previous centuries. This change in perception even involved a change in vocabulary. Before the nineteenth century, the word "science" referred to any knowledge demonstrated logically, including theological knowledge. The words "philosophy" and "science" were treated as synonyms, as in the title of a book published in 1821: *Elements of the **Philosophy** of Plants Containing the **Scientific** Principles of Botany*.[5] But by the late nineteenth century the terms "science" and "scientific method" began to be associated exclusively with the study of the physical universe through observation and experiment. This change in perception added new words to the English vocabulary, terms such as "scientist" and "physicist" which were coined in 1833 by the Anglican theologian and natural philosopher William Whewell (1794-1866 AD).[6] Sadly, the restriction of the science "word family" to one kind of human knowledge left open the possibility that other areas of knowledge such as philosophy, art, morality, poetry and theology could be considered as unfruitful, subjective flights of fancy by comparison.

Once this shift in perception and language happened, the notion of possible conflict between science and faith could emerge. In previous centuries, many of the greatest minds in history produced works of both science and theology; both were considered "scientific" (meaning rational, founded on sound principles). Sir Isaac Newton (1643-1727 AD), the genius who discovered the law of gravity, was a deeply religious man who studied the Bible almost as intensely as he studied the natural world.

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[4] Lawrence M. Principe, "The Warfare Thesis" Lecture, *Science and Religion*, downloaded from https://www.thegreatcourses.com/courses/science-and-religion.html.
[5] Sydney Ross, "Scientist: the story of a word," *Annals of Science* 18:2 (1962), 69.
[6] Ibid., 71-72.

St. Thomas Aquinas (1225-1274 AD), perhaps the greatest theologian in the history of the Church, wrote numerous works of theology and long commentaries on books of the Bible, but he also wrote a treatise on the physical motions of human heart as well as a commentary on Aristotle's *Meteorology*. Both would've been puzzled by the claim that science and religion are opposed to each other; for them they were two sides of the same coin.

The second development occurred exclusively in the United States: the rise of anti-Catholic bias in American society as a response to the influx of Irish and other Catholic immigrants beginning in the mid-1840's. While this phenomenon had nothing to do with the change in perceptions about science, it did create an intellectual environment in which bigotry and prejudice against Catholics was ripe to be exploited for social and political change. The majority of Catholic immigrants were poor and illiterate, which gave their religion an air of ignorance and superstition to those outside of the Church. A largely successful attempt to forbid public aid to Catholic schools drew upon fears that Catholics secretly wanted to bring the entire nation under the control of the pope by corrupting education. Therefore, a bias against the possibility of Catholics being open to the progress of knowledge ruled the day. False claims about the history of the Church and science could draw upon the fuel of anti-Catholic fears and hatred to promote the greatness of science to the detriment of religion.

The final development was a new suspicion of any Christian doctrines other than moral teachings. Terms such as "dogma" and "articles of faith" began to be used pejoratively to characterize foolishness and fear of progress. By the late nineteenth century, dogmas had begun to be seen by many as anti-rational, as the products of blind faith. The belief that religion must be confined only to rules about behavior became a cherished ideal. In the thinking of many, science should replace dogmas in a crusade to rescue religion from irrational ideas. The misconception of Thomas Jefferson that we addressed in Chapter One had become widespread—dogmas, because they involve the paradoxical and mysterious and go beyond scientific proof, must therefore be rejected as absurd and even as the work of tricksters who wish to control the uneducated. The recognition that dogmas have to do with realities that are by nature unable to be fully comprehended, realities that are not in any way assertions about the universe and its laws but are the self-revelation of God, was lost to view.

Science is the true savior of humanity, the Catholic Church is the enemy of progress, and divinely revealed truths are obstacles to free scientific investigation. With these assumptions, the situation was ripe for claims of conflict between science and faith, and they would not be long in appearing.

2. John William Draper and Andrew Dickson White

In 1874, John William Draper (1811-1882 AD), a successful American chemist and early innovator of photography, published his book entitled *History of the Conflict between Religion and Science*. He begins by making a generalized judgment: "The history of Science is not a mere record of isolated discoveries; it is a narrative of the conflict of two contending powers, the expansive force of the human intellect on one

side, and the compression arising from [traditional] faith."[7] Shortly after this declaration, he qualifies it by proclaiming the innocence of Protestant and Greek [Orthodox] Christians, whom he claims have never opposed the advancement of knowledge and have always had "a reverential attitude to truth, from whatever quarter it might come." The true religious enemy of science, Draper then claims, is the Roman Catholic Church, which he indicts for rejecting science and engaging in violent means so as to maintain power over its adherents in its attempt to gain total political supremacy over all peoples:

> In speaking of Christianity, reference is generally made to the Roman Church, partly because its adherents compose the majority of Christendom, partly because its demands are the most pretentious, and partly because it has commonly sought to enforce those demands by the civil power. None of the Protestant Churches has ever occupied a position so imperious—none has ever had such widespread political influence…
>
> …But in the Vatican—we have only to recall the Inquisition—the hands that are now raised in appeals to the Most Merciful are crimsoned. They have been steeped in blood![8]

Throughout the rest of the book, Draper offers example after example of conflict between the Catholic Church and science while offering little or no evidence. He makes up details and presents them as facts. He rearranges sequences of events in order to support his position. He selects quotes that seem to support his case and refuses to give the context, even leaving out parts of quotes that call into question his interpretation of them.[9]

For instance, Draper condemns the Catholic bishop and theologian St. Augustine (354-430 AD) for teaching that the sky is stretched out like a skin over a flat earth.[10] Actually, Augustine quotes Psalm 104:2 ("Lord my God, you are great indeed… you stretched out the sky like a skin") in order to demonstrate his principle that the Bible must be read figuratively, not literally, in its depictions of natural phenomena. Augustine actually affirms the very position Draper claims he is denying: "rational arguments," Augustine concludes, "inform us that the sky has the shape of a hollow globe all round us."[11]

Draper ends the book with his own prophecy of doom for religion and victory for science:

> As to the issue of the coming conflict, can any one doubt? Whatever is resting on fiction and fraud will be overthrown. Institutions that organize impostures and spread delusions must show what right they have to exist. Faith must render an

[7] John William Draper, *History of the Conflict between Religion and Science*, Vol. XII, The International Scientific Series (New York: D. Appleton, 1874), vi.
[8] Ibid., x-xi.
[9] Principe, "The Warfare Thesis."
[10] Draper, 63.
[11] St. Augustine, *De Genesi ad Litteram,* Book II.21.

> account of herself to Reason. Mysteries must give place to facts. Religion must relinquish that imperious, that domineering position which she has so long maintained against Science.[12]

Despite his fury and contempt for religion, especially Catholicism, or more likely because of it, Draper's book was an instant success. It outsold every other book in the series in which it was included. Since then it has been reprinted 50 times and has been translated into 10 languages. Even today it remains readily available.[13]

Andrew Dickson White (1832-1918 AD) was an American historian and the co-founder of Cornell University (1865), the first purely secular institution of higher learning in the United States. For this he was subjected to criticism for separating learning from religion, criticism that came mostly from competitors at Protestant institutions of higher learning. In response, White decided to write a book showing that both religion and science would be better off once "dogmatic theology," a subject *not* included in the curriculum at Cornell, was fully overcome. "I will give them a lesson which they will remember," he wrote to his friend Ezra Cornell in 1869.[14]

The "lesson" he gave to his opponents was a two-volume work, *History of the Warfare of Science with Theology in Christendom*, first published in 1896. He begins by praising Draper for "his work of great ability." He then goes on to repeat many of Draper's errors, including one that remains quite popular today: the flat-earth "dogma." White claims that, until Christopher Columbus' time, the majority of Christian thinkers had insisted on biblical grounds that the earth was flat, and that a flat-earth was practically a dogma of the Church. In reality, only two Christian thinkers, Lactantius (c. 250-c. 325 AD) and Cosmas Indicopleustes (6th century AD) had ever claimed that the earth was flat. To make his argument, White misrepresents more important Christian thinkers, such as St. Basil the Great and St. John Chrysostom, as flat-earthers and presents Lactantius and Cosmas as representative of the official Christian position. To add a touch of drama, he adopts a fictional account of Christopher Columbus struggling unsuccessfully to convince Catholic priests and professors that the earth is spherical at the University of Salamanca in 1487:

> The warfare of Columbus the world knows well… how sundry wise men of Spain confronted him with the usual quotations from the Psalms, from St. Paul, and from St. Augustine; how, even after he was triumphant, and after his voyage had greatly strengthened the theory of the earth's sphericity… the Church by its highest authority solemnly stumbled and persisted in going astray.[15]

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[12] Draper, 367.
[13] Principe, "The Warfare Thesis."
[14] Andrew Dickson White, "Letter to Ezra Cornell," 3 August 1869, as quoted in James R. Moore, *The Post-Darwinian Controversies: A Study of the Protestant struggle to come to terms with Darwin in Great Britain and America* (Cambridge: Cambridge University Press, 1979), 35.
[15] Andrew Dickson White, *History of the Warfare of Science with Religion*, Vol. I (New York: D. Appleton, 1894), 48.

Had White done his homework, he would've discovered that all parties at Salamanca *agreed* with Columbus that the earth is spherical. What was debated at Salamanca was the size of the earth; Columbus thought it was small enough to get to Asia with sufficient supplies, and his opponents thought that it was much larger. (His opponents were right; it was much larger than Columbus thought, although neither they nor Columbus knew about what lay between Europe and Asia: the Americas.)[16]

The "one-two punch" of Draper and White has had a remarkable, long-standing effect on popular opinion, as we have seen from the statistics at the beginning of this chapter. Appealing to the prejudices of their day and riding the wave of scientific progress, they created the very conflict they claimed to resolve. The errors and misrepresentations they foisted upon their readers are now routinely repeated as historical facts by non-historians, finding new life in the work of science popularizers such as Neil DeGrasse Tyson, who in his 2014 TV series *Cosmos* falsely portrayed the Church as persecuting and killing the Italian monk Giordano Bruno (1548-1600) for a scientific idea (Bruno was actually executed for theological heresies).[17] In 2012, even U.S. President Barack Obama repeated the flat-earth error in a jibe against political opponents: "If some of these folks were around when Columbus set sail, they probably would have been founding members of the Flat Earth Society. They would not have believed that the world was round."[18]

B. Fighting for the Friendship – Affirmation and Credibility[19]

With such powerful misconceptions abounding within popular opinion, the only remedy to a warfare approach to science and faith is to take a closer look at both, moving beyond the unfounded claims of Dickson and White. As we do so in this text, it will be clearly demonstrated that the Faith of the Church *affirms* and supports the value of the scientific investigation of the universe. It will also become apparent that the discoveries of science have not harmed the *credibility* of the Christian Faith (i.e. its harmony and compatibility with reason); rather, in many cases those discoveries directly support that credibility. For now, let's briefly summarize what we mean when we declare that science supports the credibility of the Christian Faith, and that the Church thoroughly affirms science as a genuine and important exercise of human reason.

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[16] Matt J. Rossano, "How the Myth of the Flat-Earth Dogma Started the Religion-Science War," *The Huffington Post Blog* (September 9, 2016), available at http://www.huffingtonpost.com/matt-j-rossano/starting-a-war-with-a-fla_b_707471.html.

[17] Davis, Ted, and Stephen Snobelen. "New Atheists and the 'Conflict' between Science and Religion." BioLogos. January 05, 2017. Accessed September 28, 2017. http://biologos.org/blogs/ted-davis-reading-the-book-of-nature/new-atheists-and-the-conflict-between-science-and-religion.

[18] climatebrad. "Obama: GOP Candidates 'Would Have Been Founding Members Of The Flat Earth Society'." *YouTube*, YouTube, 15 Mar. 2012, www.youtube.com/watch?v=Rsz3uLxTwQs.

[19] John F. Haught, *Science and Religion: From Conflict to Conversation* (New York/Mahwah: Paulist, 1995), 9. Haught's original terminology is "confirmation" and "credibility"; I have altered the former term to "affirmation."

1. Credibility – The Self-Corrections of Science and the Progress of Theology

As we have seen, in the nineteenth century a growing number of thinkers came to the conclusion that groundbreaking new scientific discoveries had damaged the credibility of the Christian Faith, including belief in God. The answers to those challenges were not very clear at the time. In the twentieth century, however, the situation began to change. Theologians began to reconsider certain assumptions and to reflect upon the Christian Faith in the light of new discoveries. Also, some of the conclusions of earlier scientific inquiry that had seemed difficult to reconcile with Christian belief were called into question and were even overturned by newer discoveries.

These newer discoveries, far from undermining Christian doctrines, actually began to point in a direction that made those doctrines more credible. (We will explore several examples later. One you may have already heard about is the Big Bang theory, which is now the generally accepted account of the beginnings of the universe. But there are other examples of discoveries that strengthen the credibility of Christian beliefs, and we shall discuss them at length.) So, in the twentieth century the story of science did not go in the direction that some had expected: there were several "twists in the plot," so to speak. These helped to overcome some of the challenges to the credibility of the Christian Faith that had once seemed so formidable. There is an important lesson in all of this: while God's truth cannot change, the conclusions of science can and do, and often in quite unexpected ways. And our conception of God's truth theologically can and does progress in the light of new knowledge. This should teach us not to jump to hasty conclusions about supposed "conflicts" that may later turn out to be illusory, based on emotions or appearances but not in reality.

These new discoveries of science began to change the minds of some people, and the notion of warfare between science and faith has begun to recede among scholars who have become more aware of the biased perspective from which it emerged. Over the course of the twentieth and twenty-first centuries, theologians began to incorporate scientific insights directly into their reflections upon the teachings of faith and clarifying the distinction between the two perspectives and the harmony between them. Also, among members of the scientific community, more and more believing scientists began to feel confident in the intellectual respectability of their faith. A powerful example can be seen in the Society of Catholic Scientists, which was founded by particle physicist Stephen Barr in June 2016. In the span of just a year the total membership grew to over 500 and includes scientists from respected institutions across the United States, including Harvard and the National Academy of the Sciences.[20]

2. Affirmation – Faith Fosters Science

The misconception that science and religion are enemies is also contradicted by the historical record, which shows that biblical religion, especially the Christian Faith, has fostered the development of modern science. This would've surprised Dickson and White, but it is a historical fact. In studying ancient civilizations, such as Greece, China,

[20] See catholicscientists.org.

Egypt, and the Aztec Empire of Mexico, historians have discovered that many of them had achieved some impressive results in science and *technology* (the practical application of mathematics and science). But of all the world's cultures and civilizations, only the Christian culture of Western Europe made the breakthrough to a total, lasting, and far-reaching scientific approach to the world. It was from there that modern science spread to the rest of the world. This is well-documented in recent books such as Edwards Grant's *God and Reason in the Middle Ages* (2001) and James Hannam's *The Genesis of Science: How the Christian Middle Ages Launched the Scientific Revolution* (2011).

That Christianity had a positive role to play in the history of science is a puzzling claim, especially to those who assume that Christian belief and natural science do not mix. Why would a society based on the Christian Faith, a Faith so many assume to be science's enemy, be the very society that formed the cradle for the natural sciences? The answer is so surprising that it is still often overlooked. According to some leading historians, it was the *centrality of Sacred Scripture* to European culture and learning which had offered the perfect atmosphere for modern science to emerge.

This makes more sense if we give a little thought to what the Bible teaches about God and the universe. Sacred Scripture insists that the universe reflects the wisdom and goodness of its Creator. Indeed, it was created by a God who, according to Christian belief, is Himself both Wisdom, Goodness and the Source of all. Because of this, Christian cultures had confidence that the world could be understood and was worthy of understanding *on its own terms*. The world was the product of a Mind, and so could be understood by minds. God, according to Scripture, had given laws to the universe "which will not pass away" (Ps. 148:6). Since other civilizations lacked a strong notion of a personal, perfectly good, wise and creative God, they also lacked a firm religious and cultural stimulus in their search for natural principles and laws in the universe.[21]

The scriptural and Christian belief that the universe is created by an all-good, all-powerful and perfectly wise Creator implies that it has limits that can be found, order which can be marveled at, and a goodness that makes it valuable. It is this outlook which gave and still gives affirmation to science, and which nurtures it and encourages it to begin and continue its quest for more knowledge.[22] For those who still mired in the warfare model, history has a wake-up call**.** Not only has the Christian Faith been the friend of science, it actually helped to bring modern science to birth. And, as we shall see in Chapter Five, the Church and Christian believers have played an active and positive role in the development of science for at least 1500 years. In the words of the evolutionary anthropologist Loren Eiseley:

> [Experimental science] began its discoveries and made use of its methods *in the faith, not the knowledge*, that it was dealing with a rational universe controlled by a Creator who did not act upon whim nor interfere with the forces He had set in operation. The experimental method succeeded beyond man's wildest dreams, but

[21] Stephen M. Barr, *Modern Physics and Ancient Faith* (Notre Dame: University of Notre Dame Press, 2003), 66-68; cf. Wilson, 31.
[22] Haught, *Science and Religion*, 22.

> the faith that brought it into being owes something to the Christian conception of the nature of God. It is surely one of the curious paradoxes of history that science, which professionally has little to do with faith, owes its origins to an act of faith that the universe can be rationally interpreted, and that science today is sustained by that assumption.[23]

C. Scientific Atheism and Creationism: Misconceptions about the Universe and Science

As we can see, the warfare model does not do justice to history. It is also often fueled by misconceptions of the natural universe and of science itself, sometimes on the part of those who claim to support science, and also by some believers who seek to defend their faith without fully understanding it. It should not surprise us that those most responsible for spreading the warfare/conflict rumor are those who start from beliefs that require them to assume that science and faith are incompatible.

Understanding these belief systems is necessary to understand why many today still hold science and faith to be at odds even when they understand the false historical foundations of the warfare model. To examine these we have to move beyond historical matters and consider some flawed philosophical and theological ideas about the universe and science.

1. Materialism, Reductionism, Scientism — What You See is ALL You Get!

One such belief system is *materialism*, the notion that *only* "lifeless and mindless 'matter' alone is real."[24] Put another way, materialism is the conviction that *only* the visible universe, that is, things that are capable of being seen, smelled, touched, heard, and tasted (or at least capable of being measured by instruments) exists. In the words of one such materialist, the evolutionary biologist Richard Lewontin:

> We take the side of science *in spite* of the patent absurdity of some of its constructs, *in spite* of its failure to fulfill many of its extravagant promises of health and life, *in spite* of the tolerance of the scientific community for unsubstantiated just-so stories, because we have a *prior commitment*, a commitment to materialism… Moreover, that materialism is absolute, for we cannot allow a Divine Foot in the door.[25]

Lewontin is clearly aware that the method of science can be entirely ruined by inserting supernatural causes ("a Divine Foot") to explain physical realities. And to that extent he is correct; as a method, scientists must assume a *methodological materialism* in which they persist in seeking material explanations, never inserting God in the gaps of

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[23] Loren Eiseley, *Darwin's Century: Evolution and the Men Who Discovered It*, (Garden City, NY: Anchor Books: 1961), 62 [italics mine].
[24] John F. Haught, *God After Darwin: A Theology of Evolution* (Boulder, CO: Westview, 2000), 1.
[25] Richard C. Lewontin, "Billions and Billions of Demons," *The New York Review of Books*, January 9, 1997, accessed October 02, 2017, http://www.nybooks.com/articles/1997/01/09/billions-and-billions-of-demons/.

our scientific understanding. The problem is that Lewontin and other materialists make the method of science into a mentality, a rigid ideology, an all-encompassing worldview, a cookie-cutter conception of reality. Only the "dough" that fits within the method is real; and since material things are the only things that fit the method of science, only material things are real. In the next chapter we will see how Catholic thinkers affirm the methodological materialism of science without embracing actual materialism, conceiving of God as the real Cause of all causes, not an alternative cause to material causes.

Closely related to materialism is *reductionism*, the idea that all real things are *only* the sum of their parts, and that all explanations of physical reality must move from the bottom-up, from smaller entities and more fundamental physical forces to more complex entities and physical forces. In this belief system what seem to be higher levels of existence (like animals and humans) are merely new collections of smaller elements, arranged in a different, more complex order, and able to be explained entirely by reference to these smaller parts. Perhaps the most famous statement of reductionism came from the well-known American scientist Carl Sagan (1934-1996 AD), who once said, "I, Carl Sagan, am nothing but a collection of atoms bearing the name 'Carl Sagan.'"[26] Of course, most people recognize that physical creatures are made up of atoms, just as Sagan said. However, reductionism is the belief that physical creatures, humans included, can be fully explained in terms of their parts; they are mere collections of smaller entities.

Reductionism is also based upon a crucial truth, that the scientific method must begin with reducing things to their most fundamental parts and the universe to its most foundational laws. As a method, scientists must assume a *methodological reductionism*, investigating what the parts contribute to the whole and attributing to these as much explanatory power as they actually have. But they must not stop there, and if they did all science would simply be reducible to physics. Chemistry and biology would simply become branches of physics, rather than distinct sciences, if reductionism were an accurate picture of reality.

To fully appreciate the flaws of reductionism, consider the mystery of a human being. It is possible to know a human being on many levels: one can study human biology or physiology, or the range of human emotions, or even human brain waves. But in such an attempt, we begin to realize that there are human activities, actions, accomplishments, and desires that go beyond the purely physical. As we realize this, what Pope John Paul II once called "the immensity of the human spirit"[27] becomes apparent, an immensity and dignity that cannot be reduced to the biological level.

The reductionist and materialist ideologies can be summarized in one term – *scientism*, which can also be called *scientific atheism*. *Scientism* is the view that

[26] Clarke, 247.

[27] John Paul II, "Address to a group of scientists gathered to honor the centenary of the birth of Albert Einstein" (September 28, 1979).

"[empirical] science alone can put us in touch with the ultimate depths of the world."[28] These scientis*t*ic (vs. scienti*f*ic) worldviews obviously allow no room for the Christian Faith as a source of truth. As the Christian Faith is concerned ultimately with God, who is spiritual and not physical, those who deny that there are any non-physical realities reject the Christian Faith. Since reductionists and materialists see science as the only way to gain knowledge of things as they really are, they consider religion to be inherently incompatible with scientific thought.

Scientism involves a logical flaw – it is based on an assertion that is not logically consistent. As we said above, scientism is the belief that only science, which observes and measures physical realities, can put us in touch with truth. And yet the very statement "only science can put us in touch with truth" is itself not able to be verified by science. If you are having a hard time grasping this, think about this statement, which is similar because it is also logically inconsistent: "Nobody goes there anymore, because it is too crowded." In the same way, if the statement "only science can put us in touch with truth" is true, then it must be scientifically verifiable. But that assertion cannot be observed or measured through scientific means. Thus, the foundational assumption of scientism is inconsistent; it claims a standard for truth that it cannot satisfy. No scientific facts defeat scientism; but no scientific facts prove it either. Those who interpret reality in this way cannot logically rule out other approaches to reality, such as belief in God.

2. Dogmas and Mysteries

As we have indicated in regard to the warfare model, scientific atheism finds fault with the Christian Faith because it involves *dogmas* and *mysteries.*[29] A closer look at both will help us understand why. It will also show that scientific atheism involves a flawed understanding of what Christians mean by dogmas and mysteries.

Dogmas (also known as *doctrines*) are truths revealed by Christ which, because they come from God himself, cannot be changed or challenged; only our understanding of them can progress.[30] An example of a dogma would be the Christian belief that the eternal Son of God became man in the womb of the Virgin Mary: the dogma of the Incarnation. Scientific atheism sees the believer's acceptance of dogmas as *anti-rational*. But this objection is incorrect. To believe in a dogma on God's own authority is perfectly rational – if God does exist and has really revealed it. And dogmas, once accepted on those grounds, can be rationally explored: we can examine them by means of our naturally derived knowledge in order to understand how they fit together to form a coherent and consistent picture of reality. As we have noted, this rational exploration is called theology.[31]

The Church teaches that what we believe as Christians and our act of believing it are in harmony with reason, and that God desires us to see the reasonableness of the

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[28] John F. Haught, *Deeper than Darwin: The Prospect for Religion in an Age of Evolution* (Boulder: Westview, 2003), 32.
[29] Barr, *Modern Physics*, 11-15.
[30] CCC #88, 94.
[31] Barr, *Modern Physics*, 11-12.

things he has revealed, so that we can better understand the world, ourselves, and God himself. The Church, therefore, invites us to approach dogmas intelligently—to ponder them and penetrate more deeply into them, just as the Blessed Virgin Mary "kept all these things and pondered them in her heart" (Luke 2:51). In the words of Vatican I (1869-1870), "The assent of faith is *by no means* a blind impulse of the mind."[32]

Mysteries are aspects of reality that transcend our ability to fully grasp them because they are so closely connected to the reality of God, who is infinite. Scientific atheism sees the Christian respect for mysteries as anti-rational because it involves the assertion that some things transcend our intellectual capacity. To say that there are things that are beyond our full comprehension, according to scientism, is to give up on thinking, to end the struggle for deeper understanding. But that which lies beyond our mental grasp does not necessarily put an end to thought. In the words of physicist Stephen Barr,

> [Divine mysteries] do not shut off thought, like a wall. Rather they open the mind to vistas that are too deep and too broad for our vision. A mystery is what cannot be seen, not because there is a barrier across our field of vision, but because the horizon is so far away. [To name something a mystery] is a statement not of limits, but of limitlessness. The reason that there are mysteries is that God is infinite and our intellects are finite.[33]

In summary, the acknowledgement of mysteries does not close the human mind. Rather, mysteries open an infinite horizon for us to explore.

Materialism, reductionism and scientism are *belief systems*, convictions about reality. They must be clearly distinguished from science as such. Science, which examines the elements of the visible world, is not the same thing as materialism, which holds that the elements of the visible world are the only things that really exist. Nor is it the same thing as reductionism, which says that all things are reducible to their physical, visible parts. Finally, the belief that only science can reveal the truth (scientism) is not a requirement for the study of science, just as the study of paintings does not require denying that other forms of art are also valuable.

3. Literal Creationism—Making God in Our Image

It would be unfair to place the burden of the warfare/conflict misconception only upon the backs of those who embrace materialism, reductionism and scientism. Another source of the rumor that science and faith are enemies is actually a very vocal group of believers. They are often referred to as *creationists* because of their belief that God created the universe exactly (or almost exactly) according to their interpretation of the first and second creation accounts found in the Book of Genesis (Gen 1-3). One common belief among creationists is that the universe is only around 6,000 years old, based upon their calculation of the dates and ages given in the Bible, rejecting modern Big Bang

[32] *Dei Filius,* 3: DS 3009, as quoted by Barr, *Modern Physics*, 12.
[33] Barr, *Modern Physics*, 14-15.

cosmology and the billlions of years of cosmic history it reveals. Another common belief is that all species were originated by God at various points in time within the first week of the earth's existence through a sudden and miraculous process, rejecting evolution and its natural explanation for the origins of living things over billlions of years. In both cases and others, creationism flatly rejects the modern scientific consensus based on the authority of the Bible, and attacks "secular science" as atheistic and as lacking solid evidence for its claims.

Creationism is a theological position; it claims to be the proper interpretation of the Bible and of the Christian doctrine of creation. As such it has been rejected by the three most recent popes. In 1981 St. John Paul II noted that the Bible does not wish to give us a "scientific treatise," declaring that the Bible wishes to teaches us theological truths, not scientific ones: "Any other teaching about the origin and make-up of the universe is alien to the intentions of the Bible, which does not wish to teach how heaven was made but how one goes to heaven."[34] In his Easter Vigil homily in 2011, Benedict XVI declared that the creation account in Genesis 1 "is not information about the external processes by which the cosmos and man himself came into being."[35] And in 2014, Pope Francis repeated the same rebuttal in greater detail:

> When we read the account of Creation in Genesis we risk imagining that God was a magician, complete with an all-powerful magic wand. But that was not so. He created beings and he let them develop according to the internal laws with which He endowed each one, that they might develop, and reach their fullness… The Big Bang theory, which is proposed today as the origin of the world, does not contradict the intervention of a divine creator but depends on it. Evolution in nature does not conflict with the notion of Creation, because evolution presupposes the creation of beings that evolve.[36]

We will look more closely at what we mean by the word "creation" and God as Creator in Chapter Three. For now these quotes should make it clear that Catholics who embrace creationism do not represent the Church's understanding of creation and run afoul of the teaching of the popes, which should be observed as authoritative Catholic teaching. Arguing against well-established science simply on one's interpretation of the Bible breaks faith and reason apart and fails to distinguish between science and theology.

Although as false as scientific atheism, creationism is based upon a crucial theological truth. The truth behind creationism is to be found in its insistence on the divine inspiration of the Bible, that through its human authors God reveals truth for the

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[34] St. John Paul II, Address to the Pontifical Academy of the Sciences, October 3, 1981, accessed October 2, 2017, https://www.ewtn.com/library/PAPALDOC/JP2COSM.HTM.

[35] Benedict XVI, Easter Vigil Homily, April 23, 2011, accessed October 2, 2017, http://w2.vatican.va/content/benedict-xvi/en/homilies/2011/documents/hf_ben-xvi_hom_20110423_veglia-pasquale.html.

[36] Francis, Address to the Pontifical Academy of the Sciences, October 27, 2014, accessed October 2, 2017, http://w2.vatican.va/content/francesco/en/speeches/2014/october/documents/papa-francesco_20141027_plenaria-accademia-scienze.html.

sake of our salvation. Creationists correctly recognize that God is not capable of error, and that his word given in Sacred Scripture cannot be wrong. Unfortunately, from this they draw a false conclusion. It is one thing to say that the purpose of the Bible is to reveal truth; it is quite another to say that it is directly concerned with the kinds of truth about the physical world that natural science investigates. Unconsciously, "scientific creationists" have absorbed some of the errors of scientific atheism, ascribing to truths about the natural world a kind of ultimate importance, instead of realizing that the truths with which Scripture is primarily concerned are of a much higher order. By failing to distinguish between the "how?" explanations of science and the "why?' explanations of faith, creationists squeeze God into a simplistic mold that fails to distinguish between what they can imagine and the divine mystery of creation. God becomes an all-powerful agent doing things the way we would do them. They remake God into their own image, making him fit their finite perspective.

In Chapter Four, we will look more closely at the issue of *how* God's Word is without error in order to explain how it is possible to accept the findings of science and also embrace Sacred Scripture as God's word. We will examine how Sacred Scripture itself gives indications that it is not about giving an account of the scientific details of the physical world, but rather shows itself open to changing views of the universe that become deeper and more accurate with time. In short, we will see that Scripture shows itself to be open to science.

D. Separation Anxiety: A False Solution to the Warfare Model

In large part, one can trace the opinion that science and the Christian Faith are irreconcilable to the groups we just examined. But while they have fueled the rumor that science and faith are enemies, another group has attempted to dispel the rumor by asserting that science and faith have *no relationship*. In other words, while scientific atheists and creationists are spreading the rumor that science and faith are not on speaking terms because they are in conflict, this third group holds that they are not speaking because they have nothing to talk about.

In their anxiety to end the rumor that science and faith are irreconcilable, many thinkers – some of whom are scientists, some of whom are believers, and some of whom are both – have argued that science and faith are really too different to be in conflict. Ian Barbour gives an excellent explanation of this position, which he calls the "Independence Model" – "Proponents of this view say there are two jurisdictions [i.e. science and faith] and each party must keep off the other's turf. Each must tend to its own business and not meddle in the affairs of the other."[37] We will refer to this approach as *separationism*, because it maintains that science and the Christian Faith must always be kept separate in every way possible.

According to separationism, a person can embrace both scientific discoveries and religious customs and values without having to worry about contradictions, because their jurisdictions never intersect. For separationism, the distinction we have made between

[37] Ian G. Barbour, *Religion and Science: Historical and Contemporary Issues* (New York: HarperCollins, 1997), 84.

"how?" and "why?" is hardened beyond a difference of perspectives into entirely different claims with no common ground.

One influential separator of science and faith is the late biologist *Stephen Jay Gould*. Science, he tells us, is about facts; religion is about "values and meaning." No war can exist between them, because they never address the same realities.[38] Gould's approach is attractive to many people. By separating science and all religious beliefs, including the Christian Faith, into their own compartments and keeping them neatly tucked away from each other, Gould intends to resolve potential problems and conflicts before they even begin.

However, this very tidy separationist approach has a fatal flaw—it involves a complete misunderstanding of the Christian Faith.

1. Getting the Facts about the Christian Faith

Contrary to the view held by the separationists, the Christian Faith is not just interested in values and meaning, but in facts as well. The problem with separationism can be explained in a single sentence: ***the Christian Faith considers facts as having value and meaning, and values and meaning as factual***. Let us look more closely at what this sentence means, and why it makes the separation approach to science and faith a dead-end.

The Christian Faith considers facts as having value and meaning. The full value of facts can only be understood in the light of faith in God. Faith in God involves the recognition that all things are *theocentric* – that is, they are centered on God because (a) they are created by God, and (b) they are created for a purpose known to God. To know about a thing without knowing (a) and (b) is to know it in a limited sense. This does not mean that science must accept things on faith – as a method, it must not. But it does mean that the Christian Faith and science really do talk about many of the same realities, contrary to separationism. The Christian Faith, like science, also reveals certain facts, and calls us to put our faith in them. The Incarnation of the Son of God, who became man in the womb of the Virgin Mary, is proclaimed by both Scripture and the Church to be a real event. It is a historical fact, something that really happened in history, although it is certainly not a fact that can be proven by science.

This is also true of other elements of faith as well, such as the belief that God is a Trinity of Persons, that Jesus rose from the dead, and that his mother was assumed body and soul into heaven. If science is about facts, and religion is only about values and meaning, then the Christian Faith could never teach that such beliefs actually are true.

The Christian Faith considers values and meaning as factual. That is, they are not mere opinions, which change from person to person. Values and meaning are not human daydreams projected onto a neutral landscape of facts which science lays out for us. The statement "murder is evil" is no less true than the statement "the water molecule contains two hydrogen atoms." Its truth just happens to be known in a different way than by looking into a microscope.

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[38] Stephen J. Gould, *Dinosaur in a Haystack* (New York: Harmony, 1995), 48.

The objectivity and factuality of values and meaning has often been overlooked by the modern world, but has never been overlooked by the Catholic Church. In the words of Joseph Ratzinger:

> We must again learn to understand that the great ethical insights of mankind are just as rational and just as true as—*indeed more true than*—the experimental knowledge of the realm of the natural sciences and technology. They are more true, because they… have a more decisive significance for the humanity of man.[39]

At a conference on the human genome project, Camillo Cardinal Ruini expressed exactly this point in relation to science's ability to map out the entire genetic information present in human beings. The map of the human genome is being drawn, he told his audience, just at the point when it seems that humans may have lost the map of the meaning and value of life itself.[40] The point is clear – there is a real map to life, just as there is now a real map of the human genome. Science and the Christian Faith both really tell us about *what is* – not just what we happen to feel or imagine.

