Advanced Procrastination Dynamics in Graduate Studies

Jane Doe

Doctoral thesis

Submitted in fulfillment of the requirements for the degree of
Doctor rerum naturalium (Dr. rer. nat.)

Reviewers
Prof. Dr. Reviewer 1
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Department of Caffeine Research
University of Typst Templates

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Dynamics in Graduate Studies
Panic City, University of Typst Templates

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"Some quote."

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ABSTRACT

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Zusammenfassung

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Publications and Contributions

Part of this cumulative thesis contains the following peer-reviewed publications. Their content is included in Part II.

1. Daniel Schoch: "*Gods as Topological Invariants*"; Journal of Theoretical Topology and Theology, Vol. 3 (Special Issue on Metaphysics), 2012; pp. 1–4.

2. Michael B. Lund: "*Astrology in the Era of Exoplanets*"; Proceedings of the Celestial Computation Conference (C3), Vol. II, 2016; pp. 1–8.

3. Samuel Albanie, Sébastien Ehrhardt, João F. Henriques: "*Stopping GAN Violence: Generative Unadversarial Networks*"; Harmony in Machine Learning Symposium (HiML), 2017; pp. 1–10.

4. Douglas Scott: "*Science Spoofs, Physics Pranks and Astronomical Antics*"; Annals of Scientific Whimsy, Vol. 12, 2021; pp. 1–35.

Apart from the above, below is a list of additional manuscripts and co-authored peer-reviewed publications.

1. Mira Patel, Jonas Keller, Priya Srinivasan: "*Probabilistic Constellations: Learning Sky Maps from Sparse Sensors*"; In Proceedings of the Synthetic Astronomy Symposium (SAS), 2023.

2. Jonas Keller, Aanya Liu, Rafael Ortega: "*Uncertainty-Aware Circuit Priors for Adaptive Telescopes*"; Workshop on Tractable Models in the Wild (TM-W), 2024; Virtual.

3. Aanya Liu, Jonas Keller, Mira Patel: "*Topology-Aware Calibration for Deep Space Probes*"; Journal of Exploratory Space Systems, 2025; accepted for publication.

4. Jonas Keller, Priya Srinivasan, Rafael Ortega: "*Neural Helm Charts: Navigating Generative Models by Star Tracker Logs*"; Preprint available at https://example.com/helm-charts.

Due to the nature of the synopsis and to enhance readability, selected paragraphs from these publications were transferred verbatim throughout the synopsis without explicitly labeling as suggested in the department regulations "