In an effort to make peace between science and religion, separationists actually make them strangers. In the process, they correctly understand science, but entirely misunderstand the Christian Faith.

Looking Ahead

We have looked at some mistaken ideas of the relationship between science and religion: materialism, reductionism, scientism, creationism and separationism. The first four want to put science and faith into a no-holds-barred cage match, while the last wants to put each in its own little airtight box so they can do no harm to each other. But what is the right relationship? There must be a way of looking at the universe that respects both science and the Christian Faith, a way that unites facts, values, and meaning, the how and the why. Can we really let science be science, let faith be faith, and yet still find places where they meet and shed light upon each other? If not, then even if science and the Christian Faith seem to be friends, their friendship is false.

For this task, a wisdom wider than modern science, a more foundational use of reason, is necessary. St. John Paul II identified philosophy as that wider wisdom, and as the bridge that connects science and faith: "The contemporary vision of the cosmos, the concept of time and space, the ever-multiplying discoveries of physics, of chemistry, of biology… demand… a renewal of philosophical thinking among Christians."[41] While science only studies material reality, the scope of philosophy is much larger, including the most universal characteristics of reality and our ability to inquire into reality and

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[39] Joseph Ratzinger, *A Turning Point for Europe? The Church in the Modern World—Assessment and Forecast* (San Francisco: Ignatius Press, 1994), 35-36.
[40] "Genome Known, but Meaning of Life Lost," in *Zenit: The World Seen from Rome Daily Dispatch*, November 28, 2005. Internet. Available from www.zenit.org; accessed April 11, 2007.
[41] John Paul II, "Address to a Colloquium on Science, Philosophy and Theology," September 5, 1986.

understand it.[42] Science studies this or that material cause-effect relationship; philosophy studies causality in all its forms. Science studies all the various kinds of existing physical beings; philosophy studies being, existence itself. Philosophy is so crucial that the Catholic Church considers it to be an essential part of "the normal exercise of the life of faith in human minds."[43]

A scientific bridge between science and faith would only get us back to material reality, and so could not shed light on the dogmas of faith. The dogmas of faith, being divine and mysterious, can shed light upon the meaning of material reality, but do not in any way include their own interpretation or connection to scientific discoveries. Philosophy serves as a middle ground, and it is through philosophical reflection on both material reality and ultimate reality that science and faith can find a common ground. In the next chapter we will tap into this wider wisdom and learn the philosophical principles that both distinguish and unite science and the Christian Faith and help us to understand God's relationship to the universe as Creator.

[42] Artigas, *The Mind of the Universe,* 12.
[43] John Paul II, "Address to a Colloquium."

Chapter Three

Bridging the Gap:
A Wisdom Wider than Science

How do our models of the universe affect our conception of God?
What is the Christian understanding of God as Creator?
How does human creativity help us understand God as Creator of the universe?

"Though we speak much we cannot reach the end, and the sum of our words is:
'The Lord is the ALL.'
Where shall we find strength to praise him?
For he is greater than all his works."

-Sirach 43:27-28

With these words Ben Sira (2nd cent. BC), the Jewish author of the Old Testament Book of Sirach, set a standard for Christian theology. For Christians, God is the perfect, unlimited source of all truth, goodness and beauty, and so he is able to be completely present to the universe as the cause of its existence and of all its beings, laws and physical causes. In the words of the Book of Sirach, God should be called "the All," because God is the cause of everything in a way more profound and more essential than physical, material causes.

And yet, the author of Sirach tells us, he is also greater than all his works, wholly different from them, and so cannot be understood as being and acting the way creatures are and act. God's relationship to the universe is not like the relationships his creatures have with each other. He doesn't have a "role" to play in the universe, for He is the Creator of everything in it. He is infinitely greater than all things, even as he is more intimately close to them than they are to themselves.

Other passages in Sacred Scripture make it very clear that our limited human conceptions can never fully express this mystery of God's relationship to his creatures. As St. Paul says, "He alone has endless life and lives in inaccessible light. No one has ever seen him, nor can anyone see him" (1 Tim 6:16). The prophet Isaiah makes the same point about God's mercy:

For my thoughts are not your thoughts,
neither are your ways my ways, says the LORD.
For as the heavens are higher than the earth,
so are my ways higher than your ways
and my thoughts than your thoughts. (Isaiah 55:8-9)

The humility involved in this Christian understanding of God is beautifully represented in a dialogue written in 1444 by the philosopher and theologian, bishop and cardinal, Nicholas of Cusa (1401-1464 AD). He called this work "On the Hidden God"

(*De Deo Abscondito*). In it a pagan approaches a Christian whom he finds at prayer. When the pagan asks the Christian to identify the God he worships, he receives a startling answer:

The *Pagan* spoke: I see that you have most devoutly prostrated yourself and are shedding tears of love-not hypocritical tears but heart-felt ones. Who are you, I ask?
Christian: I am a Christian.
Pagan: What are you worshipping?
Christian: God.
Pagan: Who is [this] God whom you worship?
Christian: I don't know.
Pagan: How is it that you worship so seriously that of which you have no knowledge?
Christian: Because I am without knowledge [of Him], I worship Him.[1]

The paradox is obvious—only a God who *cannot* be fully known, who is inexpressible Truth, could be the true God and worthy of our adoration. And yet this also means that God can only be known partially and imperfectly in this life. "For now we see in a mirror dimly, but then face to face. Now I know in part; then I shall understand fully, even as I have been fully understood" (1 Cor 13:12).

In this chapter, we will see how this humble approach to God was replaced by new and faulty conceptions of God during the Scientific Revolution. These conceptions ultimately led to the warfare model and to scientific atheism. Then we will consider how to return to the Christian conception with the help of the philosophy of St. Thomas Aquinas. In his thought will see that the Christian approach to God represents an important framework for science because of its respect for the integrity of creation, which is expressed in St. Thomas's distinction between divine, primary causality and the secondary causality of creatures, commonly known as *the principle of double agency*. This is the most important philosophical principle for the harmony between science and faith, and shall be explained in depth. For now, simply note that our distinction between "how" and "why" explanations will be deepened by a closer look at the concept of existence, with St. Thomas as our guide.

We will also consider a conception of God that can help us better understand God's relationship to the universe in the true, Christian sense: the relationship of an author to a novel or a play. Finally, we will move from philosophy to theology, and begin to reflect upon the Christian doctrine of God as Creator, whose only motive for causing the universe is to communicate his goodness. As we will see, God's infinite love, not merely his perfect knowledge or power, is the foundation of all things.

To begin, let's go back to the Scientific Revolution to see how a great scientific genius misunderstood God's relationship to the universe.

[1] Nicholas of Cusa, *De Deo Abscondito*, 1, 6, in Jasper Hopkins, ed. and trans., *A Miscellany on Nicholas of Cusa* (Minneapolis, MN, Arthur J. Banning Press, 1994), 300-311.

A. Scientific Atheism in Context: Newton's Laws and Newton's Flaws

1. Newton's Laws: The Man Who Embodied the Scientific Revolution

"Nature and Nature's laws lay hid in night: God said, 'Let Newton be!' and all was light." The great English poet Alexander Pope wrote this epitaph to be inscribed on the tomb of Sir Isaac Newton (1643-1727 AD), and captured in two lines the immense importance of Newton to the history of modern science. In the words of particle physicist Stephen Barr,

> …one could almost say that Sir Isaac Newton *was* the Scientific Revolution… Newton was a towering peak. There was no rival to him in physics until the twentieth century. One may think of everything that went before Newton as having set the stage for his great breakthroughs, and everything that came after him—until the twentieth century—as having exploited those breakthroughs.[2]

No student today makes it through high school without encountering Newton's *universal laws of motion* and his *universal law of gravity*. What makes these so important can be guessed from the word *universal* that is used to describe them. For the first time in history a human being had discovered laws that describe all earthly and celestial motion and that allow all physical cause and effect relationships to be understood with mathematical formulas. With Newton science broke through descriptions of individual phenomena in the material universe to a deep understanding that unified the way we think about the earth, the solar system and beyond.[3]

Unlike the apple in the famous event that first caused him to ponder the law of gravity, Newton's immense breakthrough did not fall out of the sky. His thought rested upon a shift in thinking that had already occurred in the centuries prior to his birth. Scientific pioneers whom Newton greatly admired, such as Galileo Galilei (1564-1642 AD), Johannes Kepler (1571-1630 AD) and Rene Descartes (1596-1650 AD) had found it very effective to think of the universe in mechanical and mathematical terms in order to understand it. Newton recognized that their successes came not only from their genius but because they worked from this kind of approach, and so he set out to describe all natural phenomena the way one might describe a clock or an engine.[4] His enormous success set science firmly upon this path of mechanical thinking, a path it was to follow exclusively for more than a century and a half.

Thinking of the universe as a machine is a great example of *scientific modeling*, a process by which scientific thinkers use something they understand to model things they do not understand. In this case Newton and his predecessors chose for their model the mechanical clock, one of the greatest technological innovations of medieval European culture, a device that that could tick away accurately for years thanks to its hidden gears,

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[2] Stephen M. Barr, *A Student's Guide to Natural Science* (Wilmington, DE: ISI Books, 2006), 33.
[3] Ibid., 34-42.
[4] Amos Funkenstein, *Theology and the Scientific Imagination: From the Middle Ages to the Seventeenth Century* (Princeton, NJ: Princeton University Press, 1986), 30.

cogs and wheels. It was a stroke of genius, and the mechanistic "clock" conception of the universe greatly benefited every area of the natural sciences. For example, much of what we know about anatomy comes from modeling living organisms as machines, an idea first proposed by Rene Descartes (1596-1650 AD).[5] In the words of Lawrence Principe, "In living organisms, the levers and pulleys were to be revealed by anatomy and the new microscope. Individual organs became mechanical devices; the heart, a pump, the kidneys, filters, and indeed the whole body, a mass of plumbing and rigging."[6]

But while extremely helpful, a scientific model is merely that; a model. The universe is not a machine, nor is a living organism, even though they both have qualities that can be modeled as such. No one model can capture everything about the universe, nor should a scientific model of the universe be simply turned into a theological model. But this is something that is easy to overlook, as even the great Isaac Newton unfortunately did.

2. Newton's Flaws and the Rise of Scientific Atheism

For all his greatness as a scientist, Newton was much less gifted as a theologian. A devoutly religious man who wanted to speak of God as insightfully as he spoke of the universe, Newton unwisely adopted the same approach in theology as he did in science. Just as he described the universe using the model of a clocklike machine, he described God as an all-powerful clockmaker, engineer or mechanic, one whose primary connection to all things was that of a craftsman who puts parts together in ingenious designs.[7] He believed that God did this through the instrument of space, and that He occasionally had to "rewind" the clock of the universe, giving the planets occasional adjustments to keep them in line in their orbits around the sun.[8] He insisted that the universe occupied infinite space and time, and if there were ever a time that space did not exist, then neither would God have existed.[9] This made the Creator of space dependent upon the existence of space, which is absurd.

Newton also involved God in the universe by reference to gravity. Gravity involves the immediate action of things upon each other without physical contact, which is not how machines worked in Newton's day. So Newton supposed that gravity was a force produced by God acting directly within the universe.[10] This gave God a constant role in the universe and seemed to be irrefutable evidence against atheism, evidence that would later be explained away when Einstein showed that gravity is not a force but is the effect of the curvature of space and time upon material objects.

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[5] Rene Descartes, *Meditations on First Philosophy*, med. 6.
[6] Lawrence Principe, "God the Watchmaker" Lecture, *Science and Religion*.
[7] Funkenstein, 96.
[8] Ibid., 95.
[9] Christopher Insole, "Kant's Transcendental Idealism and Newton's Divine Sensorium," *Journal of the History of Ideas* 72:3 (2011): 416-417, quoting Isaac Newton, "De Gravitatione et Aequipondio Fluidorum" (1684/85), 89-169, in *Unpublished Scientific Papers of Isaac Newton*, ed. Rupert Hall and Marie Boas Hall (Cambridge: Cambridge University Press, 1962).
[10] Funkenstein, 94.

Newton's flawed theological thinking would become almost as influential as his scientific breakthroughs. As later scientists began to be able to explain things that Newton could not, they imagined that they had replaced God with natural explanations. Actually, they had just squeezed Newton's clockmaker God out of the gaps where Newton had placed him. So, for example, the great French scientist Pierre Simon Laplace (1749-1827), when asked by his emperor, Napoleon Bonaparte, about why he never mentioned the Creator in his five volume work on astronomy and celestial mechanics, responded: "Sire, I had no need of that hypothesis."

Another gap was closed in 1859 when a natural explanation for living things was given by Charles Darwin and his evolutionary biology. Up to that time, many thought that the origins of living things required divine miraculous intervention, a clockmaker who not only put parts together but who mysteriously made his machines capable of sense and motion. It seemed to many that God's existence had been challenged, that God no longer had a "role" to fill. Eight years after Darwin first published his theory, the atheist poet Matthew Arnold would mourn the loss of faith in his poem "Dover Beach," comparing it to the ebbing away of seawater at low tide:

The Sea of Faith
Was once, too, at the full, and round earth's shore
Lay like the folds of a bright girdle furled.
But now I only hear
Its melancholy, long, withdrawing roar,
Retreating, to the breath
Of the night-wind, down the vast edges drear
And naked shingles of the world.[11]

And yet the only thing that had really been challenged by these new scientific discoveries was the role Newton and others had assigned to God *within* the universe. Newton's clockmaker God is much different than the Christian understanding. As we saw above, traditional Christian thought saw God as entirely other and different than the universe, not filling any physical roles but causing all things to exist. But for Newton and many to follow, God was assumed to be an explanation for *how* the universe works. As we learned in Chapter One, this is bad theology. In the words of St. John Paul II: "The theological teaching of the Bible, like the doctrine of the Church… does not seek so much to teach us the *how* of things, as rather the *why* of things."[12]

Over the rest of the seventeenth and through the following two centuries, radical new theologies began to emerge, all based upon the error of trying to make God fit the mechanistic model of the universe. Some adopted *deism*, putting God at the beginning of the universe to set up the machine and then restricting God's present action simply to legislating values and morality, and his future action to the punishment and reward of

[11] Matthew Arnold, "Dover Beach" (1867), accessed on October 9, 2017, https://www.poetryfoundation.org/poems/43588/dover-beach.
[12] St. John Paul II, "Address to a Colloquium," September 5, 1986.

behavior in the afterlife. Other thinkers began to merge God and the universe, a belief system called *pantheism*, modeling the universe as God's body. But these half-baked theologies were easily debunked, and the descent of Western culture into widespread materialism, reductionism and atheism began.

What had happened can easily be summarized: *Newton and his followers had turned his model of the universe into a mentality, reducing all of reality, including God, to fit into the mold of his mechanical model.* The machine model fits the goals of science very well, and even today remains essential to science, but it was too small for theology. Despite his unlimited power, Newton's God is a tiny God, acting the way natural beings and forces act.

Newton failed to recognize that the truth about God requires that we recognize the limitations of our theological models. Ironically, even the truth about the universe requires more than is offered by the mechanistic model, as would be discovered in the profound scientific achievements of the twentieth century. Science has pushed beyond the confines of a single model in a way that hearkens back to conceptions of the universe that were rejected in the Scientific Revolution, as we will see later. But for now, let's examine a different way of modeling God's relationship to the universe than the mechanistic theology of Newton.

B. Expanded Wisdom: Connecting the Cosmos to the Creator

1. The Art of Analogy

How can we model God's relationship to the universe in a way that respects the integrity of the natural world and also does justice to what God has revealed to us about Himself? Since God is greater than the universe and everything in it, we can only do so by creating a limited comparison, in which there are similarities but also differences. Such a comparison is called an *analogy*. An analogy exists when a term that is shared by two or more subjects, such as beauty, strength or goodness, is used to show some similarity between them.[13] Every analogy involves both similarity and difference; what makes any analogy a good analogy is awareness not only of the similarity it reveals, but also the difference between the things compared. This is especially true of theological analogies; God is infinitely greater than any of his creatures, and so the dissimilarity between God and creatures will always be greater than the similarity.

Our faith teaches that there are real similarities between God and creatures, and so Christian theology thrives on finding good *analogues*, things comparable to God, among creatures, using them to explore divine mysteries. Sacred Scripture itself engages in numerous analogies in which the characteristics of God's creatures are used to help reveal something about God. In the Book of Wisdom, beauty in nature is given as a quality that is *analogous*, similar to, divine beauty: "For from the greatness and the beauty of created things their original author, *by analogy*, is seen" (Wisdom 13:5). In other words, there are things in the world that delight us by their beauty and grandeur. *By*

[13] W. Norris Clarke, *The One and the Many: A Contemporary Thomistic Metaphysics* (Notre Dame: University of Notre Dame Press, 2001), 46.

analogy, these things show us God who is the "author of beauty," although only imperfectly: "far more excellent is the Lord than these" (Wisdom 13:3).

Returning momentarily to Newton and the many who followed him, we can say that the real problem with their mechanic model of God is that they did not limit their suggestion of similarity with the recognition of difference. They had what is called a *univocal* conception of God, in which they claimed to describe God *in the same way* one might describe an apple tree or a galaxy. In their univocal theology, God is not like an all-powerful engineer, he *actually is* an all-powerful engineer who puts things together and maintains them the way human engineers do. Had Newton used the engineer model of God as an analogy, that would've been fine. As we saw in Chapter One, the incredible order we see in the universe is the product of the wisdom of God, and so it is helpful to think of God as the source of order in the way a sophisticated machine is the product of the genius of a great mechanic, inventor or engineer. The problem is not the model Newton used. The problem was his expansion of that model into a literal description. An analogical, Christian approach is humble before the mystery of God, suggesting insights but never total comprehension. A univocal approach tries to *resolve* the mystery of God into something fully understood by the human mind. The art of analogy is the only art by which we can begin to understand God as well as acknowledge that he is ineffable, inexpressible Truth.

In order to create a proper analogy between God and creatures, we must note the infinite difference between them. To grasp that difference, we must go all the way down, beyond nature, to the very concept of existence. To do so, we need the help of a wisdom wider than science, the wisdom of philosophy.

2. Philosophy and Existence: The Principle of Double Agency

So far in this book I have offered the "how" and "why" distinction several times between the knowledge science gives about the universe and the knowledge faith, religion and theology give. But philosophy offers a second kind of knowledge about God and the universe—God is not only the "why" behind the universe but also the reason "that" it exists at all. God is "He who Is," and as such he causes all things that exist to exist. So in order to think about God, we must ask the question, "What is existence?" Thankfully, philosophy tackles this question as its primary object of study.

Existence is the first, most fundamental "property" of every being, which is why we call them "beings". Even something I imagine, such as a unicorn has a kind of existence – the unicorn exists as something thought and imagined by human beings – it has *mental being*. My dog Sophie, by contrast, is not simply something I imagine –she has *real being*. The first and most basic thing about Sophie, the one thing she shares in common with the whole universe and everything in it, is obviously not her cuteness nor her dogginess. It is her *existence*, her *being* – if Sophie did not exist she would not be a part of the universe at all. All things, even thoughts, are connected by existence and share in it as a common characteristic in different ways. Whatever else a thing is, it is only *what* it is *because* it is. *If you can say something true about being, about existence, then you have said something true about every existing thing in a single statement.*

Sophie has real being, but she *is not* Being. If Sophie were Being itself, then she would have always existed, and everything that ever existed would have to share in, or participate in, Sophie! But there was a time not long ago when Sophie did not exist. Her being is something that she *has*, not something she *is*. And she did not give existence to herself – she exists "only if" she is given existence. Existence comes to all things from without – it is like a gift.

You may be asking, "What is "existence in itself"? A being like Sophie is something that *has* being, but what *is* Being? From where do all beings get their existence? To be Being Itself is to exist necessarily, and to be the uncaused Cause, the source of being for all things, because all things do not and cannot give themselves existence. It is "the infinite fullness of pure unlimited existence, and the one ultimate Source of all being."[14] It would be, in fact it is, God. *God is Being subsisting in itself.* We are not far from theology here; this philosophical insight is also revealed in Sacred Scripture. When Moses asks God for his name, the Lord responds, "I AM THAT I AM" (Exodus 3:14). And when the Son of God becomes incarnate, he tells those Jews who were skeptical of his authority, "Amen, Amen, I tell you, before Abraham came to be, I AM" (John 8:58).

Above and beyond any other consideration, the most basic relationship between God and the universe is that God is the Giver of existence to all things. God is not simply perfect. He makes all things, and all the perfections of those things, *real*. This means that God truly does cause all things, but not in the way Newton supposed. He causes them not by crafting them but by thinking of them and so willing them to exist.

The great philosopher who most fully developed this insight to explain God's relationship to the universe was St. Thomas Aquinas (1224/25-1274 AD). According to St. Thomas, God causes all things to be, and so God should be called the *Primary Cause*. But in causing all things to be, God causes them in such a way that they are able to be causes of each other in various ways. For example, parents are the real biological causes of their offspring's bodies, giving them a particular *kind* of existence as this or that kind of animal. But it is God who gives *being* to both the parents and their offspring. God causes all dogs to be real, but Sophie's dog parents really did cause Sophie to be the kind of dog she is. The universe is made up of *secondary causes*, the very kinds of causes studied by scientists. St. Thomas taught that God set things up this way so that creatures could share in his own goodness, by being causes like (but not exactly like!) God Himself: "the first cause, by the preeminence of its goodness, gives other beings not only their existence, but also their existence as causes."[15]

This means that, for every cause and effect relationship in the universe, there are at least two causes, God the Primary Cause and whatever secondary cause or causes are involved. It also means that God and those secondary causes can really be called causes, but only in entirely different ways, such that they are *never* in competition with each other. This is called *the principle of double agency*. St. Thomas explains this in his great work, the *Summa contra Gentiles*:

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[14] Clarke, 87.
[15] St. Thomas Aquinas, *De veritate* 11.1.

> [An] effect is not attributed to a natural cause and to divine power in such a way that it is partly done by God, and partly by the natural agent; rather, it is wholly done by both… [for the] same God who transcends the created order is also intimately and immanently present within that order as upholding all causes in their causing.[16]

The key words in this quote are "wholly done by both" – God causes things in a way that no creature can cause them, and creatures cause things in their own genuine way that is *really and truly their own*. God is not the source of "how" answers about the universe; "how" questions can only be answered by his creatures. Likewise, no creature can answer the question of its very existence; that question can only be answered by God the Creator. God holds all creatures in being even as they cause each other.

We might be tempted to ask, "*How* does God cause creatures to exist and the universe to be real?" But this is dead-end thinking. "How" answers involve processes that occur in time and can be studied by science. But God is eternal and unchanging; time is something he creates; his reality is a perfect *NOW* with no past or future. In his perfect eternity God wills his creatures to be, and because he does so, they are. No process is involved in divine creation, as we will see in more detail later. As St. Thomas says, God is "the cause hidden from every human being."[17]

St. Thomas explains God's relationship to the natural world with an analogy which brings to mind Newton's clockmaker/mechanic model of God but with a crucial difference: "Hence it is clear that nature is nothing but a certain kind of art, i.e. the divine art, impressed upon things… It is as if the shipbuilder were able to give to timbers that by which they would move themselves to take the form of a ship."[18] Here God is not inserted as a "how" answer, as he is in Newton's theology; St. Thomas does not give God a role in "building" the universe. Instead, creatures (pictured here as timbers) are caused to exist by God with the ability to bring about what God intends.

In another work St. Thomas uses the analogy of a great teacher to explain why it is fitting that God makes the world in such a way that its cause and effect relationships are real:

> …it is a greater perfection for a thing to be good in itself and also the cause of goodness in others, than only to be good in itself. Therefore God so governs things that He makes some of them to be causes of others…; as a teacher, who not only imparts knowledge to his pupils, but also gives them the capacity to teach others.[19]

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[16] St. Thomas Aquinas, *Summa contra Gentiles* III.70.8.
[17] Ibid., III.101.1.
[18] St. Thomas Aquinas, *In Physicorum*, II.8.14, no. 268.
[19] St. Thomas Aquinas, *Summa Theologiae* I.103.6 resp.

From God's perspective, it wasn't enough for him to cause creatures to exist; he wanted to establish them in real causal relationships with each other. And so, unlike Newton, St. Thomas recognizes that God is not the cause of this or that, but of "the All," establishing the universe as a vast system of real causes and effects, all with their own integrity. The cosmos is not a thing that God must maintain by interference, nor by miraculously producing this or that natural phenomenon.

We can now see how the philosophy of St. Thomas is so hospitable to science. The principle of double agency preserves scientific and theological explanations from bleeding into, substituting for, or competing with, each other. Scientists rightly become upset when believers try to stick God into the processes of the universe as a "how" explanation; recall Richard Lewontin's commitment to materialism to avoid the "Divine Foot in the door" which we learned about in Chapter Two. And yet materialism is not necessary to protect the integrity of the natural world. In the Christian understanding, God is the cause of the existence, the reality, of all things, not an all-powerful, magical substitute for natural causes. He answers the ultimate questions: "Why does anything exist at all?" "Why is the universe orderly and yet open?"; not questions like "How did mammals evolve?," or "How did the universe develop during the Big Bang?" Science takes care of those, and the more science can explain, the more it shows God's mjesty as Creator.

For their part, many believers become upset when atheists like Christopher Hitchens reject the existence of God because they assume that science has squeezed God out of the gaps in our knowledge of how the universe works. "Thanks to the telescope and the microscope, religion no longer offers an explanation of anything important," declares Hitchens, as if that settles everything.[20] That is a problem for Newton's God, but not the God of Christianity. If we truly understand God in St. Thomas' way we would expect, like the Christian in Nicholas of Cusa's dialogue, not a God who explains this or that natural phenomenon, but who, beyond our greatest genius and wildest dreams, is the ultimate reason for the existence of all things, constantly upholding them in being, allowing and enabling them to cause each other in a beautiful, sometimes perplexing, always amazing, universe. Any being that could be detected with Hitchens' telescope or microscope would be too small to be Truth and Being Itself.

3. The Mind of the Maker: God as Playwright

As noted above, no one analogy can be fully sufficient for understanding the Creator. So let's add another analogy to our repertoire that highlights God as the ALL and greater than everything he has made. Here it is: As a playwright is the author of a play, so God is creator of the universe. The mystery of imagination involved in creating a play has much to add to our understanding of God the Creator.

A playwright creates a play not primarily through physical activity, but by conceiving of it in his/her mind. Whether or not the play is ever written, it exists in the mind of the playwright. By causing the play and everything within it to exist through

[20] Christopher Hitchens, *God is Not Great: How Religion Poisons Everything* (New York: Hatchette Book Group, 2009), 282.

creative genius, a playwright like Shakespeare makes a world that we also can mentally inhabit, characters we can love or hate, cause and effect relationships that sometimes delight, sometimes shock or sadden. Therefore, the playwright is "the All" to his play; nothing of it would be were it not for the playwright. Every part of it is conceived by him; he is the origin of it in its entirety. In a similar, but much greater way, God is Creator of the universe by thinking it into existence in its entirety. In the words of St. John the Evangelist, "All things came to be through him, and without him nothing came to be" (John 1:3).

Yet from the perspective of its events and characters, a play also has a real independence from the playwright's mind, it can be thought about and studied and enjoyed by anyone who reads it or sees it performed, without even knowing who wrote it. The things that happen in the play have their own real causes within the play. It makes no sense to ask, "Did Juliet accept Romeo's offer of marriage because Shakespeare wrote the play that way, or because she freely chose Romeo to be her husband?" These are two very different questions, and they must be answered separately. Shakespeare did not accept Romeo's offer of marriage; Juliet did so herself. But Shakespeare did conceive of Romeo and Juliet as well as their love for each other.

In a similar way, the universe has a real existence distinct from God. It has real cause-and-effect relationships that can be understood in their own right. It makes no sense to say, "Did the Big Bang cause the universe, or did God cause the universe?" Both explain the universe in their own way; or, as St. Thomas might say, "the universe is wholly done by both." The event of the Big Bang is the beginning of the universe in time but God is the origin of the universe from eternity.

Just as a playwright is the "All" to his play, he is also greater than his play and everything in it. The internal time of the play has no application to the activity of the author. Shakespeare's wedding, for example, has no place in *Romeo and Juliet*. Even his creation of the play, his invention of the characters, his thinking out the plot, etc., are not part of the play; they make the play possible, they aren't scenes within it. Also, the playwright can write other plays, create different characters, etc.[21] In a similar way, God is not dependent upon the universe in any way; rather, it is entirely dependent on him. God's own inner life is the perfect fullness of existence, and creation is the sharing in his perfections out of the infinite abundance of his love.

As we said above, no analogy is properly understood if we note similarity without also noting difference. So let's note some very important differences between a playwright and his/her play, on the one hand, and God and the universe on the other. For one thing, it takes time for a playwright to produce a play. But God is eternal; time is a part of his universe, but he is outside of time. To conceive of his play a playwright must use his/her brain, with neurons firing across synapses. The brain is the first "instrument" used to produce the play. But God has no physical parts; he is Perfect Truth, creating the universe simply by knowing and willing it. To communicate his play a playwright must take up a quill or type on a keyboard – both physical activities. But physical activity is

[21] Barr, *Believing Scientist*, 124-126.

something that is part of creation, not of the Creator, who is pure Spirit. God simply wills it, and the universe and all creatures exist.

Moving to theology, there are other differences that can be appreciated in the light of what God has revealed. First, while the saga of *Romeo and Juliet* is completely dependent on Shakespeare, as history and the universe are upon God, Shakespeare is not part of his play. Yet the Author of the universe has not created a story in which He is not involved. The climax of history is the moment when He enters the universe, when God becomes man in Jesus Christ. And the fulfillment of history will be when Jesus returns in glory. This brings out another important difference: unlike the story of *Romeo and Juliet*, the play of the universe is an unfinished one – for humanity, the last drama has yet to occur.

Another difference is that the characters in *Romeo and Juliet* do not have the ability to read their own story. They only think, feel, and act in imagination – when the story is not being written or read or at least thought about, they do not exist as anything but ink on a page. But the amazing characters in our story – real human beings – do have the ability to read their own story. We can both participate in the drama of the universe, but can also read that drama through reflection, understanding it through science, philosophy and theology. We are in the story but not entirely of the story – we can both live it and know it, although only imperfectly, because the "play" of the universe has not yet reached its conclusion.

Finally, God has revealed the reason why he is authoring the universe, the greatest secret of all—his desire to communicate his goodness to us and to unite us to himself in love. This is the widest wisdom—it is at the heart of the Christian doctrine of creation, to which we now turn.

C. The Widest Wisdom: The Christian Doctrine of Creation

The doctrine of creation refers to God, in absolute love, power and wisdom, bringing into being things distinct from himself. Creation is the beginning of God's revelation of himself, in which his reality is manifested to his creatures in their very coming to be and continuing in existence. It is the basis of all other Christian doctrines, and is referenced in the very first line of the Christian profession of faith, the Nicene Creed which is professed every Sunday in the Mass: "I believe in one God, the Father almighty, maker of heaven and earth, of all things visible and invisible."

The Christian belief in a Creator God has four distinctive elements. First, Christians believe that God creates the world *ex nihilo*, "from nothing." Second, Christians believe that God creates the world *cum tempore*, "with time." Third, Christians believe that God creates the world *cum libertate*, "freely." Finally, Christians believe that the world is created *ex Trinitate*, "by the Trinity," that is by all three divine Persons equally.

These elements of the Christian doctrine of creation have been solemnly professed and defined by the Catholic Church at three ecumenical councils: Lateran IV in 1215 AD, Florence in 1442 AD, and Vatican I in 1869-1970 AD. *Ecumenical councils* are assemblies at which bishops from the whole world come together to authoritatively teach regarding matters of faith and morals – there have been only 21 in the two

millennia of Church history. Catholics recognize the bishops gathered in councils by the pope as having "the charism of infallibility" from the Holy Spirit. Thanks to this grace, bishops assembled in ecumenical councils together exercise freedom from error in matters of faith and morals, and their teaching requires the unswerving "assent of faith" since God has definitively spoken through them.[22] Therefore, the four elements listed above are integral to the Christian Faith and are divinely revealed truths. Let's look at each element to theologically complete the philosophical understanding we have achieved so far.

1. Creation, Not Change: Creation ex nihilo

I have sharply distinguished between "how" and "why" questions and answers throughout the first few chapters of this book. The reason for this distinction is the Christian doctrine of creation *ex nihilo* – "from nothing." God uses no preexisting material to create the universe, so no "how" explanations are possible; his act of creation causes matter, space, time and even the very laws which govern the universe to exist, and without him, there would literally be "no thing" whatsoever. In the words of Lateran IV,

> We firmly believe and openly confess that there is only one true God… [who is] the one principle of the universe, Creator of all things invisible and visible, spiritual and corporeal, who from the beginning of time and by His omnipotent power *made from nothing* creatures both spiritual and corporeal, angelic, namely, and mundane, and then human, as it were, common, composed of spirit and body.[23]

Creation *ex nihilo* is not a change. Every change involves going from one real state to another, as when a sperm and ova unite and cease existing, contributing their genetic material to an entirely new state of being, an embryo. The Big Bang may have been a change from one state to another through an explosion. But in the divine act of creation, God causes something to exist out of nothing, and nothing is, by definition, not a state of being. In the words of philosopher William Carroll, "Whenever there is a change there must be something that changes… [by contrast Divine] [c]reation… is the radical causing of the whole existence of whatever exists… any thing left entirely to itself, wholly separated from the cause of its existence, would be absolutely nothing."[24]

No one captured this mystery more beautifully than G.K. Chesterton:

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[22] CCC 888-892.

[23] Paul Halsall, ed., "The Canons of the Fourth Lateran Council (1215 AD)," *Medieval Sourcebook: Twelfth Ecumenical Council: Lateran IV 1215*, can. 1, accessed November 17 2017, https://sourcebooks.fordham.edu/basis/lateran4.asp.

[24] William E. Carroll, "Creation, Evolution, and Thomas Aquinas," Catholic Education Resource Center, accessed October 24, 2017, https://www.catholiceducation.org/en/science/faith-and-science/creation-evolution-and-thomas-aquinas.html.

> A child kicks his legs rhythmically through excess, not absence, of life. Because children have abounding vitality, because they are in spirit fierce and free, therefore they want things repeated and unchanged. They always say, "Do it again"; and the grownup person does it again until he is nearly dead. For grownup people are not strong enough to exult in monotony. *But perhaps God is strong enough to exult in monotony.* It is possible that God says every morning, "Do it again" to the sun; and every evening, "Do it again" to the moon. It may not be automatic necessity that makes all daisies alike; it may be that God makes every daisy separately, but has never got tired of making them. It may be that He has the eternal appetite of infancy; for we have sinned and grown old, and our Father is younger than we.[25]

Chesterton's poetic imagery is true—with unlimited Divine youthfulness and energy God creates every daisy, causes every sunrise, because God is holding all things in existence through his perfect, eternal act of creation *ex nihilo*. In the words of the Letter to the Hebrews, "By faith we understand that the worlds were prepared by the word of God, so that what is seen was made from things that are not visible" (Hebrews 11:3).

2. From Beginning to End: Creation cum tempore

Along with creation *ex nihilo*, the Church's doctrine of creation includes the assertion that the universe was created "with time." In the words of Lateran IV above, which were repeated by Vatican I, God creates "from the beginning of time." This phrase should be interpreted as identifying *every moment* as the result of the divine act of creation. Since God is outside of time, then his creative act is itself timeless. The terms "with time" (*cum tempore*) has also been used by the Church and her theologians to emphasize that time only exists in relation to creatures, not God. It is a feature of the universe, and is itself created.[26]

Creation *cum tempore* means that every moment is the moment of creation, from the first moment of the universe's existence until now. All things are being brought into existence out of nothing by God *right now*. For God who is outside of time, to create at the first moment of the universe is no different than what God is doing at this moment. Right now, as much as at any time in the past, God is saying "Let there be light," "Let the earth teem with living things," etc. God's act of creation is not a historical event that happens within time, at its beginning, but a metaphysical reality describing the universe's dependence on God's eternal act of creating, which is outside of time.[27]

Sacred Scripture often refers to "the beginning" to indicate this element of creation (Genesis 1:1; Sirach 16:16; John 1:1). It also refers to God as existing and acting "before the foundation of the world" (John 17:24; Eph 1:4; 1 Peter 1:20). This phrase should be interpreted carefully, lest it lead us to assume that God is in time, rather than

[25] G.K. Chesterton, *Orthodoxy*, Moody Classics new ed. (Chicago: Moody Publishers, 2009), 92.
[26] Haffner, 52.
[27] Austriaco, et al., *Thomistic Evolution*, 65-66.

the Creator of it. God as "the beginning" is not pointing to something God did "back then," but to God as the timeless origin of all things. The Big Bang is not the moment of creation. Rather, the Big Bang, the present moment, every moment in between them and to come are all equally the moments of creation.

To help us understand this, recall our playwright analogy. The opening lines of Shakespeare's *Romeo and Juliet* are: "Two households, both alike in dignity, In fair Verona, where we lay our scene, From ancient grudge break to new mutiny, Where civil blood makes civil hands unclean." That is the *beginning* of *Romeo and Juliet*; it references a point in time when the play begins in Shakespeare's fictional Verona. But Shakespeare is the *origin* of those lines and everything else in *Romeo and Juliet*. When Sacred Scripture speaks of God acting "in the beginning" or before it, it is pointing to God as origin of the universe and history, not to some moment in the past.

It is a doctrine of the Christian Faith that the universe has a temporal beginning, as indicated by the words "at the beginning of time" quoted above from Lateran IV. This is a topic we will consider in Chapter Seven. But creation *cum tempore* refers primarily to the fact that God is outside of time, and all times rely on him as their origin. Even if the universe had no first moment, it would still be a temporal universe, and would still rely on God for its existence.

3. A Freely Created Universe: Creation cum libertate

In the First Creation Account we read that God said, "Let us make humankind in our image, according to our likeness…" (Gen 1:26). This very human image of God mulling over the prospect of making human beings, points to divine freedom, that God freely created humans and the entire universe. In the words of Psalm 135:6-7. Whatever the LORD pleases he does, in heaven and on earth, in the seas and all deeps." In the words of Vatican I,

> [The] one true God, by his goodness and almighty power, [brought things into being] not with the intention of increasing his happiness, nor indeed of obtaining happiness, but in order to manifest his perfection by the good things which he bestows on what he creates, [but] by *an absolutely free plan*…[28]

Let's reflect on what this implies. First of all, it means that God is free either to create the cosmos or not create it. It also means that God is not obligated to create the best possible world. God is not forced to create one possible universe out of all possible universes because it is "best." This shows God's radical difference from us – as creatures with a capacity to develop towards perfection, there is always a tendency to choose the best, and choosing the best is always preferable and sometimes morally necessary. But God cannot and is not perfected through creating—he is already perfect Goodness. Also, the idea of "the best world" is very deceptive. No matter what exists, a better world could always be imagined unless the world was absolutely perfect, at which point it would

[28] Vatican I, Dogmatic Constitution *Dei Filius* on the Catholic Faith, chap. 1, no. 2-3, accessed November 15, 2017, https://www.ewtn.com/library/councils/v1.htm#4.

simply be identical to God.[29] This will be important when we consider the reality of evil in Chapter Six.

The important distinction to make here is between the act of creation and the product of that act, which is the universe and all things, including human beings and angels. The act of creation is perfect because it is divine. But the object resulting from the act of creation, insofar as it is finite, is therefore imperfect. So the universe is imperfect, but it corresponds perfectly to what God freely willed to create.[30] Furthermore, God has pledged himself to bringing his creation to its fullest possible perfection. In the words of the *Catechism,*

> With infinite power God could always create something better. But with infinite wisdom and goodness God freely willed to create a world "in a state of journeying" towards its ultimate perfection. In God's plan this process of becoming involves the appearance of certain beings and the disappearance of others, the existence of the more perfect alongside the less perfect, both constructive and destructive forces of nature. With physical good there exists also physical evil as long as creation has not reached perfection.[31]

The perfect freedom by which God creates also means that the universe was created out of love. God who is Love (1 John 4:8) chose to make this universe, and did so without being under any coercion. The International Theological Commission, the pope's theological "think-tank," emphasizes the personal nature of this free choice of God, who makes it all for humanity: "[The doctrine of Creation] teach[es] us that the existing universe is the setting for a radically personal drama, in which the triune Creator calls out of nothingness those to whom He then calls out in love."[32] This brings us to our final element.

4. Love is the Reason: Creation ex Trinitate

For the world to have its beginning in God the Creator means that it has its origin from the Trinity. Not simply from the Father – the Father, Son and Holy Spirit create together. In the words of the Council of Florence,

> Most firmly [this council] believes, professes and preaches that *the one true God, Father, Son and Holy Spirit, is the creator of all things that are*, visible and invisible, who, when he willed it, made from his own goodness all creatures, both spiritual and corporeal, good indeed because they are made by the supreme good,

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[29] Haffner, 56-57
[30] Ibid., 57.
[31] *CCC* no. 310.
[32] International Theological Commission, "Communion and Stewardship: Human Persons Created in the Image of God," July 23, 2004, no. 66, accessed October 24, 2017, http://www.vatican.va/roman_curia/congregations/cfaith/cti_documents/rc_con_cfaith_doc_20040723_communion-stewardship_en.html. (Hereafter referred to as C&S.)

> but changeable because they are made from nothing, and it asserts that *there is no nature of evil* because every nature, in so far as it is a nature, is good.[33]

In Chapter One I related the universe's order and openness that we see through science to the work of the Son and the Spirit. The Son-*Logos* is the "Mind" or "Reason" to whom we attribute the orderliness of the universe. The Holy Spirit, the Gift-Love of God, is the source of its openness. To the Father, who eternally begets the Son and from whom the Spirit eternally proceeds, is attributed the very power by which the universe exists.

The Holy Trinity is a perfect communion of love, which means that the universe is the product of divine love and is good. St. Thomas Aquinas teaches that there are two kinds of love, the love that is justice and the love that is mercy. This distinction is very helpful in understanding what kind of love God manifests by creating the universe:

> When a person's love is caused by the goodness of the one he loves, then that person loves out of justice - it is just that he love such a person. When, however, love causes goodness in the beloved, then it is a love springing from mercy. The love with which God loves us produces goodness in us; hence mercy is… *the root of divine love*…[34]

Justice is the giving to another what is due to them. When I love and respect a great person such as a saint, I am not being merciful to them; I am being just. Similarly, when I give my children my time and attention, I am not being merciful to them, I am simply being just to them – I am giving them what is theirs by right. These things can be called love, but this is loving out of justice, because love is what is due. In these cases, those who receive love have a right to it.

But what about when I forgive an offense committed against me and am friendly to a person who has hurt me? When I refuse to retaliate with insult or injury and instead, offer a kind word? Or when I give to the poor, helping them to have a better life? That is a love that axtually causes goodness where it is absent, "a love springing from mercy."

But nothing can be good unless it exists, and nothing is owed to something that doesn't exist. As we have already seen, God creates the universe *ex nihilo*, out of nothing. He causes good things to exist not out of any justice to them, but out of something like mercy. Therefore divine mercy, "the root of divine love," is the reason for the universe and everything in it. The great English mystic Julian of Norwich portrays this beautifully in a vision she was given in prayer:

> The Holy Spirit showed me a little thing, the size of a hazelnut, lying in the palm of my hand, and to my understanding it was as round as any ball. I looked upon it and thought, "What may this be?" And I was answered, "It is everything that

[33] Ecumenical Council of Florence, *Bull of Union With the Copts* (1442 AD), accessed November 15, 2017, http://www.ewtn.com/library/COUNCILS/FLORENCE.HTM.
[34] St. Thomas Aquinas, *In Eph.* 2.2.

> exists." I marveled how it could endure, for I thought it would certainly fall into nothingness because of its littleness. And I was answered, ***"It lasts and always shall, because God loves it, and all things have being through the love of God."***[35]

Creation *ex Trinitate* is the heart of the Christian doctrine of creation. Nothing is unless it is created, and everything created exists because of God's inexhaustible, merciful love. Machinists sometimes create because they have some need, as do some playwrights. But God had no need to create, no hunger to fill by creating. Rather, the universe is the product of love overflowing, and merciful love is therefore the foundation and deepest meaning of all things, the same mercy with which the world is redeemed by Christ on the Cross.

D. Moving Beyond Machinery: Science After Isaac Newton

As a final note to this chapter, we should recognize that, just as we have moved beyond Newton's simplistic machine-maker model of God, science has moved beyond the mechanistic model of the universe. Scientific discoveries in the centuries since Newton, and especially the twentieth century, have revealed features of the universe that show the limits of Newton's conception.

One of the great challenges to the sufficiency of the mechanical model is the Big Bang Theory, which describes the universe as arising from an initial "singularity" in which the laws of physics did not apply. Newton's description of the universe in terms of mathematical laws, therefore, cannot describe how the universe was composed at its beginning, only what it became through the Big Bang. The fact that the universe's laws are not simply necessary but are as dependent upon certain events as the universe is itself means that, to get back to the temporal beginning of the universe, it is necessary to think beyond actualities and begin to think about potentialities.

The Greek philosopher Aristotle (384-322 BC), and St. Thomas Aquinas following him, theorized that to understand how things are caused we must not only consider how they affect each other (as in the mechanical model) but also of a fundamental potentiality he called *material causality*. Material causality explains why a thing can change into another that is entirely different, as when a living animal dies and becomes a carcass or corpse.[36] The Big Bang requires that we think about the universe not just for what it is but for what it could have been had things happened differently, which means that material causality has a role to play.

Another challenge that modern science poses to the mechanical model is the phenomenon of emergence that we briefly discussed in Chapter One. The theory of emergence implies that, at both non-living and living levels of the universe, certain features can be found that cannot be explained simply by reference to parts working together as they do in a machine. This is especially true of living things, in which we find

[35] Julian of Norwich, *Revelations of Divine Love*, chap. 5.
[36] Michael J. Dodds, *Unlocking Divine Action: Contemporary Science and Thomas Aquinas* (Washington D.C.: Catholic University of America Press, 2012),

cells running the construction of other cells according to the instructions recorded within the genome of the organism, something that cannot be fully explained by reference to the parts of the cells doing the construction.[37] Thanks to the new ability to map entire *genomes*, complete sets of genetic material present in cells or organisms, it is now clear that a genome is not a mechanical toolkit or instruction manual for parts. From this discovery has come a whole new approach to biology called *systems biology*, which describes organisms as dynamic systems rather than machines, and which focuses on studying whole organisms from the top-down, not merely from the bottom-up.[38]

To better conceive of this, consider an orchestra. It has many players and their instruments as parts of the orchestra. But to play together harmoniously, the musicians require a conductor. The formal cause is just such a conductor, "arranging" the parts in their interactions and harmony. Systems biology raises the question of what conducts the orchestra of a living biological system.[39]

Aristotle and St. Thomas recognized that things have real natures that determine their parts and how the parts interact. They called this *formal causality*, because the form (or essential nature) of the organism has an important role in determining what the organism is and how its parts operate. This is a top-down causality—the thing is not simply made what it is by its parts (bottom-up), but its parts are brought together beyond their capacity to make a single unified being, acting as a single whole (top-down).[40] Genetics and systems biology have brought us back to the idea of formal causality.

Finally, modern science since Newton has revealed that things in the universe act in regular, goal-oriented ways toward certain end-states that are intrinsic to them, what we might call goals or purposes. Machines also have purposes, but their functions are not intrinsic, to them they come from those who make them. Of course it is clear that many such things, especially at the inorganic level and in simpler organisms, act in goal-oriented ways not because they have the ability to conceive of goals and act accordingly like we do; they are not conscious and lack intelligence. And yet, according to their natures (formal causality) we do see various entities acting in regular ways toward such end-states. Aristotle and St. Thomas called this acting toward an end *final causality* or *teleology*, which plays a powerful role in explaining why things act in certain ways. For St. Thomas, final causality throughout the universe can be described as an art within creatures that they did not conceive of themselves, and therefore raises the question of where it comes from. In the words of philosopher Robert Spaemann, "If… teleology necessarily implies consciousness, then nature requires us to speak of God… indeed art is non-deliberative in things, but how did it get into them?"[41] In other words, purpose is the product of intelligence – why is there purpose in the universe at all unless it has an intelligent Source?

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[37] Ibid., 57-59.
[38] Nicanor Austriaco, "Substantial Forms, Living Networks and Natural Ends: Recovering the Teleology of St. Thomas Aquinas in Biology" (unpublished), Providence College, Providence (Rhode Island) 2014, 21.
[39] Ibid., 21.
[40] Dodds, 99.
[41] Robert Spaemann and Reinhard Löw, *Die Frage Wozu? Geschichte und Wiederentdeckung des teleologischen Denkens* (Munich: Piper, 1985), 85, as translated and quoted in Dodds, 33.

To repeat, science has not left Newton's mechanistic model behind with these advances and the questions they raise. Rather, it has reinserted mechanical causality (called *material efficient causality* by Aristotle and St. Thomas) back into a much wider picture that includes many perspectives, including those that raise the question of a Mind behind the universe. Material, formal and final causality—these are real features of our universe. Science itself beckons us to think about them and allow them to widen our wisdom.

E. Looking Forward: The "Sources" of Divine Revelation

So far, my approach to the harmony between modern science and the Christian Faith has largely stayed at a broad level. In the next two chapters, we will consider this relationship more specifically in regard to Sacred Scripture (Chapter Four) and Sacred Tradition (Chapter Five). While in reality divine revelation ultimately has only one source, which is the divine Son of God who makes God known to the world in creation and in redemption, Scripture and Tradition are the two primary ways in which we encounter the Son of God and therefore come to know divine Truth.

In Chapter Four, we will focus on the First Creation Account, the six-day story of creation with which Sacred Scripture begins, to better understand how the picture of the origins of the universe given by science and faith are not rival explanations but ones that differ and complete each other.

In Chapter Five, we will turn from Sacred Scripture to Sacred Tradition as it is embodied in the Church's history, with reference to great moments and great Catholic scientists, ending with a closer look at the life of Galileo and his condemnation by the Inquisition, which stands out as the lone exception to an otherwise glorious history of openness to, and encouragement of, scientific discovery by the Church.

Finally, in Chapter Six we will apply the concepts we developed in this chapter to three issues that are at the heart of personal spirituality—the reality of evil, the power of prayer, and the possibility of miracles.

FAITH AND SCIENCE

IN THE

CATHOLIC INTELLECTUAL TRADITION

Peter Hodgson

1. **"The Bible and Modern Science"** (excerpted from *Theology and Modern Physics* [Ashgate Publishing, 2006], pp. 21-24)
2. "**The Judeo-Christian Origin of Modern Science"** originally published in *Dizionario Interdisciplinaire di Scienza e Fede*, vol. 2, ed. Giuseppe Tanzella-Niti and Alberto Strumia (Rome: Urbana University Press, 2002), 1262–72.

Saint John Paul II, Discourses on Science and the Catholic Faith

1. **"Deep harmony unites the truths of science with the truths of faith."** *Address given on November 10, 1979 to the Pontifical Academy of the Sciences at the commemoration of the centenary of the birth of Albert Einstein.*
2. **"The spiritual heritage of humanity should accompany and control scientific research."** *Address given on October 3, 1981 to the Pontifical Academy of Sciences.*
3. **"Man, the image of God, is a spiritual and corporeal being."** *General Audience of April 16, 1986 based on Wisdom 8:5-9.*
4. **"Follow the guidelines of *Gaudium et Spes* in the light of scientific progress."** *Address given on September 5, 1986 to participants in a colloquium on science, philosophy and theology.*
5. ***"*Our knowledge of God and nature: physics, philosophy and theology."** *Letter of Pope John Paul II, dated June 1, 1988, to the Director of the Vatican Observatory. The occasion of the letter was the recognition of a study week sponsored by the Holy See marking the three hundredth anniversary of the publication of Sir Isaac Newton's "Philosophiae Naturalis Principia Mathematica".*
6. ***"*'Do the truth' for the good of humanity."** *Address given on October 31, 1988 to the plenary session of the Pontifical Academy of Sciences.*
7. **"Faith can never conflict with reason."** ***Address given on October 31, 1992 to the Pontifical Academy of Sciences regarding the Galileo case.***
8. **"The Magisterium is concerned with the question of evolution, for it involves the conception of man."** *Address given on October 22, 1996 to the Pontifical Academy of Sciences.*

9. *Untitled address given on November 8, 2004 to the participants in the plenary session of the Pontifical Academy of the Sciences*.
10. Cory J. Hayes, "A Tour of *The Cosmos*: Natural Philosophy as a Bridge Between the Catholic Faith and Modern Science in the Thought of Charles De Koninck"

The Bible and Modern Science
By
Peter Hodgson

A new beginning, a fresh style of scientific thinking, was made possible by the Judeo-Christian vision of the world. The God of the Hebrews is very different from the God of Plato or the Prime Mover of Aristotle. In sharp contrast, the God of the Hebrews freely created a world completely distinct from himself, and his actions are inscrutable to men unless he freely chooses to reveal his plans.

The book of Genesis bears witness to the Hebrew belief in a transcendent creator from its opening phrases: "In the beginning God created the heavens and the earth … And God saw all that he had made, and indeed it was very good" (Gen 1: 31). The Hebrew word translated as "good" also means "beautiful", and beauty is one of the most important characteristics of a scientific theory. In contrast to the confused creation myths of the surrounding nations, the creation story in Genesis has a clear logical structure, expressed in poetic form. It clearly expresses the belief in the absolute sovereignty, rationality and benevolence of God, who brings everything into being by his command and communicates his own goodness to them. Although not expressed in modern language, it contains the essential beliefs about the world that must be held if science is to flourish.

The earliest psalms tell us how God made the world and prepared it for man: He sets the heavens, the moon and the stars in their places, obeying a law that is fixed forever (Ps 148). He makes man the ruler over his works, ordering everything "in measure, number and weight" (Wis 11: 20). In his reply to Job, Yahweh asks

Where were you when I laid the foundation of the earth?
Tell me, if you have understanding.
Who determined its measurements — surely you know!
Or who stretched the line upon it?
On what were its bases sunk, or who laid its cornerstone,
when the morning stars sang together,
and all the sons of God shouted for joy? (Job 38: 4-7)

[In the Bible, n]othing comes into being, nothing remains in being,
without being loved and willed by God:

For thou lovest all things that exist,
and hast loathing for none of the things which thou hast made,
for thou wouldst not have made anything if thou hadst hated it.
How would anything have endured if thou hadst not willed it?
Or how would anything not called forth by thee have been preserved?
Thou sparest all things, for they are thine,
O Lord who lovest the living. (Wis 11: 24-26)

The heroic mother of the seven martyred brothers in Maccabees (2 Mc 7: 22-23) likewise expressed her belief in creation when she exhorted her sons to stand firm, saying to them:

"I do not know how you came into being in my womb. It was not I who gave you life and breath, nor I who set in order the elements within each of you. Therefore the Creator of the world, who shaped the beginning of man and devised the origin of all things, will in his mercy give life and breath back to you again, since you now forget yourselves for the sake of his laws."

When it came to the last son, Antiochus tried to persuade him to abandon the traditions of his ancestors, and appealed to his mother to advise the young man to save his life. She finally agreed to persuade her son, but she fooled the cruel tyrant with the words:

"I beseech you, my child, to look at the heaven and the earth and see everything that is in them, and recognize that God did not make them out of things that existed. Thus also mankind comes into being.
Do not fear this butcher, but prove worthy of your brothers. Accept death, so that in God's mercy I may get you back again with your brothers." (2 Mc 7: 28-29)

[In the Book of Jeremiah,] the faithfulness of God to Israel is compared with the reliability of natural phenomena (Jer 31: 35). [Ps 119 does the same:]

For ever, O LORD, thy word
is firmly fixed in the heavens.
Thy faithfulness endures to all generations;
thou hast established the earth, and it stands fast. (Ps 119: 89-90)

The order and stability of natural phenomena are taken for granted with the same quiet certainty as shown by the mother of the seven brothers:

The works of the Lord have existed from the beginning by his
creation, and when he made them, he determined their divisions.
He arranged his works in an eternal order,
and their dominion for all generations;
they neither hunger nor grow weary,
and they do not cease from their labors. (Sir 16: 26-27)

Matter is entirely passive and it consequently endures, obedient to God's will. It is a perfect model for us. Thus according to Judeo-Christian beliefs, the world is the free creation of God from nothing. The structure of the world cannot therefore be deduced from first principles; we have to look at it, to make observations and experiments to find out how God made it.

The Judeo-Christian Origin of Modern Science
By
Peter Hodgson

Introduction

WE ARE SO FAMILIAR with the presence of science in our lives and the multitude of its technological applications that we easily forget that this is a unique feature of our civilisation. Nothing remotely similar is found in any of the great civilisations of antiquity. We find in them, of course, highly developed social structures, great cities, men and women of high culture, great works of architecture, metalwork, ceramics, as well as philosophy, drama, and literature—but no science as we know it now.

Here it is necessary to specify in more detail just what we mean by modern science. In ancient civilisation we often find great skill in practical things, and also profound thinkers who tried to understand the working of the world. One thinks especially of the ancient Greeks with their great contributions to mathematics and to practical astronomy. Democritus, for example, speculated about the possibility that the world is made of atoms, small hard ultimate particles that cannot be further subdivided. But he had no idea about how to see if this is indeed the case, or, if it is, how we could find out how big they are and what is their structure. These and many other questions have only been answered in the last century.

The Greeks sought to understand the world by intuiting the essences of things and from this deducing their behaviour. They saw a purposeful world in which everything seeks its natural place. This was overambitious and mistaken: we cannot intuit the essences of things. It was Galileo, building on the work of his medieval predecessors, who realised that a much more modest and painstaking approach was needed. Physical phenomena must not only be observed, they must be measured as accurately as possible, and the measurements correlated by mathematics. This was already understood by Grosseteste in the thirteenth century, who applied geometrical rules to understand optical phenomena. Galileo went beyond this and studied the motion of falling bodies by measuring the

time taken to fall a measured distance, and correlating the results by mathematical equations. By emphasizing that science is quantitative, not qualitative, and that it is based on exact measurements, Galileo stands at the threshold of modern science. By his insight into the method of science, by his painstaking observations and measurements and by his vision of the future he did more than any other to destroy Aristotelian physics and open the way to modern science.

The Scriptures often use expressions from everyday speech without intending to endorse any particular scientific theories. It is thus important to distinguish between theological and scientific discussions, which both have their distinct methods and criteria of truth. In Galileo's time the debate was tragically confused by the opposition of the Aristotelians to his discoveries and by the failure to understand that genuine scientific discoveries show forth the works of the Creator. Furthermore, if we examine the origin of modern science, we find that it is rooted in the Christian beliefs on the nature of the material world.

By modern science I mean the detailed quantitative understanding of the material world expressed in the form of differential equations. This was first achieved by Newton when he formulated his three laws and showed how they can be used to calculate the motions of the planets and the fall of an apple. Likewise Maxwell showed how his equations enable us to understand all electric and magnetic phenomena. In the microworld of atoms and nuclei, quantum mechanics, usually in the form of Schrödinger's equation, performs the same function. The pattern is always the same: if we know the initial conditions, we can compute the subsequent course of the system in great and quantitative detail.

This detailed knowledge of the world is the essential basis of all modern technology. Without it there would be no aeroplanes, no television, no power stations. We may, of course, say that we would be better off in some respects without modern technology, and it is evident that the knowledge that we have gained is frequently put to evil use. We may also reflect that if it were not for modern science most of us would not be here at all, and most of the remainder would be living in squalor.

We are thus led to ask why it is that in all the civilisations of the world, only in our civilisation, that has flourished in Europe during the second millennium, has science developed in its modern form? This can be answered by seeing what is unique in our civilisation, and by connecting that with the origin of science.

The Conditions for the Birth of Science

All the great civilisations are characterised by an advanced social structure that enables some people to spend their time thinking about the world without worrying where the next meal is coming from. Most of them also have some system of writing, so that thoughts can be recorded, and some mathematics.

There are also present the practical skills necessary to make any instruments that may be required. These are what may be called the material conditions for the emergence of science, and their universality implies that the answer to our question must be sought elsewhere.

Perhaps what is important is the attitude of mind toward the material world. Clearly if we believe that the world is evil and not worthy of attention, then we are not likely to study it in any detail. For science to begin, the world must be regarded as in some sense good, or at the very least neutral.

We must also believe that the world is rational and orderly, so that what we find out one day is still true the next day, and in other places. This order must be of a very special kind. If we believe that the order in the world is a necessary order, that it could not be otherwise, then we might well hope to find that order just by thinking about it, as we do in mathematics. If on the other hand the order in the world is a dependent or contingent order, so that it could be otherwise, then the only way to find out about it is by looking at the world as it is, and by making experiments on it.

Scientific research is a frustrating business, and things go wrong all too often. It is easy to give up. Often the only way to succeed is by heroic

persistence, and this can only come if there is a firm belief that there is an order, and that the order can be found. So we must also believe that the order in nature is open to the human mind, that the whole enterprise is practicable.

Scientific knowledge can only be gained by the cooperative endeavour of very many men and women over many years. This will only happen if the knowledge that any one gains is not treated as a secret, but is freely shared.

As soon as it is found that scientific knowledge gives us some control over the working of the world, this provides another strong motive for scientific research. It also encourages the other members of society to regard the scientist not as a harmless eccentric indulging in his own interests, but as one whose work can be of inestimable value to society. The society will then support the scientist by providing the equipment and helpers that he needs. Of course there is a danger in this, that society will start to tell the scientist what he has to do, and there is no surer way of destroying all hope of fruitful research.

These are some of the beliefs about the material world that we can see by introspection that are necessary before science can begin. They are beliefs that must be held and indeed taken for granted by the ordinary members of society.

They may seem to us to be rather obvious beliefs, but they are a very special set of beliefs that has only been found together once in human history. If we look at the beliefs about the material world that are found in other civilisations we find something quite different. Matter is regarded as evil, or controlled by capricious demons. In such soil it is impossible for science to develop.

A very general belief in ancient civilisations is that of a cyclic universe. This is sometimes called the doctrine of the Great Year, the belief that after a very long time everything is repeated. There is nothing new; everything that happens has already happened an infinite number of times in the past and will be repeated an infinite number of times in the future.

Such a belief is intensely debilitating: if we are in the grip of an inexorable fate, what is the point of trying to do something new?

So now we are faced with the question how it was that the very special set of beliefs that is necessary for the rise of science was first imprinted on the European mind. As we have seen, modern science really took off with Newton, but its roots can be traced back through the work of Galileo and many others in the preceding centuries. We are thus led to look for the roots of science in the Middle Ages. The origin of science can be traced even further back, to the early Christian centuries, so we begin there.

The Early Christian Centuries

During the centuries following the foundation of Christianity, the Christians were one small persecuted sect among many others. The bitter struggle against pagan ideas made them suspicious of Greek science and philosophy. Nevertheless, there is inherent in Christian teaching a set of beliefs about the natural world that eventually led to the first viable birth of science in the High Middle Ages, and to its subsequent flowering in the Renaissance. The foundations of these beliefs were revealed to the Israelites, in particular the belief in the rationality of the world.

The Old Testament beliefs on creation were reinforced and extended by the teaching of Christ. The Christian belief concerning creation emphasizes not only that the universe was created by God out of nothing and in time, but also that the universe is totally dependent on God and totally distinct from God. The universe at any instant is sustained in being by God, and without this sustaining power it would immediately lapse into nothingness.

In the early Christian centuries there were passionate debates about the nature of Christ, and heresies abounded. To define the true nature of Christ was the task of a series of Councils of the Church, and of these the Council of Nicea formulated the creed that is widely held today:

“Credo in unum Deum. Pattern omnipotentum, factorem coeli et terrae, visibilium omnium et invisibilium. Et in unum Dominum Jesum

Christum, Filium Dei unigenitum. Et ex Patre natum ante omnia saecula. Deum de Deo, lumen de luminae, Deum verum de Deum vero. Genitum, non factum, consubstantialem Patri; per quem omnia facta sunt. . . ."

It is easy to recite those hallowed phrases without fully realising their impact, and still more their importance for science. The beginning of the Nicene creed asserts the creation of the universe by God: "Factorem coeli et terrae." One of the early heresies was pantheism that failed to distinguish between God and His creation, holding that it is in some way part of God. In the Greco–Roman world the universe was thought of as an emanation from a divine principle that is not distinguished from the universe. Pantheism is explicitly excluded by the Nicene creed when it says that Christ is the only-begotten Son of God. Christ is begotten, not made. Only Christ was begotten and thus shared in the substance of God; the universe was made, not begotten. ("Et in unum Dominum Jesum Christum, Filium Dei unigenitum. Genitum, non factum.") Since pantheism was one of the beliefs preventing the rise of science in all ancient cultures, the Nicene creed prepared the way for the one viable birth of science in human history

Many ancient cosmologies held that the world is a battleground between the spirits of good and evil. This dualism in inimical to science because it makes the world unpredictable. Dualism is excluded by the Nicene creed when it says that all creation takes place through Christ ("per quem omnia facta sunt").

Inherent in the Christian doctrine of creation is the belief that God freely chose to create the universe. He was not in any way constrained either to create or not to create it in the way that He did. It is therefore not a necessary universe in the sense that it has to be created or could have been created otherwise. There is therefore no possibility of finding out about the universe by pure thought or by a priori reasoning. We can only hope to understand it by studying it and by making experiments. Thus the Christian doctrine of creation encouraged the experimental method, essential for the development of science.

All ancient cultures held a cyclic view of the world, and this was one of the beliefs that hindered the development of science. This cyclic pessimism was decisively broken by the belief in the unique Incarnation of Christ; thereafter time and history became linear, with a beginning and an end.

The theological disputes of the early Christian centuries seem a long way away, but they were of decisive importance for subsequent history. Who now has heard of the Valentinians, the Marcosians, the Nicolaitans, the Encratites, the Borbonians, the Ophites, or the Sethians, to list but a few? More have heard of the Arians, a heresy still prevalent today. Arius and his followers were prepared to accept only-begotten, but consubstantial was unacceptable because it is not to be found in Scripture. If the young deacon Athanasius had not prevailed against them, Christianity would have been completely destroyed.

In his epistle to the Colossians, St. Paul says that in Christ all things took their being, and were all created through him and in him. He stressed Christ as the divine logos and the consequence that the creation must be fully logical and orderly.

In the early Christian centuries the attitude of theologians ranged from those of Tertullian (ca. 160–ca. 240), who mistrusted philosophers, to those like Justin Martyr and Clement of Alexandria (ca. 150–ca. 215), who regarded Greek learning as a useful aid to theology but not worthy of study for its own sake. Even St. Augustine of Hippo (354–430), who in his early days supported the liberal arts that included geometry and astronomy, came to regard them in his later years as of little value. Nevertheless, his theology encouraged the systematic study of the natural world, since he believed that its sacramental nature is symbolic of spiritual truths. He was a compulsive observer of a wide range of natural phenomena, always on the lookout for anything that gave even a fleeting glimpse of the Reason that he believed lie behind all things. He was interested in nature primarily because it revealed God to the attentive observer. His philosophical reflections on the nature of time are still quoted as among the most profound ever written.

In the early sixth century John Philoponus, a Christian Platonist who lived in Alexandria, wrote extensively on the material world, showing the influence of Christian beliefs on those of the surrounding pagan world, particularly those derived from ancient Greece. He commented extensively on Aristotle, whom he greatly admired, but when the teaching of Aristotle was contrary to Christian belief he did not hesitate to differ from it. This was particularly important in his commentary on Aristotle's physics where he said, contrary to Aristotle, that all bodies would fall in a vacuum at the same speed, irrespective of their weight, and that projectiles move through the air not due to the motion of the air but because they were initially given a certain quantity of motion. This is a remarkable anticipation of ideas normally associated with Galileo, and shows a decisive break with Aristotelian physics. He was not the first writer in antiquity to break with Aristotle, but he did so more clearly and decisively.

The connection between his rejection of Aristotelian ideas and his Christian beliefs is to be found in the doctrine of creation. Addressing the question of motion, he asked "could not the sun, moon and the stars be not given by God, their Creator, a certain kinetic force, in the same way as heavy and light things were given their trend to move?" He also believed that the stars are not made of the ether but of ordinary matter, thus rejecting Aristotle's distinction between celestial and terrestrial matter. This shows very clearly that the Christian beliefs about the world are incompatible with the Aristotelian views on the divinity of celestial matter and the eternity of motion. It was thus inevitable that the spread of Christianity should lead eventually to the destruction of Aristotelian physics, thus opening the way to modern science.

Philoponus was also the first to say that Genesis was written for spiritual and not for scientific instruction, a wise statement that was too far in advance of its time to be congenial to contemporary theologians. This theological boldness perhaps explains why Philoponus's ideas did not lead to further scientific developments. To be fruitful, ideas have not only to be right, they need to fall on fertile ground, in this case a society sufficiently developed to make full use of them. This was lacking for

Philoponus, but not in the High Middle Ages.

The Middle Ages

The Middle Ages is often neglected and derided, but an objective analysis shows that it was one of the most outstandingly creative periods in human history. It is convenient to define it as the period between 800 and 1450, the later years from 1200 to 1450 being the High Middle Ages. That period saw in Western Europe the foundation of universities; unprecedented technological developments that raised the standard of living to new heights; the organisation of an extensive financial system; and, most important of all, the birth of modern science.

Underlying all this was a new attitude to the material world, a new confidence, dynamism, and sense of purpose. It was a time of intellectual ferment. Universities were being founded all over Europe, and the writings of the ancient Greeks were becoming available in translation. Christian theology was being rethought using their unfamiliar but powerful concepts. The writings of Augustine and of others like Philoponus were already forming new attitudes to the natural world.

In the early twelfth century, Adelard of Bath wrote his *Quaestionta Naturales*, which marks the dawn of medieval science. His nephew believed that the spontaneous appearance of life in a dish of dried soil was miraculous. At a time when there was a strong devotion to miracles, it would have been easy for Adelard to agree. Instead he drew a firm distinction between the action of the Creator and the natural workings of His creation: “It is the will of the Creator that herbs should sprout from the earth. But the same is not without a reason either.” When his nephew persisted and pointed out that a natural explanation from the doctrine of the four elements was inadequate, he stuck to his point: “Whatever there is, is from Him and through Him. But the realm of being is not a confused one, nor is it lacking in disposition which, so far as human knowledge can go, should be consulted.” In other words, we should persist in seeking a natural explanation, and avoid attributing anything that we do not understand to the direct action of God. This advice, that is still worth

heeding today, contains the essential attitude to the natural world that lies at the basis of science.

The two characteristics of the Western intellectual tradition that make science possible are the insistence on logical coherence and experimental verification. These are already present in a qualitative way among the Greeks, and the vital contribution of the Middle Ages was to refine these conditions into a more effective union. This was done principally by insisting on the quantitative precision that can be attained by using mathematics in the formulation of the theories, and then verifying them not by observation alone, but by precise measurements. This transition was achieved in the twelfth century, principally by Robert Grosseteste, who is regarded as the founder of experimental science.

Grosseteste was a widely read man who made extensive contributions to many areas of human knowledge. He was one of the first chancellors of the University of Oxford and did much to establish the nascent university. He was also Bishop of Lincoln, the diocese in which Oxford used to be situated.

His work on experimental science owed much to Plato, who taught that the pure forms behind the appearances of things are mathematical in nature, and so if we are to show this our theories must themselves be mathematical and the results of our measurements must be expressed in numbers.

Grosseteste elaborated his theory of the scientific method in some detail, though he did not himself carry out many experiments. He recommended the method of analysis and synthesis; namely that the problem is first resolved into its simplest parts and, when these are understood, the results can be combined to give the explanation of the whole. The observations and experiments may themselves suggest hypotheses and then theories, and these in turn may be verified or disproved by comparison with further observations and measurements.

He first applied his method to the phenomena of light. He believed that light is the most fundamental form, the first principle of motion, so that

the laws of light must lie at the basis of scientific explanation. God created light, and from that all things came. Light itself follows geometrical rules, in the way it is propagated, reflected, and refracted, and is the means whereby higher bodies act on lower. Motion is therefore also geometrical. He studied the rainbow and his criticisms of the explanations of Aristotle and Seneca were useful steps along the road to an adequate explanation.

Implicit in his work is the insistence on quantitative measurement, and this in turn comes from the biblical insistence on the rationality of the Creator, who disposed everything in number, weight, and measure.

It should not be thought that these examples are typical of medieval thought about the world. They are in fact rather untypical of an age characterised by a baffling mixture of keen insights and naive credulity, of sound reasoning and fantastic superstitions, of critical analysis and magical incantations.

Nevertheless, in spite of this confusion, there did exist the insistence on rational thought, on mathematical formulation and quantitative verification, that was eventually to lead to modern science. At first it may have been but a flicker in the darkness, but that flicker grew steadily stronger until modern science was born. Essential to that birth was the insistence on quantitative precision, and this was made possible by the immense technological growth in the Middle Ages, which must now be considered.

At the beginning of the Middle Ages the monasteries were the centres of technological innovation. They were primarily houses of prayer, but the need to be largely self-supporting, often in rather remote and underdeveloped areas, forced them to develop a wide range of skills, including building and architecture, farming, cloth-making, clock-making, metallurgy, and printing.

First and most obviously the monastery itself was an integrated complex of buildings housing the monks and lay brothers and their various activities, with the church at its centre. Often the abbey church also served

as the cathedral of a city, and we still have visible reminders of the magnitude of the achievements of those generally anonymous medieval builders. Visitors to Canterbury and York, Salisbury and Winchester, Durham and Lincoln, to name but a few English cities, go first to their medieval cathedrals. These were constructed when the population was but a small fraction of today's number, and there were no steel cranes or electric saws to facilitate their construction, and yet we can now barely afford to keep them in repair. They bear silent witness to the extraordinary technical skill, tenacity of purpose, and self-sacrifice of their builders.

In the countryside, the monasteries mainly supported themselves by farming. They often owned large areas of land, sometimes in more remote areas hacked out of the wilderness by the monks themselves. The actual farm work in the larger monasteries was done by lay brothers. The medieval centuries saw many advances in agricultural techniques, such as the modern plough, which turns the earth over as well as opening it up. Horses were made more efficient by providing them with nailed horseshoes, and the breast harness enabled them to pull loads four times heavier than before. Horses were harnessed one in front of another, and the stirrup gave horse riders much greater control.

Monasteries were often built near a river, so that the water could drive machinery as well as clean the buildings. Fishponds provided the monks with fish, and frequently there was a water mill to grind the corn, and fulling machines to make cloth. The latter made use of the cam, another medieval invention, to transform rotational to linear motion. The cam also made possible mechanical saws that enabled wood for building to be prepared much more easily. Windmills were known quite widely; in Tibet they drove prayer wheels, but in Europe they ground corn.

Monasteries were strictly regulated by a rule, for the Benedictine monasteries that of St. Benedict. This prescribed the hours of prayer, of work, eating and sleeping, and all had to be aware of the time, even those working in distant fields. The bells of the monasteries chimed the hours and regulated all the activities throughout the day and night. Clocks were

thus essential to the smooth functioning of the monasteries. The early sand and water clocks, accurate to a few minutes, might well have been sufficient, but this did not satisfy the monks, and they developed the earliest clocks. A very early example (1386), showing a sophisticated double feedback mechanism, is to be seen in the nave of Salisbury cathedral. Clocks were soon installed on towers in the city centres, where they regulated commerce. Extremely complicated clocks were made, such at that in Strasbourg cathedral, which gives not only the time but a whole range of astronomical information.

The manufacture of bells and clocks required enhanced metallurgical skills, and here again the monks were among the leaders. Brass was first made in Tintern Abbey, now an imposing ruin in the narrow valley of the river Wye.

In the early Middle Ages, manuscripts were laboriously copied by the monks, and so were very rare. Woodblock printing was introduced from the East, followed by moveable type in the early fifteenth century. The improved methods soon allowed books to be produced in ever-increasing numbers. This was an invention that has trans- formed our society more than any other. Although many of these technological developments started in the monasteries, they were eagerly taken up by others, and soon became generally available.

Another important industry was the manufacture of glass, which made possible both the stained glass windows and, around 1280, the first spectacles. Mining became a key industry as it provided so many of the minerals needed by the growing manufacturing industries, as well as the coal that was rapidly replacing the increasingly scarce wood. From the thirteenth century onward, universities were founded in many cities such as Bologna, Padua, Paris, Oxford, and Prague, and soon became very active centres of learning. Students studied a wide range of subjects, including grammar, dialectic, rhetoric, music, natural philosophy, arithmetic, and geometry, bringing together the liberal and the mechanical arts. In medieval times the university was true to its name in providing a universal education, and one that contained a large scientific and

technological component. All this activity stimulated the growth of international trade, as commodities were exported from one country to another in ever-increasing quantities. This required a reliable monetary system, including a coinage and an international banking organisation. Great merchant banks such as the Medici in Florence were founded and controlled trade over all Europe. This led to greatly increased standards of living, although progress was sometimes interrupted by famines, plagues, and wars.

Science and Christian Belief

The Middle Ages saw the flourishing of a Christian civilisation for the first time in history. Christian ideas gradually permeated the European mind and formed the prevailing view of the world. We are thus led to enquire, what is the Christian concept of the material world, and how is it connected with the beliefs that we have seen are necessary for the rise of science?

The Christian believes that the world is good: we read in the first chapter of Genesis that God looked upon all that He had made, and saw that it was "very good." Matter was further ennobled by the Incarnation, when "the Word was made flesh and He dwelt amongst us."

Matter is ordered and rational because it was created by a rational God. We read in the Book of Wisdom that the Creator ordered everything in measure, number, and weight, which was the most often quoted biblical phrase in medieval times. The order of the material world is freely chosen by God. He could have made the world in many different ways, but chose to make it the way He did. This shows very clearly the importance of our theological beliefs on our view of the material world. We believe that God is both rational and free. If we stress His rationality at the expense of His freedom, we have a necessary world, and no possibility of science. But conversely, if we stress his freedom at the expense of His rationality we have an unpredictable world, and again no science. This is the reason for the failure of science to develop in Muslim lands.

Christians believe that the order in nature is open to the human mind, that

it is possible to learn about the world because God commanded man to subdue the earth: "Be fruitful, multiply, fill the earth and conquer it. Be masters of the fish of the sea, the birds of heaven and all living animals on the earth."

Christian beliefs also provide the motivation to study the world, because by learning about it we can learn more about God. In the parable of the talents Christ urged us to make full use of all our abilities, and this includes learning more about the world by observation and experiment.

The remaining condition for the development of science, the belief that knowledge must be freely shared, is enjoined by the Book of Wisdom: "What I have learned without self-interest, I pass on without reserve; I do not intend to hide her riches. For she is an inexhaustible treasure to men, and those who acquire it win God's friendship."

We thus find that during the critical centuries before the birth of science, the collective mind of Europe was inspired by a system of beliefs that included just those special elements that are necessary for the development of science. It is thus very plausible to say that there is thus a living, organic continuity between Christian revelation and modern science. Christianity provided just those beliefs that made possible the birth of modern science, and the moral climate that encouraged its growth.

It might however be said that this is just historical coincidence; how can we be sure that there is a real causal influence operating? This can indeed be found if we examine the work of some of the philosophers of the High Middle Ages.

At that time the prevailing ideas of the nature of the world were derived from the Greek philosopher Aristotle. He believed in the eternity of the world, in a cyclic universe, and in a world of purpose, even in material things. He also believed that celestial matter, the world of the stars and planets, is incorruptible, unlike terrestrial matter that can undergo change. These beliefs in effect prevented the development of science for two thousand years. Their stranglehold had to be broken before science could

develop into its modern form.

So great was the prestige of Aristotle that the philosophers of the medieval schools taught by commenting on his texts. Some of Aristotle's teaching, however, was inconsistent with the Christian faith, and the philosophers did not hesitate to differ from Aristotle when it seemed necessary. There was intense discussion on a variety of topics, notably concerning the creation of the world and the motion of bodies. In 1277 the Bishop of Paris, Etienne Tempier, found it necessary to condemn 219 philosophical propositions as contrary to the Christian belief in creation out of nothing. This was a turning point in the history of thought, as it channelled philosophical speculations about motion in a direction that led eventually to the destruction of Aristotelian physics, thus opening the way to modern science.

One of these philosophers, Jean Buridan, was particularly interested in the nature of motion. This is the most fundamental problem of physics, and so if science is to begin it must begin here. In full consistency with his belief in creation, he wrote that "God, when He created the world, moved each of the celestial orbs as he pleased, and in moving them He impressed upon them impetuses which moved them without Him having to move them any more except by the method of general influence whereby He concurs as co-agent in all things which take place."

This shows a clear break with Aristotle, who required the continuing action of the mover throughout the motion. What Buridan called impetus was later refined into the concept of momentum, and the idea in the above passage became Newton's first law of motion. Buridan's works were widely published and his ideas became known throughout Europe, and in particular to Leonardo da Vinci and hence to the scientists of Renaissance times.

The Christian belief in the creation of the world by God also undermined Aristotle's sharp distinction between celestial and terrestrial matter. Since they are both created, why should they be different? This made it possible for Newton to see that the same force that pulls an apple to the ground

also keeps the moon in its orbit.

A vital component in the rise of science is the belief in the order of the world, that is the idea that every event is the precise result of preceding events. This implies that whatever measurements we make should correspond exactly, that is within the uncertainties of measurement, with our theories. A corollary to this is that if we want to test out theories we should make the most accurate measurements we can. This insistence on precision is essential for the progress of science. An illustration of this is the work of Kepler on the orbit of the planet Mars. Some very accurate measurements had been made of its position by Tycho Brahe, probably the most accurate that could be made before the invention of the telescope. Kepler resolved to find the orbit. He believed, following Aristotle, that the orbit was circular, as befits incorruptible celestial matter. He found that indeed it is very nearly a circle, but however hard he worked, he could not make it fit Tycho's measurements. He could find a circular orbit that agreed with the measurements to about ten minutes of arc, but not to two, which was the accuracy of the measurements. Many people would have said that this was good enough, and gone on to do something else. But it was not good enough for Kepler, who believed that the fit must be exact, within the uncertainties of the measurements. So he toiled on and on for years, until he finally realised that he could never get the circle to fit. Then he tried an ellipse, and now the orbit could be fitted. This was a breakthrough that made possible Newton's work on the planetary orbits, when he showed from his theory of celestial dynamics that they must indeed be ellipses.

This vital stage in the development of science was made possible by the strong belief in the order of nature. This is what led Whitehead to say, in his Lowell lectures in 1925 on "Science and the Modern World" that "the Middle Ages formed one long training of the intellect of Western Europe in the sense of order. This by itself is not enough." He went on: "I do not think that I have even yet brought out the greatest contribution of medievalism to the formation of the scientific movement. I mean the inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general

principles. Without this belief the incredible labours of scientists would be without hope. It is this instinctive conviction, vividly poised before the imagination, which is the motive power of research: that there is a secret, a secret which can be unveiled." He went on to ask how was this conviction so vividly implanted in the European mind, and concluded: "My explanation is that the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative from medieval theology."

One might indeed query whether unconscious is the right word, for many of the medievals explicitly saw their work as showing forth the works of the Creator. Furthermore, explicitly Christian beliefs played a decisive part in making modern science possible. Thus the debilitating belief in a cyclic universe was decisively broken by the Christian belief in the uniqueness of the Incarnation. Henceforth history was no longer an infinite series of dreary cycles, but a linear story with a beginning and an end.

Galileo

The Aristotelian philosophers regarded the universe as a living organism suffused by purpose, and they analysed it in terms of essences and causes. Galileo, following Euclid and Archimedes, saw it as made of objects moving according to mathematical laws that could be discovered by experiment. He therefore studied the problem of motion in a new way, not by asking its causes, but by seeking simple mathematical descriptions of the ways things move.

Galileo had to overcome the general belief that the Greeks had attained supreme mastery of every art and science, so that every question can be studied by appeal to their authority. The idea of the progressive increase in knowledge, so familiar today, was conspicuously absent. Nature has spoken through the mouth of Aristotle, and our task is to listen and interpret. Galileo, however, believed that the book of nature is written in the language of mathematics and that we can read from the book of nature by making observations and experiments

Kepler had already realised the importance of numerical accuracy in observing the heavens, and established the laws of planetary motion. Galileo did the same for motions on the surface of the earth. He studied how balls roll down an inclined plane, and how projectiles move through the air, and was able to express his results in simple laws connecting positions, velocities, and times.

The fundamental ideas of dynamics were established qualitatively by Buridan and his successors, and subsequently there was much discussion about the motions of falling bodies and of projectiles, in particular about the relationship between the distance fallen and the time, and the trajectories of projectiles. Concepts such as momentum and energy were only refined to their present precision by centuries of effort.

Galileo realised the importance of accurate measurements, but was in a more difficult situation than Kepler. Long times, such as the periods of rotation of the planets, can be measured quite accurately by primitive means, but it is much more difficult to measure accurately the much shorter time taken by a body to fall a measured distance. According to a probably apocryphal story, Galileo used his own pulse to measure the period of swing of the lamp in the cathedral of Pisa, and found that it is independent of the amplitude. For a falling body a more accurate measure is needed, and he used a thin jet of water coming from a large jar, weighing the amount that came out during the fall. He further increased the accuracy by allowing the ball to roll down an inclined plane instead of falling freely, for then the time is much longer and so easier to measure.

By such measurements he showed that the distance traversed is proportional to the square of the time taken. This applies also to free-fall, and he obtained a rough estimate of what we now call the acceleration due to gravity. He also studied the motion of projectiles, and found that the range is a maximum when the angle of elevation of the gun is 45°. The famous story of his dropping two weights from the top of the leaning tower of Pisa is probably apocryphal, but he did show that the time of fall is independent of the mass, contrary to Aristotle.

As we saw with Kepler, the advance of science often depends on the precision of the measurements. Those of Brahe were as accurate as possible by direct sighting. The next step, the invention of the telescope, was due mainly to Galileo. Lenses had been used in spectacles for centuries. Kepler already understood the magnifying power of lenses, and early telescopes magnifying three or four times were made in Holland and France. Galileo heard of this work and succeeded in making a telescope that magnified thirty times, and was thus much superior to any other existing at that time. After extensive observation of objects on the earth convinced him that it gave real knowledge, he turned his telescope to the sky and immediately made a series of critical discoveries. He saw the sunspots and the mountains on the moon, imperfections unexpected in perfect Aristotelian spheres. He discovered several of the satellites of the planet Jupiter, and found that they revolved around it. This was just like a miniature solar system, and gave support to the Copernican idea of the solar system.

The work of Galileo was of decisive importance in several respects. It replaced the qualitative and unverifiable speculations of the Aristotelians with quantitative mathematical reasoning supported by accurate experimental verification. He showed how scientific instruments like the telescope can be used to extend the powers of our senses in a reliable way. He criticised the use of ill-defined and unverifiable concepts like "absolute perfection" and showed that they have no place in science. He replaced the imprecise terms of everyday speech with a new scientific terminology where every concept is given a precise mathematical and measurable meaning. The spirit of the new science was optimistic. It was confident that old misunderstandings and prejudices could be overcome, the secrets of nature revealed, and the world transformed.

In this way Galileo completed the destruction of Aristotelian physics began so many years previously. The Aristotelian philosophers did not give in easily. They made many plausible objections to Galileo's work, but gradually these were shown to be false or unsupportable. Some of Galileo's arguments for the motion of the earth round the sun were indeed incorrect, and he was vindicated only centuries later. He realised the

central importance of the Copernican theory and succeeded in removing most of the arguments used against it on the basis of common sense. This made possible the subsequent scientific developments that were eventually to provide the definitive proof of the Copernican theory.

Galileo saw very clearly that if the new science was to prevail, it must have the support of the Church. He had many friends in high ecclesiastic circles who were very sympathetic to his work. However, his Aristotelian opponents were able to point to passages in Scripture that seemed to be inconsistent with the heliocentric system. Galileo believed that Scripture often uses the language of ordinary speech, without thereby endorsing scientific theories. At this critical moment for the development of science the debate concerning the nature and method of science and the validity of its conclusions in the context of the teaching of the Church assumed central importance, and this continues to be the case today.

The Discovery of the Christian Origin of Science

These Christian roots of modern science are not generally known. The man primarily responsible for uncovering the evidence for the Christian origin of science was the French physicist Pierre Duhem. He was a theoretical physicist working mainly in the field of thermodynamics, but he had always been interested in the history of physics. He was asked to write a series of articles on the history of mechanics, and easily wrote the first one on the ideas of ancient Greeks. Like most historians of science, he expected to pass rapidly over the Middle Ages to the giants of the Renaissance. But he was a careful man, not content to rely on secondhand sources. He found obscure references to earlier work, and following them up, primarily in the archives in Paris, discovered the work of Buridan and his pupil Oresme, and of many other medievals who contributed to the origin of science.

Duhem wrote two volumes on the history of mechanics, three on Leonardo da Vinci, and then embarked on his greatest work, the *Systeme du Monde*. The first volume, devoted to the Greeks, was published in 1913, and was highly praised by George Sarton, the founder and editor of

the journal *Isis*, who said that he looked forward eagerly to the second volume. When he read the second volume, however, he realised that what Duhem had found was highly uncongenial to his secularist beliefs. Duhem left him in no doubt whatever. Writing on the doctrine of the Great Year, he said: "To the construction of that system all disciples of Hellenic philosophy— Peripatetics, Stoics, Neo-Platonist—contributed; to that system Abu Masar offered the homage of the Arabs; most illustrious rabbis, from Philo of Alexandria to Maimonides, have accepted it. To condemn it and to throw it overboard as a monstrous superstition, Christianity had to come."

Sarton did not try to refute Duhem; that would have been impossible. Instead he used the one remaining weapon, that of silence. None of the following volumes were reviewed in *Isis*, and the name of Duhem was thereafter hardly ever mentioned. In Sarton's own vast volumes on the history of science Duhem receives but a few mentions, whereas quite minor figures receive extensive discussion.

Tragically, Duhem died in 1916 when only the first five volumes of his *Systeme du Monde* had been published. Duhem left the text of the remaining five volumes in manuscript, and the publisher was bound by the terms of the contract to publish them in successive years. The secularist establishment however was bitterly opposed to their publication, and succeeded in preventing this for forty years. Only the death of his most determined opponent, and the threat of legal action, finally forced the publishers to act.

It is not surprising that the secularists should be so determined to prevent the publication of books of massive scholarship that completely undermine their view of the development of science, and show that science as we know it is built on Christian foundations. What is surprising is that Christians have been so slow to recognise and publish his work. Even now, after many decades of scholarly work on medieval science, the name of Duhem is hardly known outside specialist circles. It deserves to be familiar to Christians, particularly to those concerned with the education of the young, who are still taught that there is a fundamental

opposition between science and the Christian faith.

Deep harmony unites the truths of science with the truths of faith

Address given on November 10, 1979 to the Pontifical Academy of the Sciences at the commemoration of the centenary of the birth of Albert Einstein.

1. I thank you heartily, Mr. President, for the warm and fervent words you addressed to me at the beginning of your discourse. And I rejoice also with Your Excellency, as with Mr. Dirac and Mr. Weisskopf, both illustrious members of the Pontifical Academy of Sciences, in this solemn commemoration of the centenary of the birth of Albert Einstein.

The Apostolic See also wishes to pay to Albert Einstein the tribute due to him for the eminent contribution he made to the progress of science, that is, to knowledge of the truth present in the mystery of the universe.

I feel in full solidarity with my predecessor Pius XI, and with those who succeeded him in Peter's See, in calling upon members of the Pontifical Academy of Sciences, and all scientists with them, to bring about the progress of sciences more and more nobly and intensely, without asking anything else of them, and that because the mission of serving truth, with which we charge them, consists in this excellent intention and in this noble labor... (Motu proprio *In multis solaciis* of 28 October 1936, on the Pontifical Academy of Sciences, *AAS* 28 1936, p. 424).

To know truth

2. The search for truth is the task of basic science. The researcher who moves on this first versant of science feels all the fascination of St. Augustine's words: "Intellectum valde ama" (*Epist*. 120, 3, 13: PL 33, 458), "greatly love understanding" and the function that is characteristic of it, to know truth. Pure science is a good, which every people must cultivate in full freedom from all forms of international slavery or intellectual colonialism.

Basic research must be free with regard to the political and economic authorities, which must cooperate in its development, without hampering it in its creativity or harnessing it to serve their own purposes. Like any other truth, scientific truth is, in fact, answerable only to itself and to the supreme Truth, God, the creator of man and of all things.

United with conscience

3. On its second versant, science turns to practical applications, which find their full development in the various technologies. In the phase of its concrete achievements science is necessary to mankind to satisfy the rightful requirements of life and to overcome the different ills that threaten it. There is no doubt that applied science has rendered and will continue to render immense services to man provided it is inspired by love regulated by wisdom, and accompanied by the courage that defends it against the undue interference of all tyrannical powers. Applied science must be united with conscience, so that, in the trinomial science-technology-conscience, it is the cause of man's real good that is served.

Church aids science

4. Unfortunately, as I had occasion to say in my encyclical *Redemptor Hominis*, "The man of today seems ever to be under threat from what he produces. This seems to make up the main chapter of the drama of present-day human existence" (n. 15). Man must emerge victorious from this drama which threatens to degenerate into a tragedy, and he must find again his true kingship over all the world and his full dominion over the things he produces. At the present time, as I wrote in the same encyclical, "The essential meaning of this 'kingship' and 'dominion' of man over the visible world, which the Creator himself gave man for his task, consists in the priority of ethics over technology, in the primacy of the person over things, and in the superiority of spirit over matter" (n. 16).

This threefold superiority is maintained to the extent to which the sense of the transcendence of man over the world and of God over man is preserved. Exercising her mission of guardian and advocate of both transcendences, the Church considers she is helping science to keep its purity on the versant of basic research, and to carry out its service of man on the versant of practical applications.

Religion and science

5. The Church willingly recognizes, moreover, that she has benefited from science. What the Council said about certain aspects of modern culture must be attributed to it, among others. "As regards religion there is a completely new atmosphere that conditions its practice. On the one hand people are taking a hard look at all magical world-views and prevailing superstitions and demanding a more personal

and active commitment of faith, so that not a few have achieved a lively sense of the divine" (*Gaudium et Spes,* n. 7).

The collaboration between religion and modern science is to the advantage of both, without violating their respective autonomy in any way. Just as religion demands religious freedom, so science rightly claims freedom of research. The Second Vatican Council after reaffirming, with the First Vatican Council, the rightful freedom of the arts and of human disciplines in the field of their own principle and their own method, solemnly recognizes "the legitimate autonomy of culture and especially of the sciences" (*Gaudium et Spes*, n. 59). On the occasion of this solemn commemoration of Einstein, I would like to confirm again the declarations of the Council on the autonomy of science in its functions of research on the truth inscribed in creation by the finger of God. The Church, filled with admiration for the genius of the great scientist in whom the imprint of the creative Spirit is revealed, without intervening in any way with a judgment which it does not fall upon her to pass on the doctrine concerning the great systems of the universe, proposes the latter, however, to the reflection of theologians to discover the harmony existing between scientific truth and revealed truth.

The Galileo case

6. Mr. President! You said, very rightly, in your address that Galileo and Einstein characterized an era. The greatness of Galileo is known to everyone, like that of Einstein; but unlike the latter, whom we are honoring today before the College of Cardinals in the apostolic palace, the former had to suffer a great deal—we cannot conceal the fact—at the hands of men and organisms of the Church. The Vatican Council recognized and deplored certain unwarranted interventions. "We cannot but deplore"—it is written in number 36 of the conciliar constitution *Gaudium et Spes*—"certain attitudes (not unknown among Christians) deriving from a shortsighted view of the rightful autonomy of science; they have occasioned conflict and controversy and have misled many into thinking that faith and science are opposed." The reference to Galileo is clearly expressed in the note to this text, which cites the volume *Vita e opere di Galileo Galilei* by Mons. Pio Paschini, published by the Pontifical Academy of Sciences.

To go beyond this stand taken by the Council, I hope that theologians, scholars and historians, animated by a spirit of sincere collaboration, will study the Galileo case more deeply and, in loyal recognition of wrongs from whatever side they come, will dispel the mistrust that still opposes, in many minds, a fruitful concord between science

and faith, between Church and world. I give all my support to this task, which will be able to honor the truth of faith and of science and open the door to future collaboration.

Set in true light

7. Allow me, Gentlemen, to submit to your attention and your reflection some points that seem to me important to set again in its true light the Galileo affair. For in this affair the agreements between religion and science are more numerous and above all more important than the incomprehensions which led to the bitter and painful conflict that continued in the course of the following centuries.

He who is rightly call the founder of modern physics, declared explicitly that the two truths, of faith and of science, can never contradict each other, "Holy Scripture and nature proceeding equally from the divine Word, the former dictated, as it were by the Holy Spirit, the latter as a very faithful executor of God's orders", as he wrote in his letter to Father Benedetto Castelli on December 21, 1613 (National Edition of the works of Galileo, vol. V, pp. 282-285). The Second Vatican Council does not express itself otherwise, it even takes up again similar expressions when it teaches: "Methodical research in all branches of knowledge, provided it is carried out in a truly scientific manner and does not override moral laws, can never conflict with the faith, because the things of the world and the things of faith derive from the same God" (*Gaudium et Spes*, n. 36).

Creator ever present

Galileo feels in his scientific research the presence of the Creator, who stimulates him, inspires and helps his intuitions, acting in the deepest recesses of his spirit. In connection with the invention of the telescope, he writes at the beginning of *Sidereus Nuncius*, recalling some of his astronomical discoveries: "*Quae omnia ope Perspicilli a me excogitati divina prius illuminante gratia, paucis abhinc diebus reperta, atque observata fuerunt*" (*Sidereus Nuncius*, Venetus, apud Thomas Baglionum, MDCX, fol. 4), "All that has been discovered and observed in the last few days thanks to the 'telescope' that I have invented, after having been enlightened by divine grace."

Galileo's confession of divine illumination in the mind of the scientist, finds an echo in the text already quoted of the conciliar constitution on the Church in the

modern world: “The humble and persevering investigator of the secrets of nature is being led, as it were, by the hand of God in spite of himself” (*loc. cit.*).

The humility which the conciliar text stresses is a virtue of the spirit necessary for scientific research as well as for adherence to faith. Humility creates a climate favorable to the dialogue between the believer and the scientist; it calls for the illumination of God, already known or still unknown but loved in both cases by him who humbly seeks the truth.

Galileo’s norms

8. Galileo formulated important norms of an epistemological character, which are indispensable to reconcile Holy Scripture and science. In his letter to the grand-duchess mother of Tuscany, Christine of Lorraine, he reaffirms the truth of the Scriptures: “Holy Scripture can never lie, provided, however, that its real meaning is understood. The latter—I do not think it can be denied—is often hidden and very different from what the mere sense of the words seems to indicate” (National Edition of the works of Galileo, vol. V, p. 315). Galileo introduces the principle of an interpretation of the sacred books which goes beyond the literal meaning but is in conformity with the intention and the type of exposition characteristic of them. It is necessary, as he affirms, that “the wise men who expound it should show its real meaning.”

The Ecclesiastical magisterium admits the plurality of the rules for the interpretation of Holy Scripture. It teaches expressly in fact, with Pius XII’s encyclical *Divino afflante Spiritu*, the presence of different literary styles in the sacred books and therefore the necessity of interpretations in conformity with the character of each of them.

The various agreements that have mentioned do not in themselves solve all the problems of the Galileo affair, but they contribute to creating a starting point favorable to their honorable solution, a state of mind propitious to the honest and loyal solution of old oppositions.

The existence of this Pontifical Academy of Sciences, with which Galileo was associated in a certain way, though the old institution which preceded the present one to which eminent scientists belong today, is a visible sign which manifests, without any form of racial or religious discrimination, the deep harmony that can exist between the truths of science and the truths of faith.

Pontifical Academy

9. In addition to the foundation of your Pontifical Academy by Pius XI, my predecessor John XXIII wished the Church to continue to promote scientific progress and to reward it, by establishing the Pius XI medal. In conformity with the choice made by the Council of the Academy, I am happy to confer this distinction on a young researcher, Dr. Antonio Paes de Carvalho, whose basic research works have made an important contribution to the progress of science and the good of mankind.

Church and scientific progress

10. Mr. President and members of the Academy before the Lords Cardinals present here, the Diplomatic Corps accredited to the Holy See, the illustrious scientists and all the personalities attending this academic session, I would like to declare that the universal Church, the Church of Rome united with those in the world, attaches great importance to the function of the Pontifical Academy of Sciences.

The title "Pontifical" attributed to this Academy signifies, as you know the interest and support of the Church. These are manifested in very different forms, of course, from those of ancient patronage, but they are no less deep and effective. As the distinguished President of your Academy, the late Mons. LeMaître, wrote, "Does the Church need science? Certainly not, the cross and the gospel are sufficient for her. But nothing human is alien to the Christian. How could the Church have failed to take an interest in the most noble of the strictly human occupations, the search for truth?" (O. Godart—M. Heller, *J'es relations entre la science et la foi chez Georges Lemaître*, Pontificia Academia Scientarum, Commentarii, vol. III, n. 21, p. 7)

In this Academy which is yours and mine, believing and non-believing scientists collaborate, concurring in the search for scientific truth and in respect for the beliefs of others. Allow me to quote here again a luminous passage by Mons. LeMaître: "Both of them, (the believing and non-believing scientist) endeavor to decipher the palimpsest of nature, in which the traces of various stages of the long evolution of the world are overlaid on one another and confused. The believer has perhaps the advantage of knowing that the enigma has a solution, that the underlying writing is, when all is said and done, the work of an intelligent being, therefore that the problem raised by nature has been raised in order to be solved, and that its difficulty is doubtless proportionate to the present or future capacity of mankind. That will not give him, perhaps, new

resources in his investigations, but it will contribute to maintaining in him a healthy optimism without which a sustained effort cannot be kept up for long" (*op. cit.*, p. 11).

I wish you all this healthy optimism of which Mons. LeMaître speaks, an optimism which draws its mysterious but real origin from God, in whom you have put your faith, or from the unknown God, to whom the truth which is the object of your enlightened mind researches, is directed.

May the science that you profess, Members of the Academy and scientists, in the field of pure research as in that of applied research, help mankind with the support of religion and in agreement with it, to find again the way to hope and to reach the last aim of peace and faith!

The spiritual heritage of humanity should accompany and control scientific research

Address given on October 3, 1981 to the Pontifical Academy of Sciences.

Mr. President,

Members of the Academy,

Ladies and Gentlemen,

1. The program of work which your President has presented, and with which I was already acquainted before this meeting, demonstrates the great vitality of your Academy, its interest in the most acute problems of modern science and its interest in the service of humanity. On the occasion of a previous solemn session I have already had the opportunity to tell you how highly the Church esteems pure science; it is "a good, worthy of being loved, for, it is knowledge and therefore perfection of man in his intelligence. It must be honored for its own sake, as an integral part of culture" (Address to the Pontifical Academy of Sciences, November 10, 1979).

Before speaking of the questions which you have already discussed during these days and those which you now propose to study, permit me to express my warm thanks to your illustrious President, Professor Carlos Chagas, for the congratulations which he kindly expressed in the name of your whole Assembly for having regained my physical strength, thanks to the merciful Providence of God and the skill of the doctors who have cared for me. And I am pleased to avail myself of the occasion to express my particular gratitude to the Members of the Academy who from all parts of the world have sent me their good wishes and assured me of their prayers.

Topics arouse interest

2. During this Study Week, you are dealing with the subject "Cosmology and Fundamental Physics", with the participation of scholars from the whole world, from as far away as North and South America and Europe and China. This subject is linked to themes already dealt with by the Pontifical Academy of Sciences in the course of its prestigious history. Here I wish to speak of the sessions on microeisms, stellar clusters

and galactic nuclei, sessions which have taken place under the presidency of Father Gemelli, Monsignor Lemaitre and also Father O'Connell, to whom I address my most fervent good wishes and whom I pray the Lord to assist in his infirmity.

Cosmogony and cosmology have always aroused great interest among peoples and religions. The Bible itself speaks to us of the origin of the universe and its make-up, not in order to provide us with a scientific treatise, but in order to state the correct relationships of man with God and with the universe. Sacred Scripture wishes simply to declare that the world was created by God, and in order to teach this truth it expresses itself in the terms of the cosmology in use at the time of the writer. The Sacred Book likewise wishes to tell men that the world was not created as the seat of the gods, as was taught by other cosmogonies and cosmologies, but was rather created for the service of man and the glory of God. Any other teaching about the origin and make-up of the universe is alien to the intentions of the Bible, which does not wish to teach us how heaven was made but how one goes to heaven.

Any scientific hypothesis on the origin of the world, such as the hypothesis of a primitive atom from which derived the whole of the physical universe, leaves open the problem concerning the universe's beginning. Science cannot of itself solve this question; there is needed that human knowledge that rises above physics and astrophysics and which is call metaphysics; there is needed above all the knowledge that comes from God's revelation. Thirty years ago, on November 22, 1951, my predecessor Pope Pius XII, speaking about the problem of the origin of the universe at the Study Week on the subject of microeisms organized by the Pontifical Academy of Sciences, expressed himself as follows: "in vain would one expect a reply from the sciences of nature, which on the contrary frankly declare that they find themselves faced by an insoluble enigma. It is equally certain that the human mind versed in philosophical meditation penetrates the problem more deeply. On cannot deny that a mind which is enlightened and enriched by modern scientific knowledge and which calmly considers this problem is led to break the circle of matter which is totally independent and autonomous—as being either uncreated or having created itself—and to rise to a creating Mind. With the same clear and critical gaze with which it examines and judges the facts, it discerns and recognizes there the word of creative Omnipotence, whose strength raised up by the powerful *fiat* uttered millions of years ago by the creating Mind, has spread through the universe, calling into existence, in a gesture of generous love, matter teeming with energy".

“Impact of Molecular Biology on Society”

3. Members of the Academy, I am very pleased with the theme that you have chosen for your Plenary Session beginning on this very day: “The Impact of Molecular Biology on Society”. I realize the advantage that result—and can still result—from the study and applications of molecular biology, supplemented by other disciplines such as genetics and its technological application in agriculture and industry, and also, as is envisaged, for the treatment of various illnesses, some of a hereditary character.

I have firm confidence in the world scientific community, and in a very special way in the Pontifical Academy of Sciences, and I am certain that thanks to them biological progress and research, as also all other forms of scientific research and its technological application, will be carried out in full respect for the norms of morality, safeguarding human dignity, freedom and equality. It is necessary that science should always be accompanied and controlled by the wisdom that belongs to the permanent spiritual heritage of humanity and that takes its inspiration from the design of God implanted in creation before being subsequently proclaimed by his Word.

Reflection that is inspired by science and by the wisdom of the world scientific community must enlighten humanity regarding the consequences—good and bad—of scientific research, and especially of that research which concerns man, so that, on the one hand, there will be no fixation on anticultural positions that retard the progress of humanity, and that on the other hand there will be no attack on man’s most precious possession: the dignity of his person, destined to true progress in the unity of his physical, intellectual and spiritual well-being.

The question of parasitic diseases

4. There is another subject which, during these days, has occupied the thoughts of some of you, eminent scholars from different parts of the world who have been brought together by the Pontifical Academy of Sciences: the question of parasitic diseases, diseases which strike the poorest countries of the world and are a serious obstacle to the development of man in the harmonious framework of his physical, economic and spiritual well-being. The efforts to eliminate, as far as possible, the serious harm caused by parasitic diseases to a considerable part of humanity are inseparable from the efforts which should be made for the socioeconomic development of those same peoples. Human beings normally need a basic minimum of health and material goods in order to be able to live in a manner worthy of their human and divine

vocation. It is for this reason that Jesus turned with infinite love to the sick and infirm, and that he miraculously cured some of the diseases about which you have been concerned in these past days. May the Lord inspire and assist the work of the scientists and doctors who dedicate their research and profession to the study and treatment of human infirmities, especially those which are the most grave and humiliating.

5. In addition to the question of parasitic diseases, the Academy has been studying the question of a scourge of catastrophic dimensions and gravity that could attack the health of humanity if a nuclear conflict were to break out. Over and above the death of a considerable part of the world's population, a nuclear conflict could have incalculable effects on the health of the present and future generations.

The multi-disciplinary study which you are preparing to undertake cannot fail to be for the Heads of State a reminder of their tremendous responsibilities, and arouse in all humanity an ever more intense desire for concord and peace, a desire which comes from the most profound depths of the human heart, and also from the message of Christ who came to bring peace to people of good will.

By virtue of my universal mission, I wish to make myself once more the spokesman of the human right to justice and peace, and of the will of God who wishes all people to be saved. And I renew the appeal that I made at Hiroshima on February 25 of this year, "Let us pledge ourselves to peace through justice; let us now take a solemn decision, now, that war will never be tolerated or sought as a means of resolving differences; let us promise our fellow human beings that we will work untiringly for disarmament and the banishing of all nuclear weapons; let us replace violence and hate with confidence and caring."

Energy problem

6. Among the efforts to be made in order to secure the peace of humanity, there is the effort to ensure for all peoples the energy needed for their peaceful development. The Academy concerned itself with this problem during its Study Week last year. I am happy to be able to award today the Pius XI Gold Medal to a scientist who has contributed in an outstanding way, by his research in the field of photo-chemistry, to the utilization of solar energy: Professor Jean-Marie Lehn of the College de France and the University of Strasbourg, and I express to him my most cordial congratulations.

To all of you, I offer my sincere compliments on the work which you are doing in scientific research. I pray that Almighty God will bless you, your families, your loved ones, your collaborators, and the whole of humanity, for whom in diverse yet converging ways you and I are carrying out the mission which has been entrusted to us by God.

Man, the image of God, is a spiritual and corporeal being

General Audience of April 16, 1986 based on Wisdom 8:5-9.

1. Man, created in the image of God, is a being both corporeal and spiritual. On the one hand, he is bound to the external world, and on the other, he transcends it. As a spirit, besides being body, he is a person. This truth about man is an object of our faith, as is the biblical truth about his being constituted in the "image and likeness" of God. It is a truth constantly presented by the Church's Magisterium during the course of the centuries.

The truth about man does not cease in the course of history to be the *object of intellectual analysis* both in the sphere of philosophy and of numerous other human sciences—in a word, the object of anthropology.

2. That man is an incarnate spirit, or if you wish, a body informed by an immortal spirit, can already be inferred in some way from the description of creation contained in the Book of Genesis and in particular from the "Yahwist" account, which uses, as it were, a stage setting and anthropomorphic images. We read that "the Lord God formed man of *dust from the ground*, and breathed into his nostrils the breath of life; and man became a living being" (Gen 2:7). The continuation of the biblical text helps us clearly understand that *man,* created in this way, *is distinguished* from the entire visible world, and in particular *from the animal world*. The "breath of life" has made man capable of knowing these beings, of naming them, and of recognizing that he was different from them (cf. Gen 2:18-20). Although the "Yahwist" account *does not speak of the "soul,"* nevertheless *it can be easily deduced from it* that the life given to man in the act of creation is such as to transcend the mere corporeal dimension (that proper to animals). It reaches, beyond the material, *the dimension of the spirit*, wherein there is the essential foundation of that "image of God," which Genesis 1:27 sees in man.

Unity and duality

3. Man is *a unity*: he is one in himself. But in this *unity there is contained a duality*. Sacred Scripture presents both the unity (the person) and the duality (body and soul). One thinks of the Book of Sirach which says, for example: "The Lord created man out of earth, and turned him back to it again"; and further on: "He forms men's tongues and eyes and ears, and imparts to them an understanding heart. With wisdom and knowledge he fills them; good and evil he shows them" (17:1, 5-6).

From this point of view, Psalm 8 is particularly significant. Exalting man, it addresses God in the following words: "What is man that you should be mindful of him, or the son of man that you should care for him? *You have made him little less than the angels*, and crowned him with glory and honor. You have given him rule over the works of your hands, putting all things under his feet" (Ps 8:5-7).

4. It is frequently emphasized that *biblical tradition* stresses *especially the personal unity of man*, by using the term "body" to designate the whole man (cf. Ps 144[145]:21, Joel 3:1; Is 66:23; Jn 1:14). The observation is exact. But notwithstanding this, *the duality* of man is also present in biblical tradition, sometimes very clearly. This tradition is reflected in Christ's words: "Do not fear those who deprive the body of life but cannot destroy the soul. Rather, fear him who can destroy both body and soul in Gehenna" (Mt 10:28).

5. Biblical sources authorize us to view man as a personal unity and at the same time as a duality of soul and body, a concept that found expression in the Church's entire Tradition and teaching. This teaching has assimilated not only the biblical sources, but also the theological interpretations of them which have been given by developing the analyses conducted by certain schools (Aristotle) of Greek philosophy. It has been a slow, constant work of reflection, culminating principally—under the influence of St. Thomas Aquinas—in the pronouncements of the Council of Vienne (1312), where the soul is called the *"form" of the body: forma corporis humani per se essentialiter* (DS 902). The "form", as a factor determining the substance of the being "man", is of a spiritual nature. And this *spiritual "form", the soul, is immortal*. This was authoritatively stated later by the Fifth Lateran Council (1513): the soul is immortal, in contrast with the body which is subject to death (cf. DS 1440). The Thomistic school emphasizes at the same time that, by virtue of the substantial union of body and soul, this latter, even

after death, does not cease to "aspire" to be reunited with the body. This is confirmed by the revealed truth about the resurrection of the body.

6. Although the philosophical terminology used to express the unity and complexity (duality) of man is sometimes the object of criticism, it is beyond doubt that the doctrine on the unity of the human person and at the same time on the spiritual-corporeal duality of man is fully rooted in Sacred Scripture and Tradition. Notwithstanding the frequent expression of the conviction that man is the "image of God" because of the soul, traditional doctrine does not lack the conviction that the body also participates, in its own way, in the dignity of the "image of God", just as it participates in the dignity of the person.

7. *In modern times the theory of evolution* has raised a special difficulty against the revealed doctrine about the creation of man as a being composed of soul and body. Many natural scientists who, with their own methods, study the problem of the origin of human life on earth, maintain—contrary to other colleagues of theirs—not only the existence of a link between man and the ensemble of nature, but also his *derivation from the higher animal species*. This problem has occupied scientists since the last century and involves vast layers of public opinion.

The reply of the Magisterium was offered in the encyclical *Humani Generis* of Pius XII in 1950. In it we read: "The Magisterium of the Church is not opposed to the theory of evolution being the object of investigation and discussion among experts. Here the theory of evolution is understood as an investigation of the origin of the human body from pre-existing living matter, for the Catholic faith obliges us to hold firmly that souls are created immediately by God…" (DS 3896).

It can therefore be said that, from the viewpoint of the doctrine of the faith, there are no difficulties in explaining the origin of man, in regard to the body, by means of the theory of evolution. It must, however, be added that this hypothesis proposes only a probability, not a scientific certainty. *The doctrine of faith, however,* invariably *affirms* that *man's spiritual soul is created directly by God*. According to the hypothesis mentioned, it is possible that the human body, following the order impressed by the Creator on the energies of life, could have been gradually prepared in the forms of antecedent living beings. The human soul, however, on which man's humanity definitively depends, cannot emerge from matter, since it is of a spiritual nature.

8. A fine synthesis of creation as set out above is found in the Second Vatican Council: “Man, though made of body and soul, is a unity. Through his very bodily condition *he sums up in himself the elements of the material world*. Through him they are thus brought to their highest perfection…” (*Gaudium et Spes* 14). And further on: “Man is not deceived when he regards himself as *superior to bodily things*, and is more than just a speck of nature… For *by his power to know himself in the depths of his being he rises above the whole universe of mere objects*” (Ibid.).

In this way, then, the same truth about the unity and duality (the complexity) of human nature can be expressed in a language closer to the modern mentality.

Follow the guidelines of *Gaudium et Spes* in the light of scientific progress

Address given on September 5, 1986 to participants in a colloquium on science, philosophy and theology.

Ladies and Gentlemen,

1. You have taken the initiative of holding a colloquium at Rome on the theme "Science, Philosophy and Theology: Science and perspectives for man. The relative and the absolute". On this occasion you wished to meet the Pope, in your concern to show, at the very heart of your researches, an unfailing fidelity to the Catholic faith and to the directives of the ministry of Peter.

Even if this meeting is short, I receive you with joy. As you know, I attach great importance to the exact research of the truth, and to the sincere encounter of all who dedicate themselves to this task, from the starting-point of their own field of observations, studies and reflections, with respect for their methodology and for their epistemology. Truth is one. However, it presents itself to us in a fragmented manner along the many paths that lead us to approach it in a differential way. Thus it is man's greatness that he dedicates himself unwearyingly to penetrate all the dimensions of truth.

Seek the link between science and faith

By its very nature, reason is orientated to truth. Faith is adherence to the truth, and the very source of truth is revealed to the intelligence and the love of man. You belong to various disciplines of science—with natural sciences and the human sciences—with very different methods. Those among you who are philosophers and theologians know well that, as sciences, philosophy and theology themselves are limited endeavors to grasp the complex unity of the truth. We must both pursue the search for a living synthesis, driven to this by the nostalgia for such a synthesis, and also avoid any false harmonization that would not respect the orders of knowledge which are distinct, as are the degrees of certainty.

I am happy also to see your initiative, like all the other efforts to find the link between science and faith, without minimizing either of these two terms, but fully honoring the requirements of the one and of the other.

2. One of the great concerns of the Church is that of the pastoral care of the intellect, in a way that takes into account the complex data of the scientific culture of our time, with the new problems that have arisen because of the place of the sciences in contemporary culture. The Second Vatican Council, in the Pastoral Constitution *Gaudium et Spes*, has given the broad outlines in this respect, but these must be continually lived out, realized anew, in the light of the progress made by scientific knowledge. Here, Christian scholars have an essential responsibility. All too often, the specifically scientific languages remain difficult to understand for the non-initiated, including the majority of philosophers and theologians. This indicates the necessity of a permanent encounter between the renewed scientific vision of the human person and of the world on the one hand, and the results obtained by philosophical research and theological reflection on the other hand. The contemporary vision of the cosmos, the concept of time and space, the ever-multiplying discoveries of physics, of chemistry, of biology, and also of modern cosmology, together with the new contributions made by the human sciences, demand a renewed formulation of Christian anthropology, and a renewal of philosophical thinking among Christians.

Church stresses the importance of philosophy

3. Therefore, you contribute interesting material for the philosophical reflection which, in its turn, will bring you into an essential perspective, of a different order. In any case, you often observe, in the scientific milieux of your universities, a certain embarrassment when confronted with all the questions that go beyond observation, hypothesis, and technical application. Yet, the fundamental questions of metaphysics, concerning what lies beyond the phenomena, the questions of being, of the meaning and the finality of the cosmos and of man, of his relationship to God, of the infinite, of transcendence: all these remain just as important today as in the past, as some recent philosophy has shown, as it has continued the classical philosophy of being and taken it further—I am thinking of Etienne Gilson, Jacques Maritain… You yourselves are convinced of this, whether you are philosophers, or thanks to the intuitions that are bound to your faith: there is no doubt that your vocation is to contribute to opening up your own milieux to these fundamental questions.

4. The reflection of the reason, when well carried out, likewise has a highly important role to play in giving assurance to what is presupposed by faith, which is obviously of a different order. With good reason, the Magisterium of the Church has often insisted on the necessity of philosophy as the presupposition of the normal exercise of the life of faith in human minds. The Church indeed has no doubt of the power of reason. Rather, she earnestly calls for a reflection that is demanded by the new cultural situation; this situation is created by the development of the sciences and by the new ethical problems born of the emergence of a scientific and technical society.

God's plan

Sometimes it can seem that the vision of the world and of history suggested by the scientific data in the present stage of researches, or even by philosophical reflection, is hard to harmonize with the certain data of the faith. The theological teaching of the Bible, like the doctrine of the Church which makes this explicit, does not seek so much to teach us the *how* of things, as rather the *why* of things. It reveals to us the unheard-of and primordial grace given to man by God, his destiny, the mystery of his freedom, the gravity of his sin, the Redemption. This plan of God, which explains Christian anthropology, cannot be deduced from scientific data, nor has it entered into the heart of man (cf. 1 Cor 2:9). Your glory as faithful believers is to adhere loyally and firmly to this, to seek to penetrate its profound sense which lies beyond the metaphors, and to base yourselves on these essential points of faith, while always remaining scholars who never give up observing, reflecting, and forming hypotheses that are to be verified and checked. This is the demanding path on which you are called to walk, with your gaze fixed on the two aspects of the truth, so that your horizon will ever be broadened as a result of these.

5. These, my dear friends, are some reflections that invite you to have intellectual courage and to make the effort of thought: for the Christian, these go together with the commitment to a life that is authentically evangelical.

Thanks be to God that you are not alone in your researches; other centers of reflection join you. I hope that fraternal communication may bring both you and them the benefit of your knowledge and of your exchange. I trust that you may be able to meet and to work together on what is common to you, and essential, the faith. I hope that a whole pastoral care of the intellect may develop in your dioceses, under the responsibility of your bishops, bringing specific help to Christian scientists, and also to

other scientists of good will who wish to profit from their reflection, their witness, and their prayer!

Yes, our time needs people of science, philosophers and theologians who are both people of culture and people of faith, always ready for dialogue with their brothers, because they are assiduous in their encounter with God, in prayer, the meditation of the Word of God, and the sacramental life.

This is what I wish for you; this is my prayer, with my heartfelt Apostolic Blessing.

Our knowledge of God and nature: physics, philosophy and theology

Letter of Pope John Paul II, dated June 1, 1988, to the Director of the Vatican Observatory. The occasion of the letter was the recognition of a study week sponsored by the Holy See marking the three hundredth anniversary of the publication of Sir Isaac Newton's "Philosophiae Naturalis Principia Mathematica".

To the Reverend George V. Coyne, S. J.

Director of the Vatican Observatory

"Grace to you and peace from God our Father and the Lord Jesus Christ" (Eph 1:2).

As you prepare to publish the papers presented at the Study Week held at Castel Gandolfo on September 21-26, 1987, I take the occasion to express my gratitude to you and through you to all who contributed to that important initiative. I am confident that the publication of these papers will ensure that the fruits of that endeavor will be further enriched.

The three hundredth anniversary of the publication of Newton's *Philosophiae Naturalis Principia Mathematica* provided an appropriate occasion for the Holy See to sponsor a Study Week that investigated the multiple relationships between theology, philosophy and the natural sciences. The man so honored, Sir Isaac Newton, had himself devoted much of his life to these same issues, and his reflections upon them can be found throughout his major works, his unfinished manuscripts and his vast correspondence. The publication of your own papers from this Study Week, taking up again some of the same questions which this great genius explored, affords me the opportunity to thank you for the efforts you devoted to a subject of such paramount importance. The theme of your conference, "Our Knowledge of God and Nature: Physics, Philosophy and Theology", is assuredly a crucial one for the contemporary world. Because of its importance, I should like to address some issues which the interactions between natural science, philosophy, and theology present to the Church and to human society in general.

The Church and the Academy engage one another as two very different but major institutions within human civilization and world culture. We bear before God enormous

responsibilities for the human condition because historically we have had and continue to have a major influence on the development of ideas and values and on the course of human action. We both have histories stretching back over thousands of years: the learned, academic community dating back to the origins of culture, to the city and the library and the school, and the Church with her historical roots in ancient Israel. We have come into contact often during these centuries, sometimes in mutual support, at other times in those needless conflicts which have marred both our histories. In your conference we met again, and it was altogether fitting that as we approach the close of this millennium we initiated a series of reflections together upon the world as we touch it and as it shapes and challenges our actions.

A growing critical openness

So much of our world seems to be in fragments, in disjointed pieces. So much of human life is passed in isolation or in hostility. The division between rich nations and poor nations continues to grow; the contrast between northern and southern regions of our planet becomes ever more marked and intolerable. The antagonism between races and religions splits countries into warring camps; historical animosities show no signs of abating. Even within the academic community, the separation between truth and values persists, and the isolation of their several cultures—scientific, humanistic and religious—makes common discourse difficult if not at times impossible.

But at the same time we see in large sectors of the human community a growing critical openness towards people of different cultures and backgrounds, different competencies and viewpoints. More and more frequently, people are seeking intellectual coherence and collaboration, and are discovering values and experiences they have in common even within their diversities. This openness, this dynamic interchange, is a notable feature of the international scientific communities themselves, and is based on common interests, common goals and a common enterprise, along with a deep awareness that the insights and attainments of one are often important for the progress of the other. In a similar but more subtle way this has occurred and is continuing to occur among more diverse groups—among the communities that make up the Church, and even between the scientific community and the Church herself. This drive is essentially a movement towards the kind of unity which resists homogenization and relishes diversity. Such community is determined by a common meaning and a shared understanding that evokes a sense of mutual involvement. Two groups which may seem initially to have nothing in common can begin to enter into community with

one another by discovering a common goal, and this in turn can lead to broader areas of shared understanding and concern.

As never before in her history, the Church has entered into the movement for the union of all Christians, fostering common study, prayer, and discussions that "all may be one" (Jn 17:20). She has attempted to rid herself of every vestige of anti-Semitism and to emphasize her origins in and her religious debt to Judaism. In reflection and prayer, she has reached out to the great world religions, recognizing the values we all hold in common and our universal and utter dependence upon God.

Within the Church herself, there is a growing sense of "world-church", so much in evidence at the last Ecumenical Council in which bishops native to every continent— no longer predominantly of European or even Western origin— assumed for the first time their common responsibility for the entire Church. The documents from that Council and of the magisterium have reflected this new world-consciousness both in their content and in their attempt to address all people of good will. During this century we have witnessed a dynamic tendency to reconciliation and unity that has taken many forms within the Church.

Nor should such a development be surprising. The Christian community in moving so emphatically in this direction is realizing in greater intensity the activity of Christ within her: "For God was in Christ, reconciling the world to himself" (2 Cor 5:19). We ourselves are called to be a continuation of this reconciliation of human beings, one with another and all with God. Our very nature as Church entails this commitment to unity.

Turning to the relationship between religion and science, there has been a definite, though still fragile and provisional, movement towards a new and more nuanced interchange. We have begun to talk to one another on deeper levels than before, and wish greater openness towards one another's perspectives. We have begun to search together for a more thorough understanding of one another's disciplines, with their competencies and their limitations, and especially for areas of common ground. In doing so we have uncovered important questions which concern both of us, and which are vital to the larger human community we both serve. It is crucial that this common search based on critical openness and interchange should not only continue but also grow and deepen in its quality and scope.

For the impact each has, and will continue to have, on the course of civilization and on the world itself, cannot be overestimated, and there is so much that each can offer the other. There is, of course, the vision of the unity of all things and all peoples in Christ, who is active and present with us in our daily lives—in our struggles, our sufferings, our joys and in our searchings—and who is the focus of the Church's life and witness. This vision carries with it into the larger community a deep reverence for all that is, a hope and assurance that the fragile goodness, beauty and life we see in the universe is moving towards a completion and fulfillment which will not be overwhelmed by the forces of dissolution and death. This vision also provides a strong support for the values which are emerging both from our knowledge and appreciation of creation and of ourselves as the products, knowers and stewards of creation.

The scientific disciplines too, as is obvious, are endowing us with an understanding and appreciation of our universe as a whole and of the incredibly rich variety of intricately related processes and structures which constitute its animate and inanimate components. This knowledge has given us a more thorough understanding of ourselves and of our humble yet unique role within creation. Through technology it also has given us the capacity to travel, to communicate, to build, to cure, and to probe in ways which would have been almost unimaginable to our ancestors. Such knowledge and power, as we have discovered, can be used greatly to enhance and improve our lives or they can be exploited to diminish and destroy human life and the environment even on a global scale.

The unity we perceive in creation on the basis of our faith in Jesus Christ as Lord of the universe, and the correlative unity for which we strive in our human communities, seems to be reflected and even reinforced in what contemporary science is revealing to us. As we behold the incredible development of scientific research we detect an underlying movement towards the discovery of levels of law and process which unify created reality and which at the same time have given rise to the vast diversity of structures and organisms which constitute the physical and biological, and even the psychological and sociological, worlds.

Contemporary physics furnishes a striking example. The quest for the unification of all four fundamental physical forces—gravitation, electro-magnetism, the strong and weak nuclear interactions—has met with increasing success. This unification may well combine discoveries from the subatomic and the cosmological domains and shed light both on the origin of the universe and, eventually, on, the origin of the laws and

constants which govern its evolution. Physicists possess a detailed though incomplete and provisional knowledge of elementary particles and of the fundamental forces through which they interact at low and intermediate energies. They now have an acceptable theory unifying the electro-magnetic and weak nuclear forces, along with much less adequate but still promising grand unified field theories which attempt to incorporate the strong nuclear interaction as well. Further in the line of this same development, there are already several detailed suggestions for the final stage, superunification, that is, the unification of all four fundamental forces, including gravity. Is it not important for us to note that in a world of such detailed specialization as contemporary physics there exists this drive towards convergence?

In the life sciences, too, something similar has happened. Molecular biologists have probed the structure of living material, its functions and its processes of replication. They have discovered that the same underlying constituents serve in the make-up of all living organisms on earth and constitute both the genes and the proteins which these genes code. This is another impressive manifestation of the unity of nature.

By encouraging openness between the Church and the scientific communities, we are not envisioning a disciplinary unity between theology and science like that which exists within a given scientific field or within theology proper. As dialogue and common searching continue, there will be growth towards mutual understanding and a gradual uncovering of common concerns which will provide the basis for further research and discussion. Exactly what form that will take must be left to the future. What is important, as we have already stressed, is that the dialogue should continue and grow in depth and scope. In the process we must overcome every regressive tendency to a unilateral reductionism, to fear, and to self-imposed isolation. What is critically important is that each discipline should continue to enrich, nourish and challenge the other to be more fully what it can be and to contribute to our vision of who we are and who we are becoming.

We might ask whether or not we are ready for this crucial endeavor. Is the community of world religions, including the Church, ready to enter into a more thoroughgoing dialogue with the scientific community, a dialogue in which the integrity of both religion and science is supported and the advance of each is fostered? Is the scientific community now prepared to open itself to Christianity, and indeed to all the great world religions, working with us all to build a culture that is more humane and in that way more divine? Do we dare to risk the honesty and the courage that this task

demands? We must ask ourselves whether both science and religion will contribute to the integration of human culture or to its fragmentation. It is a single choice and it confronts us all.

For a simple neutrality is no longer acceptable. If they are to grow and mature, peoples cannot continue to live in separate compartments, pursuing totally divergent interests from which they evaluate and judge their world. A divided community fosters a fragmented vision of the world; a community of interchange encourages its members to expand their partial perspectives and form a new unified vision.

Yet the unity that we seek, as we have already stressed, is not identity. The Church does not propose that science should become religion or religion science. On the contrary, unity always presupposes the diversity and the integrity of its elements. Each of these members should become not less itself but more itself in a dynamic interchange, for a unity in which one of the elements is reduced to the other is destructive, false in its promises of harmony, and ruinous of the integrity of its components. We are asked to become one. We are not asked to become each other.

Religion and science must preserve their autonomy

To be more specific, both religion and science must preserve their autonomy and their distinctiveness. Religion is not founded on science nor is science an extension of religion. Each should possess its own principles, its pattern of procedures, its diversities of interpretation and its own conclusions. Christianity possesses the source of its justification within itself and does not expect science to constitute its primary apologetic. Science must bear witness to its own worth. While each can and should support the other as distinct dimensions of a common human culture, neither ought to assume that it forms a necessary premise for the other. The unprecedented opportunity we have today is for a common interactive relationship in which each discipline retains its integrity and yet is radically open to the discoveries and insights of the other.

But why is critical openness and mutual interchange a value for both of us? Unity involves the drive of the human mind towards understanding and the desire of the human spirit for love. When human beings seek to understand the multiplicities that surround them, when they seek to make sense of experience, they do so by bringing many factors into a common vision. Understanding is achieved when many data are unified by a common structure. The one illuminates the many; it makes sense of the whole. Simple multiplicity is chaos; an insight, a single model, can give that chaos

structure and draw it into intelligibility. We move towards unity as we move towards meaning in our lives. Unity is also the consequence of love. If love is genuine, it moves not towards the assimilation of the other but towards union with the other. Human community begins in desire when that union has not been achieved, and it is completed in joy when those who have been apart are now united.

In the Church's earliest documents, the realization of community, in the radical sense of that word, was seen as the promise and goal of the Gospel: "That which we have seen and heard we proclaim also to you, so that you may have fellowship with us, and our fellowship is with the Father and with his Son Jesus Christ. And we are writing this that our joy may be complete" (1 Jn 1:3-3). Later the Church reached out to the sciences and to the arts, founding great universities and building monuments of surpassing beauty so that all things might be recapitulated in Christ (cf. Eph 1:10).

What, then, does the Church encourage in this relational unity between science and religion? First and foremost that they should come to understand one another. For too long a time they have been at arm's length. Theology has been defined as an effort of faith to achieve understanding, as *fides quaerens intellectum*. As such, it must be in vital interchange today with science just as it always has been with philosophy and other forms of learning. Theology will have to call on the findings of science to one degree or another as it pursues its primary concern for the human person, the reaches of freedom, the possibilities of Christian community, the nature of belief and the intelligibility of nature and history. The vitality and significance of theology for humanity will in a profound way be reflected in its ability to incorporate these findings.

Now this is a point of delicate importance, and it has to be carefully qualified. Theology is not to incorporate indifferently each new philosophical or scientific theory. As these findings become part of the intellectual culture of the time, however, theologians must understand them and test their value in bringing out from Christian belief some of the possibilities which have not yet been realized. The hylomorphism of Aristotelian natural philosophy, for example, was adopted by the medieval theologians to help them explore the nature of the sacraments and the hypostatic union. This did not mean that the Church adjudicated the truth or falsity of the Aristotelian insight, since that is not her concern. It did mean that this was one of the rich insights offered by Greek culture, that it needed to be understood and taken seriously and tested for its value in illuminating various areas of theology. Theologians might well ask, with respect to contemporary science, philosophy and the other areas of human knowing, if they

have accomplished this extraordinarily difficult process as well as did these medieval masters.

No substitute for knowledge of the ultimate

If the cosmologies of the ancient Near Eastern world could be purified and assimilated into the first chapters of Genesis, might not contemporary cosmology have something to offer to our reflections upon creation? Does an evolutionary perspective bring any light to bear upon theological anthropology, the meaning of the human person as the *imago Dei*, the problem of Christology—and even upon the development of doctrine itself? What, if any, are the eschatological implications of contemporary cosmology, especially in light of the vast future of our universe? Can theological method fruitfully appropriate insights from scientific methodology and the philosophy of science?

Questions of this kind can be suggested in abundance. Pursuing them further would require the sort of intense dialogue with contemporary science that has, on the whole, been lacking among those engaged in theological research and teaching. It would entail that some theologians, at least, should be sufficiently well versed in the sciences to make authentic and creative use of the resources that the best established theories may offer them. Such an expertise would prevent them from making uncritical and overhasty use for apologetic purposes of such recent theories as that of the "Big Bang" in cosmology. Yet it would equally keep them from discounting altogether the potential relevance of such theories to the deepening of understanding in traditional areas of theological inquiry.

In this process of mutual learning, those members of the Church who are themselves either active scientists or, in some special cases, both scientists and theologians, could serve as a key resource. They can also provide a much-needed ministry to others struggling to integrate the worlds of science and religion in their own intellectual and spiritual lives, as well as to those who face difficult moral decisions in matters of technological research and application. Such bridging ministries must be nurtured and encouraged. The Church long ago recognized the importance of such links by establishing the Pontifical Academy of Sciences, in which some of the world's leading scientists meet together regularly to discuss their researches and to convey to the larger community where the directions of discovery are tending. But much more is needed.

The matter is urgent. Contemporary developments in science challenge theology far more deeply than did the introduction of Aristotle into Western Europe in the thirteenth century. Yet these developments also offer to theology a potentially important resource. Just as Aristotelian philosophy, through the ministry of such great scholars as St. Thomas Aquinas, ultimately came to shape some of the most profound expressions of theological doctrine, so can we not hope that the sciences of today, along with all forms of human knowing, may invigorate and inform those parts of the theological enterprise that bear on the relation of nature, humanity and God?

Can science also benefit from this interchange? It would seem that it should. For science develops best when its concepts and conclusions are integrated into the broader human culture and its concerns for ultimate meaning and value. Scientists cannot, therefore, hold themselves entirely aloof from the sorts of issues dealt with by philosophers and theologians. By devoting to these issues something of the energy and care they give to their research in science, they can help others realize more fully the human potentialities of their discoveries. They can also come to appreciate for themselves that these discoveries cannot be a genuine substitute for knowledge of the truly ultimate. Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes. Each can draw the other into a wider world, a world in which both can flourish.

For the truth of the matter is that the Church and the scientific community will inevitably interact; their options do not include isolation. Christians will inevitably assimilate the prevailing ideas about the world, and today these are deeply shaped by science. The only question is whether they will do this critically or unreflectively, with depth and nuance or with a shallowness that debases the Gospel and leaves us ashamed before history. Scientists, like all human beings, will make decisions upon what ultimately gives meaning and value to their lives and to their work. This they will do well or poorly, with the reflective depth that theological wisdom can help them attain, or with an unconsidered absolutizing of their results beyond their reasonable and proper limits.

Both the Church and the scientific community are faced with such inescapable alternatives. We shall make our choices much better if we live in a collaborative interaction in which we are called continually to be more. Only a dynamic relationship between theology and science can reveal those limits which support the integrity of either discipline, so that theology does not profess a pseudo-science and science does

not become an unconscious theology. Our knowledge of each other can lead us to be more authentically ourselves. No one can read the history of the past century and not realize that crisis is upon us both. The uses of science have on more than one occasion proved massively destructive, and the reflections on religion have too often been sterile. We need each other to be what we must be, what we are called to be.

And so on this occasion of the Newton Tercentennial, the Church speaking through my ministry calls upon herself and the scientific community to intensify their constructive relations of interchange through unity. You are called to learn from one another, to renew the context in which science is done and to nourish the inculturation which vital theology demands. Each of you has everything to gain from such an interaction, and the human community which we both serve has a right to demand it from us.

Upon all who participated in the Study Week sponsored by the Holy See and upon all who will read and study the published papers thereof, I invoke wisdom and peace in our Lord Jesus Christ and cordially impart my Apostolic Blessing.

‘Do the truth’ for the good of humanity

Address given on October 31, 1988 to the plenary session of the Pontifical Academy of Sciences.

Mr. President,

Eminent Cardinals,

Excellencies,

1. I am happy to meet the Members of the Pontifical Academy of Sciences on the occasion of the plenary session which dealt with the theme of the responsibility of science. The importance of this meeting is underlined by the presence of the Cardinals and of the Heads of the Diplomatic Missions accredited to the Holy See. I thank them for their interest in the work of the Academy.

This plenary meeting takes place following a study week in the course of which two groups of experts from all over the world discussed, on the one hand, “agriculture and the quality of life”, and on the other, “the structure and function of the brain”.

On the question of agriculture, the experts were able to carry out a wide assessment where the scientific and technical aspects of the problem are finally catching up with the ethical aspects. On one hand, scientific research has made possible a considerable increase of the world’s food production. On a global scale, agricultural production today would be sufficient to satisfy the needs of the whole of humanity. This observation raises by contrast the dramatic problem of hunger and malnutrition in the world. Certainly, one must take into account the physical and material obstacles, such as the great difference in levels of fertility in the different regions. But the very unequal distribution of food resources has not yet given rise to an overall policy, nor to sufficiently effective projects to ensure that agricultural production benefits all peoples and all individuals. Once more, we must observe that the problem of development requires above all a political will and action of an ethical and cultural nature, as I said in the Encyclical *Sollicitudo Rei Socialis*. The key to all human development is to be found in a generous effort of solidarity among all groups and all men and women of good will. With good reason did you stress that the necessary interventions with regard to this

grave question should respect individuals and their own traditions, that is to say, they should go beyond the strictly economic and technical levels and take into consideration the principles of social justice and of the authentic development of the human person.

The mystery of the human spirit

2. A second group of scholars evaluated the studies on the human brain and its marvelous functions. The results of research provide better understanding today of the organic structures and processes which underlie the cognitive and affective operations of the human being. But beyond all empirical observation, there appears the mystery of the spirit; which cannot be reduced to the biological supports which come into play in the behavior of the intelligent being open to transcendence. Confronted with what is now known about the brain, the believer cannot forget the words of the Book of Genesis: “The Lord God formed man of dust from the ground, and breathed into his nostrils the breath of life” (Gen 2:7). In anthropological terms, the ancient narrative of creation brings out very well the intimate bond that exists between the physical organ and the spirit in man. Thus it was opportune that scientists compare the results of their experimental studies with the reflections of philosophers and theologians on the relationship between the spirit and the cerebral apparatus. Niels Stensen, in his “Discourse on the anatomy of the brain”, had already said of the brain that it was “the most beautiful masterpiece of nature”.

3. You desired to take part in the recent celebration of the beatification of Niels Stensen, that great scientist who sought, in his whole life and work, to reconcile the different orders of knowledge which constitute the grandeur of the human being. Your Academy, together with Denmark, desired that the memory of this event should endure and be commemorated by a plaque placed in its own offices. I must express my deep gratitude to the Danish nation and to the Academy for this gesture.

4. Today, having very much in mind the itinerary followed by Niels Stensen throughout his life, I would like to note here some elements which contribute to deepening the meaning, the value and the responsibility of science. This scientist explored the marvels of nature, particularly in the domains of anatomy, physiology and geology. While pursuing his studies of the natural phenomena, he never lost sight of that which transcends nature itself and, while directing his attention to the infinitely minute and to measurable data, he always remained open to the grandeurs that surpass

all measure. For him, the synthesis of knowledge combines the data obtained thanks to experiments on nature and the values which, while inaccessible to experimentation perceptible to the senses, nevertheless form part of reality. Stensen was profoundly attracted by the beauty of the physical universe, but even more so by spiritual values and the nobility of human behavior. He studied with care the certitudes of the mathematical order, but he was just as much drawn by other certitudes of the historical, moral and spiritual orders.

5. Experimental science arouses a legitimate admiration, and the Church willingly encourages the research of scientists who help us to understand the enigmas of the physical and biological universe. Yet experimental science does not exhaust the whole knowledge of reality. Beyond the visible and sensible, there exists another dimension of reality, attested to by our most profound experience: this is the world of the mind, of moral and spiritual values. Above all, there is the order of charity, which binds us to each other and to God whose name is Love and Truth.

Even with the frailty of his condition as creature, man still maintains the imprint of the original divine unity in which all perfections are united without confusion. In the visible world, these perfections appear dispersed and diminished, but they no less effectively recall, particularly in man, the image of the true unity of the Creator. This image is that of the Truth itself.

Such are the characteristics of the overall synthesis which establishes the unity of knowledge and which inspires, by way of consequence, a unity and consistency of behavior. It is a question here of a unity constantly to be built, according to the dynamic characteristics of life.

6. My predecessor, Pope Pius XI, in one of the first speeches which he addressed to the Pontifical Academy of Sciences after its reconstitution, developed at length this theme of truth. He said that it is important to conceive and to affirm the truth, but that it is still more important to recall that “he who *does* what is true comes to the light” (Jn 3:21). This is the fundamental rule of thought and of action which transforms every work into a visible reflection of the truth. It was this ideal that inspired Pius XI when, in 1936, he named the first seventy members of the restored Academy, inviting them to take part in it in view of the importance of their original scientific studies and their high moral quality, without any ethnic or religious discrimination. This is still expressed in

your Statues and it is in the same spirit that I invite you to pursue your work and your research.

7. The Pope still today asks your Academy to contribute to “doing the truth”, that is to say, to seek the unity of knowledge in international scientific solidarity, in human solidarity, in openness to all values, for the good of humanity.

Undoubtedly, as scholars, you must rigorously apply the rules proper to each of your disciplines so as to arrive at conclusions that will be valid and verifiable by every other specialist in your fields. Yet, while respecting the necessity for methodological abstraction and the autonomy of each discipline, you are invited to examine the results of your research in the light of the other sciences. Every scholar is called on today to participate in a patient reintegration of human knowledge. No less than the future of man and of culture is at stake.

Your Academy, which is international, presents a peculiar characteristic: on the one hand, it has the duty of working in close connection with the international scientific community and, on the other hand, it is called to collaborate with the departments of the Church so as to supply them with elements useful in the fields of their competences.

It is in this spirit that I would like to renew to the illustrious Members of the Academy the request I made during the audience for the fiftieth anniversary, urging them to promote concrete proposals which would favor interdisciplinary collaboration at all levels. While continuing your specialized programs, it would also be useful that you develop joint research projects, in close consultation with other cultural, scientific and university organisms of the Holy See. The Church needs your research to deepen her knowledge of man and of the universe. She likewise counts on your studies to confront the grave technical, cultural and spiritual problems which concern the future of human society. I thank you in advance for your indispensable contribution to our common effort to understand in greater depth the enigma of man and of his destiny, in the order of creation and in the order of salvation.

8. Before concluding, I would like very specially to greet Professor Carlos Chagas who, at the end of sixteen years of presidency, is now relinquishing the responsibilities which he discharged with such distinction, generosity and selflessness. I must pay him a very special tribute by noting the considerable work accomplished under his leadership. Thanks to him, the Academy has seen an important development in the number of its members and in the diversity of the countries from which they come; one could speak

now of universal representation. Under his impulse, the Academy has become a center of continual activity, making contact with other Academies and with scholars of numerous countries, taking up important themes in the realm of the historical sciences, for example, the studies on Galileo and Albert Einstein, in the domain of the fundamental sciences, such as research on cosmology, astronomy, the microsciences, the structure of matter, the origin of life, biological processes, or again in the field of the sciences applied to the problems of the modem world, notably in matters pertaining to peace and disarmament. One could say that the important concerns of today's world have not escaped its attention. Today, the Holy See thanks Professor Chagas for the vitality he has communicated to the Academy, for the radiance he has given to it, for his highly appreciated activity which has made it possible for the Church to become much more present to the world of science. And I am personally grateful to him for being willing to continue to place his outstanding talents at the service of the Church.

I have asked Professor Giovanni Battista Marini-Bettolo to succeed Professor Chagas. He has collaborated actively in the work of the Academy for over twenty years; in his new responsibilities, I wish him a fruitful period of work. I am confident that, with the help of the members of the Academy, he will continue the work undertaken by his predecessors.

While renewing the expression of my esteem for the work of the Academy and of my gratitude for the service it renders to the Holy See, I invoke upon you the Blessing of God.

Faith can never conflict with reason

Address given on October 31, 1992 to the Pontifical Academy of Sciences regarding the Galileo case.

Your Eminences,

Your Excellencies,

Ladies and Gentlemen,

1. The conclusion of the plenary session of the Pontifical Academy of Sciences gives me the pleasant opportunity to meet its illustrious members, in the presence of my principal collaborators and the Heads of the Diplomatic Missions accredited to the Holy See. To all of you I offer a warm welcome.

My thoughts go at this moment to Professor Marini-Bettólo, who is prevented by illness from being among us, and, assuring him of my prayers, I express fervent good wishes for his restoration to health.

I would also like to greet the members taking their seats for the first time in this Academy; I thank them for having brought to your work the contribution of their lofty qualifications.

In addition, it is a pleasure for me to note the presence of Professor Adi Shamir, of the Weizmann Institute of Science at Rehovot, Israel, holder of the Gold Medal of Pius XI, awarded by the Academy, and to offer him my cordial congratulations.

Two subjects in particular occupy our attention today. They have just been ably presented to us, and I would like to express my gratitude to Cardinal Paul Poupard and Fr. George Coyne for having done so.

I.

2. In the first place, I wish to congratulate the Pontifical Academy of Sciences for having chosen to deal, in its plenary session, with a problem of great importance and great relevance today: the problem of *the emergence of complexity in mathematics, physics, chemistry and biology.*

The emergence of the subject of complexity probably marks in the history of the natural sciences a stage as important as the stage which bears relation to the name of Galileo, when a univocal model of order seemed to be obvious. Complexity indicates precisely that, in order to account for the rich variety of reality, we must have recourse to a number of different models.

This realization poses a question which concerns scientists, philosophers and theologians: how are we to reconcile the explanation of the world—beginning with the level of elementary entities and phenomena—with the recognition of the fact that "the whole is more than the sum of its parts?"

In his effort to establish a rigorous description and formalization of the data of experience, the scientist is led to have recourse to *metascientific concepts,* the use of which is, as it were, demanded by the logic of his procedure. It is useful to state exactly the nature of these concepts in order to avoid proceeding to undue extrapolations which link strictly scientific discoveries to a vision of the world, or to ideological or philosophical affirmations, which are in no way corollaries of it. Here one sees the importance of philosophy which considers phenomena just as much as their interpretation.

3. Let us think, for example, of the working out of new theories at the scientific level in order to take account of *the emergence of living beings.* In a correct method, one could not interpret them immediately and in the exclusive framework of science. In particular, when it is a question of the living being which is man and of his brain it cannot be said that these theories of themselves constitute an affirmation or a denial of the spiritual soul, or that they provide a proof of the doctrine of creation, or that, on the contrary, they render it useless.

A further work of interpretation is needed. *This is precisely the object of philosophy,* which is the study of the global meaning of the data of experience, and therefore also of the phenomena gathered and analyzed by the sciences.

Contemporary culture demands *a constant effort to synthesize knowledge and to integrate learning.* Of course, the successes which we see are due to the specialization of research. But unless this is balanced by a reflection concerned with articulating the various branches of knowledge, there is a great risk that we shall have a "shattered culture," which would in fact be the negation of true culture. A true culture cannot be conceived of without humanism and wisdom.

II.

4. I was moved by similar concerns on November 10, 1979, at the time of the first centenary of the birth of Albert Einstein, when I expressed the hope before this same Academy that "theologians, scholars and historians, animated by a spirit of sincere collaboration, will study the *Galileo case* more deeply and, in frank recognition of wrongs from whatever side they come, dispel the mistrust that still opposes, in many minds, a fruitful concord between science and faith."[42] A *Study Commission* was constituted for this purpose on July 3, 1981. The very year when we are celebrating the 350th anniversary of Galileo's death, the Commission is presenting today, at the conclusion of its work, a number of publications which I value highly. I would like to express my sincere gratitude to Cardinal Poupard, who was entrusted with coordinating the Commission's research in its concluding phase. To all the experts who in any way took part in the proceedings of the four groups that guided this multi-disciplinary study, I express my profound satisfaction and my deep gratitude. The work that has been carried out for more than 10 years responds to a guideline suggested by the Second Vatican Council and enables us to shed more light on several important aspects of the question. In the future, it will be impossible to ignore the Commission's conclusions.

One might perhaps be surprised that, at the end of the Academy's study week on the theme of the emergence of complexity in the various sciences, I am returning to the Galileo case. Has not this case long been shelved and have not the errors committed been recognized?

That is certainly true. However, *the underlying problems of this case concern both the nature of science and the message of faith.* It is therefore not to be excluded that one day we shall find ourselves in a similar situation, one which will require both sides to have an informed awareness of the field and of the limits of their own competencies. The approach provided by the theme of complexity could provide an illustration of this.

5. *A twofold question* is at the heart of the debate of which Galileo was the center.

The first is of the epistemological order and concerns *biblical hermeneutics.* In this regard, two points must again be raised. In the first place, like most of his

[42] *AAS* 71(1979), pp. 1464-1465.

adversaries, Galileo made no distinction between the scientific approach to natural phenomena and a reflection on nature, of the philosophical order, which that approach generally calls for. That is why he rejected the suggestion made to him to present the Copernican system as a hypothesis, inasmuch as it had not been confirmed by irrefutable proof. Such, therefore, was *an exigency of the experimental method* of which he was the inspired founder.

Secondly, the geocentric representation of the world was commonly admitted in the culture of the time as fully agreeing with the teaching of the Bible, of which certain expressions, taken literally, seemed to affirm geocentrism. The problem posed by theologians of that age was, therefore, that of the compatibility between heliocentrism and Scripture.

Thus the new science, with its methods and the freedom of research which they implied, obliged theologians to examine their own criteria of scriptural interpretation. Most of them did not know how to do so.

Paradoxically, Galileo, a sincere believer, showed himself to be more perceptive in this regard than the theologians who opposed him. "If Scripture cannot err," he wrote to Benedetto Castelli, "certain of its interpreters and commentators can and do so in many ways."[43] We also know of his letter to Christine de Lorraine (1615) which is like a short treatise on biblical hermeneutics.[44]

6. From this we can now draw our first conclusion. The birth of a new way of approaching the study of natural phenomena demands *a clarification on the part of all disciplines of knowledge.* It obliges them to define more clearly their own field, their approach, their methods, as well as the precise import of their conclusions. In other words, this new way requires each discipline to become more rigorously aware of its own nature.

The upset caused by the Copernican system thus demanded epistemological reflection on the biblical sciences, an effort which later would produce abundant fruit in modern exegetical works and which has found sanction and a new stimulus in the Dogmatic Constitution *Dei Verbum* of the Second Vatican Council.

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[43] Letter of November 21, 1613, in *Edizione nazionale delle Opere di Galileo Galilei,* dir. A. Favaro, edition of 1968, vol. V, p. 282.

[44] Letter to Christine de Lorraine, 1615, in *Edizione nazionale delle Opere di Galileo Galilei,* dir. A. Favaro, edition of 1968, vol. V, pp. 307-348.

7. The crisis that I have just recalled is not the only factor to have had repercussions on biblical interpretation. Here we are concerned with *the second aspect of the problem, its pastoral dimension.*

By virtue of her own mission, the Church has the duty to be attentive to the pastoral consequences of her teaching. Before all else, let it be clear that this teaching must correspond to the truth. But it is a question of knowing how to judge a new scientific datum when it seems to contradict the truths of faith. The pastoral judgment which the Copernican theory required was difficult to make, in so far as geocentrism seemed to be a part of scriptural teaching itself. It would have been necessary all at once to overcome habits of thought and to devise a way of teaching capable of enlightening the people of God. Let us say, in a general way, that the pastor ought to show a genuine boldness, avoiding the double trap of a hesitant attitude and of hasty judgment, both of which can cause considerable harm.

8. *Another crisis,* similar to the one we are speaking of, can be mentioned here. In the last century and at the beginning of our own, advances in the historical sciences made it possible to acquire *a new understanding of the Bible and of the biblical world.* The rationalist context in which these data were most often presented seemed to make them dangerous to the Christian faith. Certain people, in their concern to defend the faith, thought it necessary to reject firmly-based historical conclusions. That was a hasty and unhappy decision. The work of a pioneer like Fr. Lagrange was able to make the necessary discernment on the basis of dependable criteria.

It is necessary to repeat here what I said above. It is a duty for theologians to keep themselves regularly informed of scientific advances in order to examine, if such be necessary, whether or not there are reasons for taking them into account in their reflection or for introducing changes in their teaching.

9. If contemporary culture is marked by a tendency to scientism, the cultural horizon of Galileo's age was uniform and carried the imprint of a particular philosophical formation. This unitary character of culture, which in itself is positive and desirable even in our own day, was one of the reasons for Galileo's condemnation. The majority of theologians did not recognize *the formal distinction between Sacred Scripture and its interpretation,* and this led them unduly to transpose into the realm of the doctrine of the faith a question which in fact pertained to scientific investigation.

In fact, as Cardinal Poupard has recalled, Robert Bellarmine, who had seen what was truly at stake in the debate, personally felt that, in the face of possible proofs that the earth orbited round the sun, one should "interpret with great circumspection" every biblical passage which seems to affirm that the earth is immobile and "say that we do not understand, rather than affirm that what has been demonstrated is false."[45] Before Bellarmine, this same wisdom and same respect for the divine Word guided St. Augustine when he wrote: "If it happens that the authority of Sacred Scripture is set in opposition to clear and certain reasoning, this must mean that the person who *interprets Scripture* does not understand it correctly. It is not the meaning of Scripture which is opposed to the truth, but the meaning which he has wanted to give to it. That which is opposed to Scripture is not what is in Scripture but what he has placed there himself, believing that this is what Scripture meant."[46] A century ago, Pope Leo XIII echoed this advice in his Encyclical *Providentissimus Deus:* "Truth cannot contradict truth, and we may be sure that some mistake has been made either in the Interpretation of the sacred words, or in the polemical discussion itself."[47]

Cardinal Poupard has also reminded us that the sentence of 1633 was not irreformable, and that the debate, which had not ceased to evolve thereafter, was closed in 1820 with the *imprimatur* given to the work of Canon Settele.[48]

10. From the beginning of the Age of Enlightenment down to our own day, *the Galileo case* has been a sort of "myth," in which the image fabricated out of the events was quite far removed from reality. In this perspective, the Galileo case was the symbol of the Church's supposed rejection of scientific progress, or of "dogmatic" obscurantism opposed to the free search for truth. This myth has played a considerable cultural role. It has helped to anchor a number of scientists of good faith in the idea that there was an incompatibility between the spirit of science and its rules of research on the one hand and the Christian faith on the other. *A tragic mutual incomprehension* has been interpreted as the reflection of a fundamental opposition between science and faith. The clarifications furnished by recent historical studies enable us to state that this sad misunderstanding now belongs to the past.

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[45] Letter to Fr. A. Foscarini, April 12, 1615, cf. *Edizione nazionale delle Opere di Galileo Galilei,* dir. A. Favaro, vol. XII, p. 172.
[46] Saint Augustine, *Epistula 143,* n. 7, *PL* 33, col. 588.
[47] *Leonis XIII Pont. Max. Acta,* vol. XIII (1894), p. 361.
[48] Cf. Pontificia Academia Scientiarum, *Copernico, Galilei e la Chiesa. Fine della controversia (1820). Gli atti del Sant'Ufficio,* a cura di W. Brandmuller e E. J. Griepl, Firenze, Olschki, 1992.

11. From the Galileo affair we can learn a *lesson which remains valid* in relation to similar situations which occur today and which may occur in the future.

In Galileo's time, to depict the world as lacking an absolute physical reference point was, so to speak, inconceivable. And since the cosmos, as it was then known, was contained within the solar system alone, this reference point could only be situated in the earth or in the sun. Today, after Einstein and within the perspective of contemporary cosmology, neither of these two reference points has the importance they once had. This observation, it goes without saying, is not directed against the validity of Galileo's position in the debate, it is only meant to show that often, beyond two partial and contrasting perceptions, *there exists a wider perception which includes them and goes beyond both of them.*

12. Another lesson which we can draw is that *the different branches of knowledge call for different methods.* Thanks to his intuition as a brilliant physicist and by relying on different arguments, Galileo, who practically invented the experimental method, understood why only the sun could function as the center of the world, as it was then known, that is to say, as a planetary system. The error of the theologians of the time, when they maintained the centrality of the earth, was to think that our understanding of the physical world's structure was, in some way, imposed by the literal sense of Sacred Scripture. Let us recall the celebrated saying attributed to Baronius *"Spiritui Sancto mentem fuisse nos docere quomodo ad coelum catur, non quomodo coelum gradiatur."* In fact, the Bible does not concern itself with the details of the physical world, the understanding of which is the competence of human experience and reasoning. There exist two realms of knowledge, one which has its source in Revelation and one which reason can discover by its own power. To the latter belong especially the experimental sciences and philosophy. The distinction between the two realms of knowledge ought not to be understood as opposition. The two realms are not altogether foreign to each other; they have points of contact. The methodologies proper to each make it possible to bring out different aspects of reality.

III.

13. Your Academy conducts its work with this outlook. Its principal task is to promote the advancement of knowledge, with respect for the legitimate freedom of

science[49] which the Apostolic See expressly acknowledges in the statutes of your institution.

What is important in a scientific or philosophic theory is above all that it should be true or, at least, seriously and solidly grounded. And *the purpose of your Academy* is precisely *to discern and to make known,* in the present state of science and within its proper limits, *what can be regarded as an acquired truth* or at least as enjoying such a degree of probability that it would be imprudent and unreasonable to reject it. In this way unnecessary conflicts can be avoided.

The seriousness of scientific knowledge will thus be the best contribution that the Academy can make to the exact formulation and solution of the serious problems to which the Church, by virtue of her specific mission, is obliged to pay close attention—problems no longer related merely to astronomy, physics and mathematics, but also to relatively new disciplines such as *biology* and *biogenetics.* Many recent scientific discoveries and their possible applications *affect man more directly than ever before,* his thought and action, to the point of seeming to threaten the very basis of what is human.

14. Humanity has before it *two modes of development.* The first involves culture, scientific research and technology, that is to say *whatever falls within the horizontal aspect of man* and creation, which is growing at an impressive rate. In order that this progress should not remain completely external to man, it presupposes a simultaneous raising of conscience, as well as its actuation. The second mode of development involves what is deepest in the human being, when, transcending the world and transcending himself, man turns to the One who is the Creator of all. It is only this *vertical direction* which can give full meaning to man's being and action, because it situates him in relation to his origin and his end. In this twofold direction, horizontal and vertical, man realizes himself fully as a spiritual being and as *homo sapiens.* But we see that development is not uniform and linear, and that progress is not always well ordered. This reveals the disorder which affects the human condition. The scientist who is conscious of this twofold development and takes it into account contributes to the restoration of harmony.

Those who engage in scientific and technological research admit, as the premise of its progress, that the world is not a chaos but a "cosmos;" that is to say, that there exist order and natural laws which can be grasped and examined, and which, for this

[49] Cf. Second Vatican Ecumenical Council, Pastoral Constitution *Gaudium et Spes,* n. 36, par. 2.

reason, have a certain affinity with the spirit. Einstein used to say: "What is eternally incomprehensible in the world is that it is comprehensible."[50] This intelligibility, attested to by the marvelous discoveries of science and technology, leads us, in the last analysis, to that transcendent and primordial Thought imprinted on all things.

Ladies and gentlemen, in concluding these remarks, I express my best wishes that your research and reflection will help to give our contemporaries useful directions for building a harmonious society in a world more respectful of what is human. I thank you for the service you render to the Holy See, and I ask God to fill you with his gifts.

[50] In *The Journal of the Franklin Institute,* vol. 221, n. 3, March 1936.

The Magisterium is concerned with the question of evolution, for it involves the conception of man

Address given on October 22, 1996 to the Pontifical Academy of Sciences.

To the Members of the Pontifical Academy of Sciences taking part in
The Plenary Assembly

With great pleasure I address cordial greetings to you, Mr. President, and to all of you who constitute the Pontifical Academy of Sciences, on the occasion of your plenary assembly. I offer my best wishes in particular to the new academicians, who have come to take part in your work for the first time. I would also like to remember the academicians who died during the past year, whom I commend to the Lord of life.

1. In celebrating the 60th anniversary of the Academy's refoundation, I would like to recall the intentions of my predecessor Pius XI, who wished to surround himself with a select group of scholars, relying on them to inform the Holy See in complete freedom about developments in scientific research, and thereby to assist him in his reflections.

He asked those whom he called the Church's *Senatus scientificus* to serve the truth. I again extend this same invitation to you today, certain that we will all be able to profit from the fruitfulness of a trustful dialogue between the Church and science (cf. *Address to the Academy of Sciences*, n. 1, October 28, 1986 *L'Osservatore Romano* English edition, November 24, 1986, p. 22).

Science at the dawn of the third millennium

2. I am pleased with the first theme you have chosen, that of the origins of life and evolution, an essential subject which deeply interests the Church, since Revelation, for its part, contains teaching concerning the nature and origins of man. How do the conclusions reached by the various scientific disciplines coincide with those contained in the message of Revelation? And if, at first sight, there are apparent contradictions, in what direction do we look for their solution? We know, in fact, that truth cannot contradict truth (cf. Leo XIII, Encyclical *Providentissimus Deus*). Moreover, to shed greater light on historical truth, your research on the Church's relations with science between the 16th and 18th centuries is of great importance.

During this plenary session, you are undertaking a "reflection on science at the dawn of the third millennium," starting with the identification of the principal problems created by the sciences and which affect humanity's future. With this step you point the way to solutions which will be beneficial to the whole human community. In the domain of inanimate and animate nature, the evolution of science and its applications gives rise

to new questions. The better the Church's knowledge is of their essential aspects, the more she will understand their impact. Consequently in accordance with her specific mission she will be able to offer criteria for discerning the moral conduct required of all human beings in view of their integral salvation.

3. Before offering you several reflections that more specifically concern the subject of the origin of life and its evolution, I would like to remind you that the Magisterium of the Church has already made pronouncements on these matters within the framework of her own competence. I will cite here two interventions.

In his Encyclical *Humani generis* (1950), my predecessor Pius XII had already stated that there was no opposition between evolution and the doctrine of the faith about man and his vocation, on condition that one did not lose sight of several indisputable points (cf. *AAS* 42 [1950], pp. 575-576).

For my part, when I received those taking part in your Academy's plenary assembly on October 31, 1992, I had the opportunity, with regard to Galileo, to draw attention to the need of a rigorous hermeneutic for the correct interpretation of the inspired word. It is necessary to determine the proper sense of Scripture, while avoiding any unwarranted interpretations that make it say what it does not intend to say. In order to delineate the field of their own study, the exegete and the theologian must keep informed about the results achieved by the natural sciences (cf. *AAS* 85 [1993] pp. 764-772; *Address to the Pontifical Biblical Commission*, April 23, 1993, announcing the document on *The Interpretation of the Bible in the Church: AAS* 86 [1994] pp. 232-243).

Evolution and the Church's Magisterium

4. Taking into account the state of scientific research at the time as well as of the requirements of theology, the Encyclical *Humani generis* considered the doctrine of "evolutionism" a serious hypothesis, worthy of investigation and in-depth study equal to that of the opposing hypothesis. Pius XII added two methodological conditions: that this opinion should not be adopted as though it were a certain, proven doctrine and as though one could totally prescind from Revelation with regard to the questions it raises. He also spelled out the condition on which this opinion would be compatible with the Christian faith, a point to which I will return.

Today, almost half a century after the publication of the Encyclical, new knowledge has led to the recognition of the theory of evolution as more than a hypothesis. It is indeed remarkable that this theory has been progressively accepted by researchers, following a series of discoveries in various fields of knowledge. The convergence, neither sought nor fabricated, of the results of work that was conducted independently is in itself a significant argument in favor of this theory.

What is the significance of such a theory? To address this question is to enter the field of epistemology. A theory is a metascientific elaboration, distinct from the results of observation but consistent with them. By means of it a series of independent data

and facts can be related and interpreted in a unified explanation. A theory's validity depends on whether or not it can be verified; it is constantly tested against the facts; wherever it can no longer explain the latter, it shows its limitations and unsuitability. It must then be rethought.

Furthermore, while the formulation of a theory like that of evolution complies with the need for consistency with the observed data, it borrows certain notions from natural philosophy.

And, to tell the truth, rather than *the* theory of evolution, we should speak of *several* theories of evolution. On the one hand, this plurality has to do with the different explanations advanced for the mechanism of evolution, and on the other, with the various philosophies on which it is based. Hence the existence of materialist, reductionist and spiritualist interpretations. What is to be decided here is the true role of philosophy and, beyond it, of theology.

5. The Church's Magisterium is directly concerned with the question of evolution, for it involves the conception of man: Revelation teaches us that he was created in the image and likeness of God (cf. Gn 1:27-29). The conciliar Constitution *Gaudium et spes* has magnificently explained this doctrine, which is pivotal to Christian thought. It recalled that man is "the only creature on earth that God has wanted for its own sake" (n. 24). In other terms, the human individual cannot be subordinated as a pure means or a pure instrument, either to the species or to society; he has value per se. He is a person. With his intellect and his will, he is capable of forming a relationship of communion, solidarity and self-giving with his peers. St. Thomas observes that man's likeness to God resides especially in his speculative intellect, for his relationship with the object of his knowledge resembles God's relationship with what he has created (*Summa Theologica*, I-II, q. 3, a. 5, ad 1). But even more, man is called to enter into a relationship of knowledge and love with God himself, a relationship which will find its complete fulfillment beyond time, in eternity. All the depth and grandeur of this vocation are revealed to us in the mystery of the risen Christ (cf. *Gaudium et spes*, n. 22). It is, by virtue of his spiritual soul that the whole person possesses such a dignity even in his body. Pius XII stressed this essential point: if the human body takes its origin from pre-existent living matter, the spiritual soul is immediately created by God (*"animas enim a Deo immediate creari catholica fides nos retinere iubet"* Encyclical *Humani generis, AAS* 42 [1950], p. 575).

Consequently, theories of evolution which, in accordance with the philosophies inspiring them, consider the mind as emerging from the forces of living matter, or as a mere epiphenomenon of this matter, are incompatible with the truth about man. Nor are they able to ground the dignity of the person.

6. With man, then, we find ourselves in the presence of an ontological difference, an ontological leap, one could say. However, does not the posing of such ontological discontinuity run counter to that physical continuity which seems to be the main thread of research into evolution in the field of physics and chemistry?

Consideration of the method used in the various branches of knowledge makes it possible to reconcile two points of view which would seem irreconcilable. The sciences of observation describe and measure the multiple manifestations of life with increasing precision and correlate them with the time line. The moment of transition to the spiritual cannot be the object of this kind of observation, which nevertheless can discover at the experimental level a series of very valuable signs indicating what is specific to the human being. But the experience of metaphysical knowledge, of self awareness and self-reflection; of moral conscience, freedom, or again, of aesthetic and religious experience, falls within the competence of philosophical analysis and reflection, while theology brings out its ultimate meaning according to the Creator's plans.

We are called to enter eternal life

7. In conclusion, I would like to call to mind a Gospel truth which can shed a higher light on the horizon of your research into the origins and unfolding of living matter. The Bible in fact bears an extraordinary message of life. It gives us a wise vision of life inasmuch as it describes the loftiest forms of existence. This vision guided me in the Encyclical which I dedicated to respect for human life, and which I called precisely *Evangelium vitae*.

It is significant that in St John's Gospel life refers to the divine light which Christ communicates to us. We are called to enter into eternal life, that is to say, into the eternity of divine beatitude.

To warn us against the serious temptations threatening us, our Lord quotes the great saying of *Deuteronomy*: "Man shall not live by bread alone, but by every word that proceeds from the mouth of God" (Dt 8:3; cf. Mt 4:4).

Even more, "life" is one of the most beautiful titles which the Bible attributes to God. He is the *living* G*od*.

I cordially invoke an abundance of divine blessings upon you and upon all who are close to you.

ADDRESS OF JOHN PAUL II TO THE PARTICIPANTS IN THE PLENARY SESSION OF THE PONTIFICAL ACADEMY OF SCIENCES

Monday, 8 November 2004

Ladies and Gentlemen,
Dear Friends,

1. It is with particular pleasure that I greet the distinguished members of the *Pontifical Academy of Sciences*. I thank your President, Professor Nicola Cabibbo, for the kind message of greetings and good wishes which he has offered me in your name.

The meetings of the Academy have always been an occasion of mutual enrichment and, in some cases, have resulted in studies of significant interest to the Church and the world of culture. These initiatives have contributed to a more fruitful dialogue between the Church and the scientific community. I trust that they will lead to an ever deeper investigation of the truths of science and the truths of faith, truths which ultimately converge in that one Truth which believers acknowledge in its fullness in the face of Jesus Christ.

2. This year's plenary session, devoted to science and creativity, raises important questions deeply connected with the spiritual dimension of man. Through culture and creative activity, human beings have the capacity to transcend material reality and to "humanize" the world around us. Revelation teaches that men and women are created in the "image and likeness of God" (cf. *Gen* 1:26) and thus possessed of a special dignity which enables them, by the work of their hands, to reflect God's own creative activity (cf. *Laborem Exercens*, 4). In real way, they are meant to be "co-creators" with God, using their knowledge and skill to shape a cosmos in which the divine plan constantly moves towards fulfilment (cf. *Gaudium et Spes*, 34). This human creativity finds privileged expression in the pursuit of knowledge and scientific research. As a spiritual reality, such creativity must be responsibly exercised; it demands respect for the natural order and, above all, for the nature of each human being, inasmuch as man is its subject and end.

The creativity which inspires scientific progress is seen especially in the capacity to confront and solve ever new issues and problems, many of which have planetary repercussions. Men and women of science are challenged to put this creativity more

and more at the service of the human family, by working to improve the quality of life on our planet and by promoting an integral development of the human person, both materially and spiritually. If scientific creativity is to benefit authentic human progress, it must remain detached from every form of financial or ideological conditioning, so that it can be devoted solely to the dispassionate search for truth and the disinterested service of humanity. Creativity and new discoveries ought to bring both the scientific community and the world's peoples together, in a climate of cooperation which values the generous sharing of knowledge over competitiveness and individual interests.

3. The theme of your meeting invites renewed reflection on the "paths of discovery". There is in fact a profound inner logic to the process of discovery. Scientists approach nature with a conviction that they confront a reality which they have not created but received, a reality which slowly reveals itself to their patient questioning. They sense – often only implicitly – that nature contains a *Logos* which invites dialogue. The scientist seeks to ask the right questions of nature, while at the same time maintaining an attitude of humble receptivity and even of contemplation in its regard. The "wonder" which sparked the earliest philosophical reflection on nature and which gave rise to science itself, has in no way been diminished by new discoveries; indeed, it constantly increases and often inspires awe at the distance which separates our knowledge of creation from the fullness of its mystery and grandeur.

Contemporary scientists, faced with the explosion of new knowledge and discoveries, frequently feel that they are standing before a vast and infinite horizon. Indeed, the inexhaustible bounty of nature, with its promise of ever new discoveries, can be seen as pointing beyond itself to the Creator who has given it to us as a gift whose secrets remain to be explored. In attempting to understand this gift and to use it wisely and well, science constantly encounters a reality which human beings "find". In every phase of scientific discovery, nature stands as something "given." For this reason, creativity and progress along the paths of discovery, as in all other human endeavours, are ultimately to be understood against the backdrop of the mystery of creation itself (cf. *Laborem Exercens*, 12).

4. Dear members of the Academy, once again this year I offer my prayerful good wishes for your work on behalf of the advancement of knowledge and the benefit of the human family. May these days of reflection and discussion be a source of spiritual enrichment for all of you. Despite the uncertainties and the labour which every attempt to interpret reality entails – not only in the sciences, but also in philosophy and theology – the paths of discovery are always paths towards truth. And every seeker after truth, whether aware of it or not, is following a path which ultimately leads to God, who is Truth itself (cf. *Fides et Ratio*, 16, 28). May your patient and humble dialogue with the world of nature bear fruit in ever new discoveries and in a reverent appreciation of its untold

marvels. Upon you and your families I cordially invoke God's blessings of wisdom, joy and peace.

Communion and Stewardship: Human Persons Created in the Image of God[1]

International Theological Commission

CHAPTER THREE
IN THE IMAGE OF GOD: STEWARDS OF VISIBLE CREATION
1. Science and the Stewardship of Knowledge

62. The endeavor to understand the universe has marked human culture in every period and in nearly every society. In the perspective of the Christian faith, this endeavor is precisely an instance of the stewardship which human beings exercise in accordance with God's plan. Without embracing a discredited concordism, Christians have the responsibility to locate the modern scientific understanding of the universe within the context of the theology of creation. The place of human beings in the history of this evolving universe, as it has been charted by modern sciences, can only be seen in its complete reality in the light of faith, as a personal history of the engagement of the triune God with creaturely persons.

63. According to the widely accepted scientific account, the universe erupted 15 billion years ago in an explosion called the "Big Bang" and has been expanding and cooling ever since. Later there gradually emerged the conditions necessary for the formation of atoms, still later the condensation of galaxies and stars, and about 10 billion years later the formation of planets. In our own solar system and on earth (formed about 4.5 billion years ago), the conditions have been favorable to the emergence of life. While there is little consensus among scientists about how the origin of this first microscopic life is to be explained, there is general agreement among them that the first organism dwelt on this planet about 3.5-4 billion years ago. Since it has been demonstrated that all living organisms on earth are genetically related, it is virtually certain that all living organisms have descended from this first organism. Converging evidence from many studies in the physical and biological sciences furnishes mounting support for some theory of evolution to account for the development and diversification of life on earth, while

[1] *Preliminary Note*
The theme of "man created in the image of God" was submitted for study to the International Theological Commission. The preparation of this study was entrusted to a subcommission whose members included: Very Rev. J. Augustine Di Noia, O.P., Most Reverend Jean-Louis Bruguès, Msgr. Anton Strukelj, Rev. Tanios Bou Mansour, O.L.M., Rev. Adolpe Gesché, Most Reverend Willem Jacobus Eijk, Rev. Fadel Sidarouss, S.J., and Rev. Shun ichi Takayanagi, S.J.
As the text developed, it was discussed at numerous meetings of the subcommission and several plenary sessions of the International Theological Commission held at Rome during the period 2000-2002. The present text was approved *in forma specifica*, by the written ballots of the International Theological Commission. It was then submitted to Joseph Cardinal Ratzinger, the President of the Commission, who has give his permission for its publication.

controversy continues over the pace and mechanisms of evolution. While the story of human origins is complex and subject to revision, physical anthropology and molecular biology combine to make a convincing case for the origin of the human species in Africa about 150,000 years ago in a humanoid population of common genetic lineage. However it is to be explained, the decisive factor in human origins was a continually increasing brain size, culminating in that of *homo sapiens.* With the development of the human brain, the nature and rate of evolution were permanently altered: with the introduction of the uniquely human factors of consciousness, intentionality, freedom and creativity, biological evolution was recast as social and cultural evolution.

64. Pope John Paul II stated some years ago that "new knowledge leads to the recognition of the theory of evolution as more than a hypothesis. It is indeed remarkable that this theory has been progressively accepted by researchers following a series of discoveries in various fields of knowledge"("Message to the Pontifical Academy of Sciences on Evolution"1996). In continuity with previous twentieth century papal teaching on evolution (especially Pope Pius XII's encyclical *Humani Generis*), the Holy Father's message acknowledges that there are "several theories of evolution" that are "materialist, reductionist and spiritualist" and thus incompatible with the Catholic faith. It follows that the message of Pope John Paul II cannot be read as a blanket approbation of all theories of evolution, including those of a neo-Darwinian provenance which explicitly deny to divine providence any truly causal role in the development of life in the universe. Mainly concerned with evolution as it "involves the question of man," however, Pope John Paul's message is specifically critical of materialistic theories of human origins and insists on the relevance of philosophy and theology for an adequate understanding of the "ontological leap" to the human which cannot be explained in purely scientific terms. The Church's interest in evolution thus focuses particularly on "the conception of man" who, as created in the image of God, "cannot be subordinated as a pure means or instrument either to the species or to society." As a person created in the image of God, he is capable of forming relationships of communion with other persons and with the triune God, as well as of exercising sovereignty and stewardship in the created universe. The implication of these remarks is that theories of evolution and of the origin of the universe possess particular theological interest when they touch on the doctrines of the creation *ex nihilo* and the creation of man in the image of God.

65. We have seen human persons are created in the image of God in order to become partakers of the divine nature (cf. 2 Pet 1:3-4) and thus to share in the communion of trinitarian life and in the divine dominion over visible creation. At the heart of the divine act of creation is the divine desire to make room for created persons in the communion of the uncreated Persons of the Blessed Trinity through adoptive participation in Christ. What is more, the common ancestry and natural unity of the human race are the basis for a unity in grace of redeemed human persons under the headship of the New Adam

in the ecclesial communion of human persons united with one another and with the uncreated Father, Son, and Holy Spirit. The gift of natural life is the basis for the gift of the life of grace. It follows that, where the central truth concerns a person acting freely, it is impossible to speak of a necessity or an imperative to create, and it is, in the end, inappropriate to speak of the Creator as a force, or energy, or ground. Creation *ex nihilo* is the action of a transcendent *personal* agent, acting freely and intentionally, with a view toward the all-encompassing purposes of personal engagement. In Catholic tradition, the doctrine of the origin of human beings articulates the revealed truth of this fundamentally relational or personalist understanding of God and of human nature. The exclusion of pantheism and emanationism in the doctrine of creation can be interpreted at root as a way of protecting this revealed truth. The doctrine of the immediate or special creation of each human soul not only addresses the ontological discontinuity between matter and spirit, but also establishes the basis for a divine intimacy which embraces every single human person from the first moment of his or her existence.

66. The doctrine of *creatio ex nihilo* is thus a singular affirmation of the truly personal character of creation and its order toward a personal creature who is fashioned as the *imago Dei* and who responds not to a ground, force or energy, but to a personal creator. The doctrines of the *imago Dei* and the *creatio ex nihilo* teach us that the existing universe is the setting for a *radically personal* drama, in which the triune Creator calls out of nothingness those to whom He then calls out in love. Here lies the profound meaning of the words of *Gaudium et Spes:* "Man is the only creature on earth that God willed for his own sake" (24). Created in God's image, human beings assume a place of responsible stewardship in the physical universe. Under the guidance of divine providence and acknowledging the sacred character of visible creation, the human race reshapes the natural order, and becomes an agent in the evolution of the universe itself. In exercising their stewardship of knowledge, theologians have the responsibility to locate modern scientific understandings within a Christian vision of the created universe.

67. With respect to the *creatio ex nihilo*, theologians can note that the Big Bang theory does not contradict this doctrine insofar as it can be said that the supposition of an absolute beginning is not scientifically inadmissible. Since the Big Bang theory does not in fact exclude the possibility of an antecedent stage of matter, it can be noted that the theory appears to provide merely *indirect* support for the doctrine of *creatio ex nihilo* which as such can only be known by faith.

68. With respect to the evolution of conditions favorable to the emergence of life, Catholic tradition affirms that, as universal transcendent cause, God is the cause not only of *existence* but also the cause of *causes*. God's action does not displace or

supplant the activity of creaturely causes, but enables them to act according to their natures and, nonetheless, to bring about the ends he intends. In freely willing to create and conserve the universe, God wills to activate and to sustain in act all those secondary causes whose activity contributes to the unfolding of the natural order which he intends to produce. Through the activity of natural causes, God causes to arise those conditions required for the emergence and support of living organisms, and, furthermore, for their reproduction and differentiation. Although there is scientific debate about the degree of purposiveness or design operative and empirically observable in these developments, they have *de facto* favored the emergence and flourishing of life. Catholic theologians can see in such reasoning support for the affirmation entailed by faith in divine creation and divine providence. In the providential design of creation, the triune God intended not only to make a place for human beings in the universe but also, and ultimately, to make room for them in his own trinitarian life. Furthermore, operating as real, though secondary causes, human beings contribute to the reshaping and transformation of the universe.

69. The current scientific debate about the mechanisms at work in evolution requires theological comment insofar as it sometimes implies a misunderstanding of the nature of divine causality. Many neo-Darwinian scientists, as well as some of their critics, have concluded that, if evolution is a radically contingent materialistic process driven by natural selection and random genetic variation, then there can be no place in it for divine providential causality. A growing body of scientific critics of neo-Darwinism point to evidence of design (e.g., biological structures that exhibit specified complexity) that, in their view, cannot be explained in terms of a purely contingent process and that neo-Darwinians have ignored or misinterpreted. The nub of this currently lively disagreement involves scientific observation and generalization concerning whether the available data support inferences of design or chance, and cannot be settled by theology. But it is important to note that, according to the Catholic understanding of divine causality, true contingency in the created order is not incompatible with a purposeful divine providence. Divine causality and created causality radically differ in kind and not only in degree. Thus, even the outcome of a truly contingent natural process can nonetheless fall within God's providential plan for creation. According to St. Thomas Aquinas: "The effect of divine providence is not only that things should happen somehow, but that they should happen either by necessity or by contingency. Therefore, whatsoever divine providence ordains to happen infallibly and of necessity happens infallibly and of necessity; and that happens from contingency, which the divine providence conceives to happen from contingency" (*Summa theologiae,* I, 22,4 ad 1). In the Catholic perspective, neo-Darwinians who adduce random genetic variation and natural selection as evidence that the process of evolution is absolutely unguided are straying beyond what can be demonstrated by science. Divine causality can be active in a process that is *both* contingent and guided. Any evolutionary mechanism that

is contingent can only be contingent because God made it so. An unguided evolutionary process – one that falls outside the bounds of divine providence – simply cannot exist because "the causality of God, Who is the first agent, extends to all being, not only as to constituent principles of species, but also as to the individualizing principles....It necessarily follows that all things, inasmuch as they participate in existence, must likewise be subject to divine providence" (*Summa theologiae* I, 22, 2).

70. With respect to the immediate creation of the human soul, Catholic theology affirms that particular actions of God bring about effects that transcend the capacity of created causes acting according to their natures. The appeal to divine causality to account for genuinely *causal* as distinct from merely *explanatory* gaps does not insert divine agency to fill in the "gaps" in human scientific understanding (thus giving rise to the so-called "God of the gaps"). The structures of the world can be seen as open to non-disruptive divine action in directly causing events in the world. Catholic theology affirms that that the emergence of the first members of the human species (whether as individuals or in populations) represents an event that is not susceptible of a purely natural explanation and which can appropriately be attributed to divine intervention. Acting indirectly through causal chains operating from the beginning of cosmic history, God prepared the way for what Pope John Paul II has called "an ontological leap...the moment of transition to the spiritual." While science can study these causal chains, it falls to theology to locate this account of the special creation of the human soul within the overarching plan of the triune God to share the communion of trinitarian life with human persons who are created out of nothing in the image and likeness of God, and who, in his name and according to his plan, exercise a creative stewardship and sovereignty over the physical universe.

About The Author(s)

The International Theological Commission (ITC) was formed by Pope Paul VI in July 1969 with the task of offering its services to the Holy See and the Sacred Congregation for the Doctrine of the Faith "in examining doctrinal questions of major importance" (Provisory Statute [cf. *AAS* 61 (1969): 540-541). It is comprised of theologians of "various schools and nations are outstanding in the science of theology and fidelity towards the Magisterium of the Church" appointed by the Pope. Each member serves a term of five years. The Cardinal Prefect of the Congregation of the Doctrine for the Faith is the *de facto* President of the ITC. Its documents are approved by its members in one of two ways: a) *in forma specifica* ("in specific form"), in which the entire text (ideas, wording, presentation) is accepted by the absolute majority of the members present at the annual plenary session, or b) *in forma generica* ("in general form") in which only the principal ideas of the text are accepted. *Communion and Stewardship* was approved *in forma specifica*.

A TOUR OF *THE COSMOS*: Natural Philosophy as a Bridge between the Catholic Faith and Modern Science in the Thought of Charles De Koninck

By
Cory J. Hayes

Nearly 40 years before Etienne Gilson engaged the best scientific thought of the twentieth century regarding evolution with the philosophical world view of Aristotle and St. Thomas Aquinas in his *From Aristotle to Darwin and Back Again* (1971), a lesser known Charles De Koninck,[1] a young philosopher at the Université Laval, had already done so in his *The Cosmos*, a treatise he penned in 1936 but which remained unpublished until 2008. With a commitment to the unity of the truth[2] De Koninck, in *The Cosmos*, looks at the universe from three distinct though complementary levels of explanation: the scientific, the philosophical and the theological. The first two sections (dedicated to surveying the cosmos from the "Scientific Point of View" and the "Philosophical Point of View," respectively) come down to us as finished, while the third ("The Theological Point of View"), remains unfinished.[3] Unlike some of his philosophical contemporaries in the Thomist school, De Koninck seemed to be (if the text and argument of *The Cosmos* is any indication) convinced that Thomistic philosophy (a mainstay of the Catholic intellectual tradition) has something to offer both as an important framework and *a support* to modern scientific conceptions of nature and the human person—and these conceptions are ineluctably evolutionary in character and claim. Regarding any given question involving biological evolution De Koninck says,

> *It is not to the philosopher that we put the question. Experimental science must answer it. Since it is a matter of responding to a question of fact, it is experimental science that undertakes the research. Even if the philosopher had already established what he has to establish, he would not for that reason be able to prevent the scientist from finding out what he finds out. And we should be disposed to believe every explicative*

[1] Charles De Koninck (1906-1965) was a Belgian born, Canadian philosopher who directed the department of Philosophy at the Université Laval in Quebec. After writing his dissertation on the philosophy of science of Sir Arthur Eddington, he spent much of his time writing on the influence of Aristotle in the work of Thomas Aquinas, debates about the nature of the political common good, the philosophy of science, and trying to articulate a robust relationship between Aristotelian-Thomistic philosophy and modern science. He even authored an influential tract in Mariology. It is unfortunate that he is one of the least known players in the early twentieth century revival of Thomism. It is only fairly recently that one of his former students, the late Ralph McInerny (1929-2010), translated and edited a collection of De Koninck's complete works. All references to *The Cosmos* are taken from *The Writings of Charles De Koninck*, Vol. I, ed. and trans. by Ralph McInerny (Notre Dame, IN: University of Notre Dame Press, 2008).

[2] Whether true propositions come from science, philosophy or theology, that they are in fact *true* makes them immune from any contradiction. If they are true, they can only complement one another.

[3] *Writings*, 334 (Editor's note).

> *theory of observed phenomena, insofar as they are within the bounds of experience and logic.*[4]

Though a philosopher by trade, De Koninck had an academic background heavy in the sciences which enabled him to be sympathetic to the scientific approach. Part of his claim is that when properly understood, the insights of philosophy can do more than allow for such an evolutionary view, but they can in fact give a foundational rational coherence to it, and that the complementary relation of one to the other is a thing worth embracing.

The purpose of this article is to give a brief tour of *The Cosmos*. In doing this I am treating De Koninck's project not only as a prime example of excellence in the engagement of the Catholic intellectual tradition with science, but also as a template or paradigm for doing so. During this tour I will introduce the reader to the concepts and categories by which De Koninck looks at the evolution of the cosmos and the life in it from a philosophical point of view, and then explain how he arrives at the conclusion that all evolutionary roads find their terminus or purpose in the human being.[5]

The purpose of the tour itself is two-fold. First, the purpose is to introduce the unfamiliar reader to the philosophical views of Aristotle and Thomas Aquinas, along with the key terms and concepts that belong to them. The second, which is only realizable once the first has been accomplished, is to give the non-specialist something that he may not have in his toolbox before reading this article: an informed perspective through which to grapple with the relation between science and the Catholic Intellectual Tradition. With these two goals in mind, this tour is mainly restricted to De Koninck's treatment of what he calls "the philosophical point of view," the second and longest of the three sections. I do this because the topics treated and the arguments made in this section seem to be at the core of De Koninck's concerns for the text, namely, that if the philosophy of St. Thomas is really the *philosophia perennis* (perennial philosophy) that can illumine the true insights of any age, then it *must* be able to do so in the face of scientific evidence for big bang cosmology, evolution, etc. Yet, before the terms and concepts can be learned, and De Koninck's argument engaged, one needs to have some clarity on exactly what the philosophical point of view is.

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[4] *Cosmos*, 247-48.

[5] A very important clarification must be issued here. Throughout the article I will refer to 'philosophers,' 'philosophy,' and 'the philosophical point of view.' This can be deceptive because the world is filled with various, and sometimes opposing philosophical viewpoints. In this article, both its author (me) and the author whose work is being analyzed (De Koninck), are firmly in the realist tradition of Aristotle and Thomas Aquinas. Therefore the philosophical point of view argued for by this article is largely that of Thomas Aquinas and his tradition. 'Defining' characteristics of Thomistic philosophy will be noted as the article unfolds.

I. The Scientific and Philosophical Points of View[6]

The single most important factor in understanding De Koninck's engagement (or any engagement by the Catholic intellectual tradition for that matter) with modern scientific claims and theories is that one clearly distinguishes the scientific point of view from both the philosophical and theological, and even the latter two from one another.[7] Failure to do this is virtually guaranteed to result in myriad confusions and colossal mistakes that are to the detriment of each of the disciplines in question—one only needs to consume a bit of contemporary news reporting to confirm this.

De Koninck is committed to the thesis that while one can inquire into the cosmos and the beings in it from a physical point of view, this physical point of view does not cover "the whole of beings"[8]; i.e., that it neither gives an exhaustive picture of beings nor does it provide answers for the deepest and most fundamental questions we have about them. The scientific point of view is limited to the (at least in principle) empirically observable, measurable, and predictable aspects of things. If its method is fundamentally bound to the observable, measurable, and predictable, then the authoritative conclusions and claims about beings that result from this method must be essentially ***metric*** (measurable or able to be modeled mathematically) in character, and so are only valid for the metrical aspects of things, what De Koninck calls the "exterior."[9] This is not to relativize experimental science, but only to be clear about its competency and character. If one has a question about the material composition of frogs, or if one wonders what role other entities (animate or inanimate) have played in the composition of frogs, or finally if one is searching for a description in which to classify the general pattern of activity of such and such a physical mass alone or in relation to other entities (i.e., a law), then experimental science is the method by which one ought to search for, and hopefully arrive at, an answer. All of the phenomena in question are potentially measurable, and therefore potentially measured: "How much does it weigh?" or "How fast does it go?" or "Under what conditions does *x* behave in way *y* rather than in way *z*?" are all questions of this sort.

Yet, there is a series of questions that we can ask, that aim at trying to find explanations for, and give coherence to, our common human experience.[10] By common human

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[6] If one wants to gain a general idea of what science and the scientific method are, he needs only to go through a bit primary and secondary schooling. Hence, I will spend the lion's share of our time talking about what virtually no one learns in primary or secondary education, i.e., what philosophy and the philosophical method are.

[7] My purpose here is only to deal specifically with science and philosophy, not theology although certain theological considerations will be mentioned when I consider them helpful.

[8] *Cosmos*, 243.

[9] Ibid.

[10] Introductory courses in philosophy in our undergraduate days has unfortunately trained many of us to think of philosophy as an essentially skeptical and destructive enterprise (some would say the terms 'pedantic' and 'annoying' are more apt). However, philosophy as De Koninck sees it, in the tradition of Aristotle and Thomas Aquinas, begins with a commitment to the basic intelligibility of the world, and as such our common human experience (precisely as it is common) is a reflection of, and a reliable starting

experience the philosopher does not mean something like the folk wisdom of Grandma or the culturally, time conditioned judgments from which pithy aphorisms tend to spring, but he means those experiences shared by all human creatures regardless of their time, place or culture: permanence, change, unity, diversity, value, being, nothing, thinking, feeling, etc. For example, human beings do not now nor have they ever experienced the world primarily as a series of metric characteristics or properties like weight, mass, velocity, molecular and atomic structure, etc. In fact, we encounter the world as made up of beings that are more or less integrated wholes and we experience them *as* wholes, e.g., I do not encounter or experience an organic electrical system of tissue and organs that is ultimately reducible to atomic relationships, but *I do* experience a whole human being which I can perceive, about which I can think, and with which I can interact. We make judgments that the human being in question is a definite sort of *this* as opposed to a definite sort of *that*, e.g., a human being rather than a shrub. We experience this human being in a constant state of change, yet throughout its life we designate it with the same name and file it away mentally connected with the same idea. We judge that said human being is worthy of praise and admiration when it does something we think is excellent and blame when it does something we think is base or ignoble.

All of these experiences are as valid for post-modern denizens of the 21st century as they were for "Og," the pre-historic *homo sapiens* sitting by a fire in the Pyrenees 10,000 years ago. These experiences can give rise to questions like: "What must reality be like such that we experience things as wholes?" or "What is it in or about things by which I experience them to be similar/different?" or "What accounts for the permanence in things that are otherwise in a state of constant flux?" or "Who or what decides what is worthy of praise or blame?" or finally "Why is there something rather than nothing and is there any meaning to human striving beyond my own interests?"[11] There are a few things about the above questions that one must notice.

First, none of these questions deal with matters that admit of a strictly metric answer. Praise, blame, meaning, and the immediacy of our own experience of the world escape the grasp of the scales. In other words these questions are philosophical in that they strive towards an understanding of the whole.

Second, at least three of the four questions above (the first, second and fourth) are pre-scientific. I do not count the third question about standards of praise and blame, which is an ethical concern, because its relation to the scientific is an ambiguous thing--on the face of it they seem quite unrelated. It is sad for both us and the scientist or technocrat that both of them are often called upon to offer opinions as to whether we ought to clone

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point to, gaining insight into the world. Philosophy is born of wonder or initial puzzlement at the world, not skepticism or doubt. "For it is owing to their wonder that men both now begin and first began to philosophize…"—Aristotle, *Metaphysics,* I.1.982b.12-13.

[11] If you are skeptical as to whether "Og" asked these questions, think on it a bit. It could have been that "Og" was too busy trying to eat and not get eaten to take the time to philosophize. It's hard to philosophize without leisure. However, sitting by the fire with the rest of the homo sapiens could have been the kind of practice that gave "Og" the right context to begin philosophizing.

human beings, conceive and abort fetuses in order to harvest stem cells, etc. on the basis of their scientific or technological expertise. These are not fair questions because the moral ought (what I *should* do) is neither observable, nor measurable, nor predictable and therefore the scientist *as* scientist, by his very method of discovery, is incompetent in matters of this kind—how much does an "ought" weigh anyway?[12] It's like letting the electrician decide who (if anyone) gets electrocuted.

The other questions are ***pre-scientific*** in that their answers can provide a framework or picture of the cosmos at a more fundamental level such that properly scientific conclusions can have coherence as more or less accurate pictures of the extrinsic aspects of the cosmos. This notion tends to be a bit obscure. Some examples are in order. Take the following two dilemmas. First, for example, one must decide whether the physics that enabled Apollo 11 to successfully land on the moon was merely a set of useful functions not necessarily related to the world they purported to describe or if they were more or less accurate descriptions of the world as it is. If one were to choose the former, then he would have to explain how it was that these mere functions just so happened to be a reliable guide to action (Apollo 11 got to the moon!) in that world to which they had no necessary relation. If one chooses the later, the realistic path, then one needs a pre-scientific (philosophical) justification for his position. Second, later we will talk about the "essential natures" or "substantial forms" of the wholes that make up the ensemble that is nature. ***Form*** is the principle that we will invoke to account for both the stability and identity of things, i.e., that which makes a thing a *this* rather than a *that* (a human being rather than a tulip). Empirical science can claim competence over all of the observable and measurable aspects of beings (various characteristics and properties) but not over beings as the wholes that we experience them as.[13] Again, one is faced with a choice: the Reductionist might say that beings are *nothing but* collections of these properties and it is these properties that make up the really real. On the other side, a Philosopher (like myself) might say that wholes *as* wholes are in fact "really real" though they escape the grasp of the measurable. Then, as a follow up, a Philosopher (like myself) might ask the Reductionist how various properties could exist for his study and verification (speed, weight, etc.) without anything to hold them up or nothing in which to inhere, namely a whole being? As De Koninck would put it, "[It is true that] (t)he atoms

[12] Yet every scientist, in virtue of being a rational human being, is to some degree a 'philosopher.' Therefore any given person *as* rational being is (more or less!) competent in these matters.

[13] If this seems like an odd notion to the scientist he might want to reflect for a moment. A biologist might object that, "I studied oysters night and day during my 5 years of graduate work at N.I.C.E. (The National institute for Coordinated Experiments), and that, darn it, I observed and measured more 'whole' oyster beings than you could shake a stick at with a stick made for shak'n!" While I would not doubt that he experienced more 'whole oyster beings' than I ever will, his experience of 'whole oyster beings' *as* 'whole oyster beings' does not now and nor will it ever count as science strictly speaking. He weighed them, measured them, observed and recorded what they did, traced the bio-chemical reactions and patterns of their physiology, tested hypotheses and statistically modeled all of the foregoing. All of these *scientific observations* are about the properties and characteristics *of* oysters, but none of them are about the oyster *as* oyster. As we will see, there is a distinction. Our apprehension of things is prior to our scientific investigations *about* them.

of a gentleman are as truly physical atoms as those of a rock. But the atoms are not parts of beings as bricks are of a house. The physical world is a metric and extrinsic aspect of the world. Atoms exist in the way a smile does."[14] By this remark De Koninck means to say that an atom that is part of the physical make up of any given man is an integrated part of a whole that is greater than the sum of its parts. It is not a part in the sense that parts of an aggregate are; like the planks of a sailing ship that exist with no intrinsic relation to the ship at all. Ships are, from the philosophical point of view, wholly reducible to their parts. Human beings, for instance, are not.

Third, everyone should agree that while none of the answers to the above philosophical questions could help us build better bridges or find a cure for cancer, they are nonetheless more important from a *human* point of view and that we are the only creatures known (so far) who can ask them and who worry about them.[15] The philosophical point of view begins with the interior of human beings (i.e. the common human experience of the cosmos and our own experience of our experience), moves outward toward the interior of the cosmos and the beings in it, and returns back to the interior of the person as insight and understanding.

The main point to always keep in mind when approaching the cosmos from both the scientific and philosophical points of view is that since each has its own characteristic methods (the empirical and the rational), data (the measurable external world and common human experience), and tools (technological instruments of observation and measurement, and reason). There are certain questions, respective to each field of inquiry, that either of them can purport to answer. Each discipline has its own unique set of jargon and technical vocabulary. As De Koninck puts it,

> *The profound distinction between these two domains will appear more clearly when we will have studied the same problem from a strictly philosophical perspective. Take any electron. What prevents me from following its trail from the water of a spring through the grass eaten by a cow and the cow eaten in its turn by this gentleman? Will the electric charge of the electron undergo transformations as it is passed form water to the tip of this gentleman's nose? Let the philosopher introduce as many transformations as he wants, the electron has not undergone any change that could not have experimental signification…Scientists and philosophers do not speak the same language. 'Matter,' 'force,' 'nature,' life,' 'transformation,' 'species,' etc. are so many absolutely equivocal terms. There is nothing sadder than the conflicts raised by scientists,*

[14] *Cosmos*, 243.

[15] By this I do not mean that finding a cure for cancer is not a human concern, but that finding ways to make our surroundings work for us in the most efficient possible way is not the highest thing of which a rational creature is capable.

> *philosophers, and theologians by assuming a univocal meaning of these expressions.*[16]

In an effort to avoid such confusions we now turn to introduce, define, and explain some preliminary notions in the philosophy of nature.[17]

II. Philosophical Notions

A. Nature and Becoming from the Philosophical Point of View

> *By the term 'nature,' taken in a general sense, we mean the coordinated ensemble of spatio-temporal things which surround us and of which we are a part. Becoming is the common and specific character of each thing in this ensemble. The universality of becoming is most obvious in temporal duration. The natural being which seems not to change or be changed in any other way can only continue its existence on condition that it be constantly renewed. Existence is received by it only in a successive and continuous manner. Successive and continuous duration is the definition of time. If this successive duration were not continuous the natural being could only exist by always being other… Let us say then that a natural being is a mobile being. And that nature is an ensemble of* fluxibilia*… It is mobile being, not as being, but under the precise angle of mobility,* ens mobile in quantum mobile*, mobile being precisely as mobile, that is the formal object of the Philosophy of Nature.*[18]

Here, De Koninck sets the stage for the one of the most basic points of philosophical reflection on ***nature***: our experience of change. The 6th century B.C., Greek philosopher Heraclitus (6th B.C.) stated it this way, "*panta rhei* (all things flow)." To say that we experience all beings as ***mobile*** is to say that all beings are in a constant state of flux or change—to be "mobile" is to be "changeable." The successive and continuous nature of ***mobile beings*** consists in their constant assumption of new states of being throughout time. At any given moment everything is altering either in quantity, quality, and position (in either time or space), or coming to be and passing away. Nothing has its being (its existence) all at once—if it did, it would not *need* to assume a new state. Particular ***species*** or kinds of change like local motion or organic growth due to nutrition are not themselves the interest of the philosopher but of the scientist. The philosopher is interested in the phenomenon of change as such (the mobile as mobile) and what such a phenomenon must be like in order to be thinkable.

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[16] *Cosmos*, 255.

[17] If the reader has not already noticed, key terms have been emphasized by being put in italic boldface (e.g., ***metric***) to indicate their importance and the need to understand their use during the rest of the tour. This practice will continue in the following sections.

[18] *Cosmos*, 257.

The world of nature is in a constant state of ***generation and corruption*** (coming to be and passing away) and ***change***. Yet, not all instances of change are corruptions/generations. In spite of a mobile being's mobility (my Uncle Larry is constantly changing) I do not give him a different name every time he assumes a new state of being (gaining 20 pounds, losing his hair, etc.)—he is not experienced by me as a radically different sort of thing. However, if he gets blown to ashes in an explosion (heaven forbid) I would not for a second (even in my grief) think that those ashes were the same sort of thing that gave me ten bucks every Christmas when I was a kid. Or, for a more uplifting example, the uniting of sperm and ovum involves both their corruption (*as* sperm and ovum) and the generation of a human organism. A man gaining 20 pounds is what philosophy would classify as an ***accidental change*** or ***alteration*** in reference to quantity, some quality or place, while the conception of a human being in the womb would be called a ***substantial change*** or ***generation***. Accidental change is not accidental in the sense of "not on purpose," but it carries the technical sense of being non-essential, i.e., a change in an accidental property does not entail a change into a radically different kind of thing. A substantial change, on the other hand, would be just that; a whole new entity has been generated (come to be) by the corruption of the former (passing away).

Substances are independently existing entities (the wholes of our experience) that exist in themselves and not in another (a man, a cockroach, a rock, a star, etc.). ***Accidents***, however, have no independent existence but only exist as non-essential *aspects* of substances; their *being is to be in* a substance (purple, 20 pounds, extension in space, etc.). Try to point out purple. All you could ever do is point out a purple *substance*.

One ought to have noticed above that I treated Uncle Larry and the pile of ashes as radically different kinds of things, or, in newly introduced terms, kinds of substance. De Koninck explains,

> *The ensemble of beings constituting nature is divided into four species: men, animals, plants, and the inorganic. One can know without understanding: animal; live without knowing: plant; be without living: inorganic. These four species are the only ones philosophically definable. The canine species is not a species in the philosophical sense.*
>
> *Natural species thus constitute a hierarchy. The plant is manifestly more perfect than the rock or a nebula (abstracting from the life it may contain), being at once corporeal and vegetative. The animal is at once sensitive, vegetative, and corporeal; to which man adds rationality. We say that these species are essentially different. One lives or one does not, one can know or one cannot. There is no intermediary.*[19]

It is on the basis of their characteristic activities that the four basic kinds (species) of substances are classified. These ***philosophical species*** are kinds of substances in a sense

[19] *Cosmos*, 258.

that is analogous to the way that polygons or ellipses are kinds of figures. By definition, polygons have a finite amount of sides and therefore angles; ellipses do not. The definitional property of "having a finite amount of sides and angles" is essential to what it means to be a polygon. It sets it off as a radically different in kind of figure from an ellipse. We say radically different because there is no developmental continuity from one to the other possible. No matter how many angles one adds (as long as it is a finite amount) the gap between the two, polygon and ellipse, is unbridgeable. This impossibility of developmental continuity is what constitutes a kind as a true kind, rather than an apparent kind. Hence, most all *species* (in the scientific sense of the term) would, in light of evolutionary theory, be only apparent kinds.

As our above quotation of De Koninck shows, the general characteristics (we will later refer to them as perfections) possessed by the lower species (inorganic, plant, and animal) are all possessed by the highest (man). Each level of the hierarchy possesses the perfections of the lower. The characteristics that separate the four philosophical species and constitute them—being, living, perception and understanding—are not matters open to empirical measurement and prediction, but are part of the *interior* of things that are manifested by certain signs and acts that we judge by our own *interior* experience of being, living, perception, and understanding.[20] This is not to say, however, that beings radically different in kind share nothing in common. The polygon and the ellipse are, after all, both figures just as a man and a cat are both animals. Both a man and a cat share the same ***genus***. The definition of human being, 'rational animal,' contains both his genus (animal) and his ***specific difference*** (rationality).

But, all is not well. We've concluded that the world is an ensemble of constantly changing beings, which as such do not exist all at once. Yet, we have been talking as if they do have at least some of it at once. As soon as we talked about substance, we implicitly claimed that the mobile is immobile in a certain way. How can this be?

B. The Problem of Permanence and Change

> *The few notions that we have just summarily defined already raise a host of problems, of which the most general is that of becoming, that of mobile being… It is* mobile being as given *which raises a problem in our minds. Apparently, a mobile being is a contradictory being. In order to be, it must be successively other. But if it is always other, how can it be what it is? And if it is not always the same across the succession, how can it succeed itself continuously? Mobile being must be a being which changes and which does not change.*
>
> *Are we going to say that mobile being is composed of two parts, one of which changes and the other of which is immobile? This solution is too*

[20] We will look at this in more detail later when we talk about the philosophical conception of soul.

> *easy. And yet it is necessary to arrive at a distinction. What will be the terms of the distinction?*[21]

The problem raised by De Koninck (or rather the problem which we cannot escape and only to which he gives voice) above is easily seen by examining the grammar of any of the examples of accidental change I used in the previous section. In every instance there was always a subject (a being) that endured the change and that assumed a new state of being. The very notion of change, arrived at from common human experience, *requires* of the mobile some permanent aspect. There must be a more or less stable *something* that undergoes the change. The very logic of change dictates that there be conditions or principles which enable beings to be both determinate (a definite *this*) and indeterminate (possibly other). The essential nature or what it is to be a mobile being must be composed of these two principles. If it were not, then such statements like "Last week *I* went fishing" or "*Uncle Larry* has gained twenty pounds since September" would be deprived of all meaning and coherence. In the first case the "I" who uttered the proposition would not be the same "I" who went fishing. In the second, the "Uncle Larry" of September (a bit heavy) and the "Uncle Larry" of the present (a lean machine) would be separate entities with no relation to each other. The foregoing examples hopefully serve the purpose of showing that these issues are more than the idle talk of very lonely people. The ability to utter any meaningful assertion whatsoever (including scientific ones) about the world is at issue. A necessity of logic leads us to assert a distinction between the determinate and the indeterminate as real aspects of mobile beings.

The principle of determination or stability is called ***form*** (Gk: *morphe*), and the principle of indetermination or the potential to be other is called ***prime matter*** (Gk: *proto hyle*).[22] Form is that principle which explains or is the reason why any given substance (this animal) is the kind of substance (an animal) that it is, i.e., a member of one of the four species philosophically definable (human, animal, plant, or inorganic). Prime matter is that which allows substances to be otherwise by assuming new states of being; it is the very possibility of being otherwise. Before we continue, a few clarifications about form and prime matter are in order.

First, these terms *form* and *matter* do not have the same meaning as they may have in empirical science. Form is not physical shape and matter is not the stuff of which the cosmos is composed. Second, neither of these is a being, a substance or a thing, nor have they been applied to any particular species of changeable being yet. They are ***conditions*** and ***principles*** that govern mobile beings as such and that give coherence to our experience of them. All beings in the ensemble of nature are ***composites*** of these *two principles*. They are self-existing unified wholes (substances) whose unity is not endangered by being composite. Form and matter are principles and not things, so substances cannot be thought of as aggregates (a form and matter "sandwich") but as true

[21] *Cosmos*, 259.
[22] *Cosmos*, 261.

unities of which matter and form are co-principles. We must be careful to treat matter and form as conditions of real things and not to "reify" them [i.e. treat them as things].[23]

Finally, since we are talking about mobile beings in general, as opposed to any particular kind of mobile being (human, animal, etc.), prime matter must be *pure* indetermination. If it is determinate in any way (if it can be a *this* or a *that*) then it could not possibly be open to being other. "In other words," says De Koninck, "its proper determination consists of not having one: it is pure potency."[24] As pure potency matter must be, by definition, always associated or correlated with form in composite things. The potential to be otherwise is anchored (logically) in actually being something.[25] In other words, it is always the ***potential*** of a definite kind of thing (an ***actual*** this) to *actually* assume a new definite state of being. Uncle Larry possesses the potential to assume any new state of being in virtue of actually being a realized human substance in the first place.

The philosophical analysis of change in a mobile being (both accidental and substantial) is governed and explained by the principles of form (***actuality***) and matter (***potentiality***). De Koninck explains,

> *It is again by matter and form that we explain generation and corruption. The cosmic beings which appear and disappear, one after the other and the one from the other, are drawn from the potency of matter by beings already existent, and they are reduced to it by corruption. Prime matter is not a kind of reservoir containing in a latent state determined forms which only await a chance to be released. Prime matter is pure indetermination. Forms can only be contained in it in the manner of possible cuts in an indefinitely divisible line. For natural beings, then, there do not exist forms of structure determined* a priori, *with the exception no doubt of the form or forms given at the outset, and of the form which will realize the finality of nature as a whole. Moreover, existing forms are by definition determined. Yes, but in the manner of the cuts when a line is actually divided. These forms of existent beings are fixed like whole numbers. Between any two existing forms there is more than an infinity of others possible.*
>
> *Generation is not therefore in any way a creation, but the act by which a given compound educes another from the potency of prime matter. It is understood that prime matter is created, or rather co-created (since it cannot subsist outside a composite), and that any composite whatever insofar as it is a finite being is a created being. In this respect, the entire*

[23] Ibid.
[24] *Cosmos*, 260.
[25] The phrase, "A purely indefinite being" is a contradiction in terms. The "purely indefinite" isn't, on its own, anything at all. Imagine a blank piece of paper or the unmarked surface of a white board as the pure possibility of prime matter. Until one makes a mark on either of them (determination), there isn't *anything* there even though the blank nature of the board is a condition for the possibility of making the mark.

> *universe opens directly on God. But this does not prevent the composite from being generated, and that a created being is its generator.*[26]

From the philosophical perspective any and all change that occurs in mobile beings is the continual ***eduction*** (bringing or drawing out) of form (actuality) from the potency of prime matter by a being already in some way realized in act. When a being is *generated* (comes to be) as a whole new composite or is *altered* in some way (accidental change), its new form, either substantial (e.g., a man) as is the case in generation, or accidental (e.g., the man is now standing, learning, drinking a beer, or whatever) as is the case in alteration, it is a case of the potentiality of matter being realized by something already realized —the potential can only be made actual by something already actual. It is logically impossible for the "potentially existing" to be made to exist by something else that only potentially exists.

The *coming to be* from the potency of matter (generation) and the *passing away* back into the potency of matter (corruption) are constitutive principles of the created cosmos. Beginning with the "form or forms given at the outset," meaning the first created composite[27] (whatever it might have been), the potential for any and every created kind of thing to be realized (substances and their various states of being) is contained in prime matter like "the possible cuts in an indefinitely divisible line" because the possibility to be otherwise (prime matter) is a principle of the created cosmos from the outset. This process of generation and corruption is not the same thing as creation from nothing (*ex nihilo*).[28] It is not creation (a supernatural, divine activity which no apparatus, not even reason, can penetrate) but change (a natural, intra-cosmic activity that is comprehensible by reason). While God is the ***ultimate cause***, explanation or reason for the cosmos, his creative act is not necessary to explain the generating and altering activity of creatures if creatures provide a ***sufficient explanation*** for the effect--even principles of creation like form and matter are still part of creation, i.e., not God.

At this point one ought to suspect that the term 'cause,' as it has been used so far, has a different meaning than it does in everyday usage. When a being, already realized in some way, educes a new form from the potency of matter and thereby realizes it, that being is said to be the *cause* of the generation or alteration. In philosophy, causality is understood in terms of form and matter, and especially the movement from potency to act.

However, today we tend to think of cause and effect mainly in terms of antecedent and consequent events. When we have one event that regularly and reliably precedes another we call the former the cause and the latter the effect. At root, causality is, in the common view of today, this constant conjunction of events—when the circles overlap a

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[26] *Cosmos*, 262.
[27] Ibid.
[28] I mean "from nothing" in the sense that nothing but God's power is presupposed or required in the act of creating. It's not that God uses "nothing" as some sort of raw material.

statistically significant amount of the time we call it correlation, when they overlap virtually every time we call it causation. In either case it is never the causing itself we observe, but only the two events (antecedent and consequent) from which we infer causality.[29] However, this is clearly not what Aristotle, Thomas Aquinas, and De Koninck mean by causality or cause at all.

First, a ***cause*** is the deep reason which accounts for and explains (in a comprehensive and fundamental way) the 'why' of a mobile being so that one can gain a comprehensive understanding of a mobile being. Cause in the sense of 'reason for,' 'explanation,' or 'that which gives an account of' can have many facets. For example, we can talk about ***efficient causes***, namely ***that by which*** a generation or alteration occurs (in other words the efficient cause is the ***agent*** of change)—In one way Uncle Larry is the efficient cause of the finely crafted coffee table in his living room (on which he puts beer, and only occasionally coffee) because he is the craftsman of the artifact. In another way he, along with his wife, is the efficient cause of my cousins as one of their biological parents.

Looked at from the perspective of act and potency here is what we have: Let's call Uncle Larry "a builder." We call him 'a builder' because of the craftsman's art (knowledge) he possesses in himself. In his mind he has the form or blueprint of a coffee table. All of this only makes him a potential builder, not an active one. He happens upon some cypress wood (the ***patient***, or the one that undergoes the change) which has the potential to be, among other things, made into a coffee table. It is in the act of building when Larry, so to speak, becomes the "builder building" that the potential of the wood is actualized or realized into the form of the coffee table. From the philosophical point of view this is not two events between which we simply infer a causal connection, but one event in which cause and effect are simultaneous, i.e., in the 'builder building.' The cause, effect, and the causing are all, in a sense, observable in the one event that we refer to as "the builder building." From the immediately preceding cause and effect and all that we have said so far (form/act and matter/potency), there are some summary conclusions that we can draw about generation and corruption from the philosophical perspective.

First, as De Koninck says, substance is "invariable… *Substantia non suscipit magis vel minus* (Substance does not admit of the greater or the lesser)."[30] There are, strictly speaking, no quasi-substances. A thing is either the kind of thing that it is (e.g., human) or not. There is no in between. When a sperm and an ovum unite their corruption is instantaneous with the coming to be of the zygote—remember that causes are instantaneous with their effects. Even though the scientist can track chromosomes from one to the other, the chromosomes of the gametes and those of the zygote are those of

[29] We have one David Hume (1711-1776) to thank (or possibly blame) for this now all too common notion of causality. Rather, perhaps it is better to say that we have Hume to blame for fooling us into thinking that this is the *only* way to think about cause and effect. It is a legitimate way, but not the only way.
[30] *Cosmos*, 278; translation mine.

two different substances.[31] There is no intermediate state between A and B where only the pure potency of prime matter exists. What looks to be a gradual process from the empirical point of view is, from the ontological point of view, instantaneous.

The second has to do with De Koninck's claim that natural beings are sufficient explanations (not in the ultimate sense) for cosmic change. It is true that God is the ***primary cause***, ultimate explanation, ground or reason for everything in the cosmos. But, this does not mean that every act of non-rational nature (the eduction of form from matter on the philosophical level or the something like celestial mechanics or evolution on the scientific level) is the result of God's direct intervention. Mobile beings act as ***secondary causes***. A secondary cause is like the hammer uncle Larry used to make the coffee table. If one were to ask who or what is achieving the effect of pounding the nails the answer would be that b*oth are simultaneously*, but in different ways: Uncle Larry, by means of the hammer, and the hammer, in virtue of the power imparted to it by Uncle Larry—hammers can't pound nails unless they are used by an agent. In this example the hammer is an ***instrumental secondary cause***. The power of the agent passes through it so that it can achieve an effect greater than it is capable of by nature. *Unlike* the hammer, mobile beings and everything in creation act as ***true secondary causes***, meaning that they achieve their effects by the powers they posses in virtue of their forms. *Like* Uncle Larry and his hammer, God and creatures *achieve the whole effect simultaneously*, but in different ways. In natural generations of any sort efficient causes are responsible for the whole effect, i.e., the new composite. These effects (created and finite) are in proportion to the forms and powers of natural agents and are therefore truly their own. God, as primary cause, governs the universe by enabling nature to unfold under its own power and according to its own laws and spontaneity—the highest form of this spontaneity is the freedom of the rational creature. Notice that I used the term 'govern' in reference to God and 'spontaneity' and 'freedom' in reference to creatures. The proposition that God's providence and plan for the perfection of the universe will turn out just as he wants it to while the creatures which inhabit that universe are spontaneous and free should not bother anyone. God's divine causality and the causality of the creature are what philosophers call "equivocal;" they are not of the same order or on the same level. They cannot be in competition, even theoretically. Without God's causality the spontaneous and free causality of the creature would not be possible. God is the cause of the rational creature's freedom. According to De Koninck, the confusion of these two causalities is at the root of creationism,

> *which opens the world directly on God, bypassing the universal hierarchy, implicitly rejects what is essential to the universe: the unity of order…One imagines that scientific explanations replace the philosophy of nature and one retains only what is directly useful for theology. But, if in astronomy cosmic repulsion sufficiently explained the expansion of the universe, and the theory of genes puts us on the way to explain mutations—and it would*

[31] *Cosmos*, 279. De Koninck's earlier comments about atoms existing in the way a smile does apply here also.

> *be ridiculous to call them insufficient from a scientific point of view, which in its fashion constitutes a closed domain— none of that could explain the simple displacement of a material point from an ontological point of-view. For that, one cannot have recourse directly to the general notions of metaphysics, we must find the proper causes. If I have a headache because God wishes it, that does not prevent me from attributing it to a too long night and accepting that an aspirin might relieve it.*[32]

From the philosophical perspective, both God and creatures achieve the same effect, each in the way appropriate to them. If God wants me to get a headache (the part that this will play in his plan for the perfection of the universe is anybody's guess) he doesn't need to zap me from heaven—my biology and beer accomplish this task on their own. De Koninck will have more to say on creationism later.

C. The *Raison d'être* of the Cosmos and Finality in Nature

> *Mobile being pursues its existence, but it cannot continue to exist in order to have had a history. Its end cannot consist in the pursuit of an existence always infinitely removed, that is unrealizable. If mobile beings existed in order to exist, their reason for being would be impossible: their existence would even be contradictory. Therefore the terminal point of every mobile being must be in itself immobile, a being which, as terminal point, does not have to pursue its existence. It would have a successive existence insofar as it is composite, but it would be outside time because of its spiritual form. And this is the* raison d'être *of the whole of nature.*
>
> *But a being which does not have existence in a successive manner is a being with a simple essence: its existence will be equally simple. Such a being is not, therefore, educed from the potency of matter, it is given from the outset by a creative act. But if it is entirely given from the outset, natural beings would be superfluous. Such a being would be essentially trans-cosmic, a pure spirit But the particular end of the cosmos ought to be interior to the cosmos. If mobile being as such cannot be that end since it is only a means, its reason for being is essentially utilitarian. But its existence cannot be useful for a pure spirit. That is why a pure spirit cannot be the* raison d'être *of the cosmos.*[33]

With the above principles in hand we are now ready to enter into what, from the scientific point of view, could be considered De Koninck's most controversial claim: that the *purpose* of mobile beings and of the entire cosmos is the human being. The reason for this 'controversy' is because the concept of beings having a purpose, a reason for being,

[32] *Cosmos*, 270.
[33] *Cosmos*, 263-264.

etc. is foreign to empirical science. Purpose is neither measurable nor predictable nor able to be statistically modeled. Yet, purpose, or what we will call ***final causality***, is indispensible for the philosopher. The indispensability of this notion is due, in part, to the orientation of philosophy. It tends, as a general rule, to look at the universe from 'the top down' so to speak. It begins with the fully realized, actualized, and perfected and then looks backwards at the process of potency being brought into act. The temporally prior is of less interest to the philosopher than is the ontologically prior (the more perfect or the more excellent). For the philosopher (or at the very least one of the Thomistic stripe) the cosmos is a fundamentally intelligible place, a fundamentally understandable place, and the practice of philosophy (along with science by a different method) aims at making that intelligibility transparent to us. To say that a thing has a purpose is to say that, in virtue of its form (the kind of being it is, its nature), it has a proper function that, all things being equal, it tends to realize. This function or characteristic activity is part of what makes mobile beings and their mobility understandable to us. This is why 'the purpose for which' a thing exists is a facet of causality philosophically; it helps to explain, account, or give the reason for that thing.[34]

We have said already that mobile beings do not exist all at once, but do so successively throughout time. From the perspective of actuality and potentiality we would say that mobile beings are continually being realized and renewed. This is why De Koninck says that a cosmic being "pursues its existence." It is characterized by a constant movement of assuming new states of being. It *has to change* because it cannot posses all of these states of being simultaneously. Uncle Larry can only move from here to there, only *needs* to move from here to there (from the couch to the fridge) because he is not *already* there--in this way the existence of mobiles is "always infinitely removed" from them. The essential nature or purpose of a cat cannot simply be to exist because, in light of all that we have said, there is never any point in which the cat fully is, i.e., at which the cat exercises all of its various possible states of being simultaneously. A purpose that is theoretically unrealizable is contradictory and therefore no purpose at all. So, simply to exist cannot be the purpose or finality of the mobile being as mobile. If there is no sufficient reason or explanation for this (which purpose provides) then everything in the cosmos would be unintelligible. So, if the purpose of the mobile cannot be mobility (a contradiction) then it must be something that is in some way immobile.

One of the points at issue has been the successive and continuous (time conditioned) nature of things in the cosmos that defines them as changeable. The way in which time

[34] Whenever philosophers talk about the purpose of natural beings hackles begin to rise because we tend to think that purpose necessarily implies intelligence, design, etc., and that it is therefore a crypto-argument for the existence of God. Those whose hackles have just risen often offer a refutation along the lines of it being another example of the philosopher projecting his own experience of purpose and intelligence onto nature. If purpose were offered as a scientific thesis he may be right. However, this idea of final causality originated with Aristotle, who certainly did not think that the universe was a product of created design. Aristotle's God is not a creator. For Aristotle, the intelligence was not in the thing or its design, but in the fact that it was *intelligible*. The purpose of a thing was an expression of its intelligibility. In fact, Aristotle thought that human beings acted in a purposeful way *in imitation of nature*. Not the other way around.

and mobility are overcome are in the immobility of human rationality; the human spiritual form. When we know and understand the cosmos, by which I mean understanding it *as it really is*, we integrate *in ourselves* what has been spread out over the continuous succession of time in things. We make what is changing by nature stable in us *as known*. De Koninck calls this "making a tour of being."[35] All of those various states of being assumed and assumable by Uncle Larry over the course of his life that come to be and then pass away come to rest in us (knowers) by our coming to insights concerning the causes or reasons for their being (knowing).[36] We are the only intra-cosmic beings (that we know of) that can achieve the immobile integration needed for the *raison d'être* of nature. This philosophical conception of the human person as being that which can understand the deep 'what' and 'why' of things is far removed from the view that would make the human person a particularly sophisticated organic calculator.

While the true end of all possible natural forms must be realized in the spiritual form of man, this does not mean that the route is in any way rigidly determined, i.e. that the cosmos and life must march lockstep and without variation towards the emergence of man and nothing else. Remember, natural causes are truly causes in accordance with their own natures and according to their own powers and activities. Created causes can and do fail. Nothing save the purpose is given in advance. "One can say in advance that it must arrive at life, at knowledge, at intelligence, but it is for experimental science to say how this world has been molded…"[37] The path that nature has in fact taken is not in the philosopher's competency. The tracing out the torturous evolutionary path of the spontaneity, "failures," and order of natural causes is a job for the natural sciences. In the end it is up to scientists to tell us the 'how.' The 'why' and for 'what purpose' is for the philosopher (and the theologian of course) to reflect upon.

So, the purpose or the 'that for the sake of which' of the cosmos is the human race. De Koninck sees that the perfections which reside in the human being (first and foremost free rationality) provide the deep reason why the cosmos has proceeded in the fashion that it has from the beginning. The philosopher starts with the fully actualized and realized perfections (in our case those of the human being) and works backwards by explaining and therefore understanding the process of potency being realized into actuality (the given process of the cosmos from the philosophical point of view) in terms of the move from the imperfect (potency) to the perfect (act). Being is more perfect than non-being, life more than non-life, perception more than nutrition, rationality and understanding more than perception alone. Not only is the cosmos hierarchical to the philosopher, but its movement is seen as an ascendency from lower to higher for the sake of the higher. Act (form) is potency's (matter's) reason for being.

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[35] *Cosmos*, 264.
[36] From the theological perspective one might say with De Koninck that, "nature could not be ordered to God except through man."—Ibid.
[37] *Cosmos*, 267.

This talk of perfection and an ascendency to and for perfection is certainly odd sounding to the scientific ear. Within the confines of the scientific method this is natural and to be expected. For instance, the biologist sees the evolutionary path, by fits and starts, as an ascendency of physical complexity. Increased biological complexity and organization may or may not serve what are essentially utilitarian purposes, namely, navigating one's environment, reproductive success, etc. If 'perfection' has any meaning here, it is a utilitarian one. Yet, while the philosopher *would surely acknowledge* that while the perfection of rationality *can certainly be viewed* as a 'useful adaption,' and therefore utilitarian, its value does not consist in this alone. It is true that a certain degree of biological complexity is required as a necessary condition for the exercise of certain kinds of perceptual activities and even understanding, but it does not follow that said complexity is a sufficient condition or offers a comprehensive explanation for those activities beyond which there is no other possible. After all, when trapped in a pit with a rabid tiger, all the capacity for 'taking a tour of being' gets me is eaten. Taking a tour of being is an activity in which I can engage *for its own sake*, not for any utilitarian purpose whatsoever: "The ultimate end… is not control or the shipping of beans and bananas, nor weather prediction; it is more profoundly an exploration of the world with an eye to gathering it to a point, and contemplation."[38] This is one of the reasons that the philosopher deems such a power a perfection; it can wholly transcend the utilitarian. A thing done for its own sake is more excellent than a thing done for another purpose. While the move from the less to the more complex on the biological level is perfectly explainable in terms of *physical* mechanisms, this is not what the philosopher is talking about at all.

III. The Movement or Evolution of the World

A. Soul and Evolution

> *The vital activities of which I am conscious flow from my substance. Every substantial form immediately actuates matter. Thus the form of a living thing is the act of a matter. But the form of a non-living thing is also the act of a matter. How then can we differentiate between these two species of form?*
>
> *Let us call soul the principle of life that we seek to define. We will say that we are dealing with the corporeal in the narrow sense when we encounter no sign of life in a being. Still, the definition of soul cannot be 'form of a body.'*[39]

Over the course of this essay I have claimed, along with De Koninck, that the philosophical point of view looks at things 'from the top down,' or from the 'interior' perspective. To grasp the philosophical notion of soul or life some further elaboration and clarification of this 'interior' view is in order.

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[38] *Cosmos*, 303.
[39] *Cosmos*, 275.

Earlier I said that the criteria (being, life, perception, and understanding) by which we classify the four philosophical species (inorganic, vegetable, animal, and rational) are grounded in our own interior experiences of them. I am infallibly aware that I think, live, etc. *I know* what it is like for me to think, live, etc. *I know* all of the things that I can do in virtue of thinking, living, etc., and *I know* that I am the principle or source of all of them. Therefore, "these activities [living, thinking, etc.] involve objectively observable signs that I connect directly with the activities. But when I find elsewhere similar signs quite independent of the observable signs of my own activities, I attribute them—for they are signs—to a life other than mine, to another subject."[40] This "other subject" could be anything from a bacterial flagellum (a self-mover) to a philosopher (a self-mover who also talks, ponders, and writes articles), both of which, *like me*, are principles and sources (interiority) of the activities from which the observable signs emanate. I know that Uncle Larry is a living, thinking kind of thing because he does what I know living, thinking things do—I know this because I essentially am one myself. This does not mean that all the philosopher does is reflect on *his life as his* (this would be useless to anyone but him) but that his own life, thinking, etc. is the basis on which he looks outward to the interior of things. It should be easy to see, therefore, that philosophically speaking, the inorganic is in many ways obscure. We define it by what it is not, by what it cannot do. We judge it from the perspective of life in a negative manner, e.g., an inorganic substance is not a self-mover; motion (change considered as the interplay between act and potency) comes to it from without. As a whole, it does not cause its own motion.[41]

From this perspective ***soul*** (that by which living things live) is the act of an organized body. A whole having organs that are differentiated by function is the observable manifestation or sign that such and such is living rather than not. If at this point, one connects the *act* of the above definition of soul with *form* (that which actualizes and determines matter) such that soul is then the form of an organized body, then he or she has gotten it exactly right. If form is the principle of determination in things, then soul is the principle or condition which determines living things *as* living. If one did not make this connection, it may have been due to the unfortunate cluster of ideas which 'soul' commonly connotes. People all too often think of 'soul' as the real inner 'me,' this inner spiritual light that bounces around inside the body, etc. For the philosopher (and the theologian also) many of these connotations are false.

As we have already said, in generation, when a substantial form is brought forth from the potency of prime matter by the causal activity of a substance already in act, a new substance is produced which is a composite of form (a this) and matter (yet possibly other and capable of change). However, in the new substance, it is the form and matter of a *definite* kind of thing. From the perspective of this new thing, the form has actuated the matter into the matter of a definite kind of composite (human, animal, inorganic, etc.). De Koninck calls these "actuating form" and "actuated matter" respectively.[42] This is to

[40] *Cosmos*, 271.
[41] *Cosmos*, 273.
[42] *Cosmos*, 278.

say that each kind of substance has a limited potential to perform and undergo change that is proportional to, and conditioned by its nature (form). As a human being, Uncle Larry can stand up, cry, break his leg, run a marathon, and solve a differential equation, etc., while a pile of ashes can neither perform nor undergo any of these changes— on the flip side Uncle Larry can't dissipate in the breeze. In relation to soul, this means that when the form of a living thing is educed from prime matter, the result is the matter and a body of a certain kind, i.e., an organized body of a living thing with all of the potential for change that characterizes it as such.

So, we have it that form conditions and actuates matter—it makes it the matter of a definite kind. Therefore, *a rational soul or human form is what makes our bodies the definite sorts of bodies they are, and grants to human organisms their whole range of possibilities of being and acting*.[43] The soul is not some ethereal spirit that is placed into an already awaiting body to which it originally had no relation. Rather, it is a metaphysical principle, along with matter, of a mobile being that is living and rational. "That is why," says Aristotle, "we can wholly dismiss as unnecessary the question whether the soul and the body are one: it is as meaningless as to ask whether the wax and the shape given to it by the stamp are one, or generally the matter of a thing and that of which it is the matter."[44]

But free, rational activity is part of this range of being and acting made possible by human form (soul). It is in virtue of soul that the human person has the faculty of ***mind***, the ability to think abstractly about universal concepts that go beyond any of the particular objects of sensation. The faculty of mind is that by which we are able to take a tour of being; to gain an insight into the principles that govern the whole. It is this activity that De Koninck claims is the goal of the evolution of the cosmos. Yet, God's governing causality being exercised via the causality of nature does seem to create problems when we talk about the soul. If the soul is immobile in the sense of it being able to stand above the fray of the cosmos by making what is mobile by nature immobile in thought, then how can naturally mobile beings be the true cause of a form which is immobile? This is one reason why theology teaches that the soul is created immediately by God. True causes cannot achieve effects that are disproportionate to their power (sufficient causality). The power inherent in the mobile is insufficient to completely explain the coming to be of the immobile. If the human being and his soul are the goal or perfection of nature, how does nature accomplish it?

To this question De Koninck gives the following answer,

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[43] This does not mean that prime matter (pure potency) is further specified by form into actuated matter (limited potency). If this were the case, then prime matter would no longer be pure indeterminacy and any further sort cosmic change (being otherwise) would have been impossible after the first change of the initial composite. A better way to think of the relation of the two is to conceptualize the same thing on two different levels. On the most general level of mobile beings as such potential to be otherwise is unlimited; while on the level of specific beings *the same potential* to be otherwise is limited. Remember, we are dealing with principles, not things.

[44] *On the Soul*, II.i.412b.5.

> *The body is like an instrument that enables the spirit to exercise its proper activities. But the human soul cannot be the form of matter formed just any way. It presupposes on the side of matter a given disposition which necessitates informing. No doubt this disposition given in advance is not that of a human body, since the body is human only because of the spiritual form which actuates it, but it is immediate disposition to the human body. It is this immediate disposition that the whole of nature brings about under the spiritual pressure exercised on it according to the laws of nature.*[45]

As we have seen, form is proportioned to matter. The kinds of change (generations or alterations) that a being can cause as agent or undergo as patient is limited and defined by its nature. There is only so much that Uncle Larry can do, or have done to him because of his humanity. Over the course of time things assume new states of being that, while not qualifying as substantial changes (the organism is still *this* organism), do ***dispose*** the creature to eventual corruption. But, the corruption of beings is always followed by the generation of a new being. From the perspective of the ascendency to perfection, the disposition to corruption is ultimately ordered to and the condition that makes possible the generation of the new being. These alterations dispose the composite to a corruption or, from the evolutionary perspective under consideration here, to be *the cause* of a generation of a new composite--the mutations studied by evolutionary biologist would be an example of a species (kind) of alteration that disposes. What evolution does, from the philosopher's perspective, is dispose matter in such a way that it is fit for human form. Reflecting on this idea of alterations disposing matter for human form, De Koninck says,

> *Nothing equals the seriousness and pragmatism of the lower animals who do nothing useless. Higher animals, on the contrary, play. They have energy to dispense gratuitously. And if it is not perfectly disinterested, their play at least tends toward an activity exercised for themselves. Nothing prevents us from imagining that it is in play, which requires a quick adaption to new situations and sharp attention, that the higher animals have been progressively disposed and have called intelligence into the world. For the proper life of intelligence is above all play, a game within the principles of being and thought.*[46]

Yet the soul is not a pre-existent thing that God places into a body, but *the two come into being simultaneously*, as form and matter do in any generation. Remember that God's causality and the causality of nature do not work in competition; "for it is the divine power that gives existence to the body and to the soul, although it forms the body by means of a natural agent, which is the power inherent [in the agent], and that it produces the soul immediately."[47] *Both* nature and God are causes of the uniting of form and

[45] Cosmos, 288.
[46] *Cosmos*, 310.
[47] *Cosmos*, 291.

matter, "(t)he two causal lines meet in a being essentially one."[48] In one sense the spiritual form of man comes from "outside," but in another sense just as profound, it is the most natural thing in the world because matter disposed in the correct way *calls* for it—it *needs* it for its perfection, it's *raison d'étre*. This is as much as the philosophical perspective can offer: "What now was this animal whose elevation to the necessitating disposition by way of alteration calls *naturally* for the creation of the soul? It is for experimental science to tell us."[49]

B. De Koninck and Faith/Science Dialogue

There were many in his time that saw De Koninck's perspective as an affront to human dignity and the sovereignty of God. Yet, on both counts, there are good reasons to think they were wrong in that De Koninck's perspective accomplishes just the opposite; he elevates both. As to the charge that such a view debases the human, De Koninck responds, "And if man and the ape have, in this respect, a common ancestor, how would that detract from human dignity? Why prefer that he came from mud? [as a literalist reading of *Genesis* would have it]...Is it not rather his glory to be the goal of these immense efforts of the world, prodigious and concentrated with an eye to his arrival?"[50] The dignity of the human person is rooted in the fact of his *creation in the image and likeness of God*, not the *process or means whereby* he was created.

To the charge that an evolutionary view robs God of his sovereignty, De Koninck thinks that it is rather the creationist who is guilty of such an offense. The creationist view "consists in diminishing as much as possible the causality of the creature…They want us to think that it takes a special creative act for the production of each natural and biological species…They deny the scientist the right to derive biological species from one another."[51] On the other hand, there is De Koninck's own view which he labels as "Thomistic," which exalts the causality of creatures and thus, in a paradoxical way, exalts the causality of God. God's power, "envisaged from the side of its effect is most profoundly at work where created causes are most causes. The more a creature is capable of acting, the more it manifests the power of its ultimate cause, for God is the cause of all causality."[52] In light of this statement, De Koninck is right to say that creationism, in its neutering of creation and hence the creative power of God, "is not creationist enough."[53] What kind of a God would God be if he made his creation such that it required his constant special intervention because he couldn't or wouldn't make it in such a way that it could function and develop under its own power? It is in recognizing the dignity of creation that one comes to recognize the dignity of the Creator.

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[48] *Cosmos*, 292.
[49] Ibid.
[50] *Cosmos*, 292.
[51] Ibid.
[52] *Cosmos*, 263.
[53] Ibid.

IV. Conclusion

Our tour of *The Cosmos* is at an end. Yet, we have only scratched the surface of both De Koninck's work and the cosmos that it attempts to make more intelligible. He has shown us that the best of what the Catholic intellectual tradition has to offer in the area of philosophy can shed light on what the best human intellectual tradition has to offer in the area of science. In the introduction I said that *The Cosmos* was not only an excellent example of an engagement of the Catholic intellectual tradition and science, but also a paradigm for it. It is paradigmatic for faith/science dialogue in many ways, but if I were to pick one it would be this: the posture that we inheritors of the Catholic intellectual tradition ought to take is one of careful, yet confident engagement with the best insights our age has to offer, so that a higher synthesis in search of the truth may be achieved, rather than a retreat into an intellectual ghetto where such wisdom will surely be missed.

In a footnote, De Koninck provides an example of the human capacity to make a tour of being by quoting the words of Anne Morrow Lindbergh, wife of the aviator Charles Lindbergh, describing her view of the world from her husband's airplane. The awe and reverence which suffuse her words exemplify De Koninck's own tour of the cosmos and are a fitting conclusion to our survey of his thought:

> *One could sit still and look at life from the air; that was it. And I was conscious again of the fundamental magic of flying, a miracle that has nothing to do with any of its practical purposes and will not change as they change. It is a magic that has more kinship with what one experiences standing in front of serene Madonnas or listening to cool chorales, or even reading one of those clear passages in a book—so clear and so illuminating that one feels the writer has given the reader a glass-bottomed bucket with which to look through the ruffled surface of life far down to that still permanent world below.*
>
> *For not only is life put in new patterns from the air, but it is somehow arrested, frozen into form. There is no flaw, no crack in the surface. Looking down from the air that morning, I felt that stillness rested like a light over the earth. The waterfalls seemed frozen solid; the tops of the trees were still; the river hardly stirred, a serpent gently moving under its shimmering skin. Everything was quiet: fields and trees and houses. What motion there was, took on a slow grace: the crawling cars, the rippling skin of the river, and birds drifting like petals down the air; like slow-motion pictures which catch the moment of outstretched beauty—a horse at the top of a jump—that one cannot see in life itself; so swiftly does it move.*

And if flying, like a glass-bottomed bucket, can give that vision, that seeing eye, which peers down to the still world below the choppy waves—it will always remain magic.[54]

[54] *Cosmos*, 351-352, n. 105; cf. Anne Morrow Lindbergh, *North to the Orient* (New York: Harcourt, Brace, 1935).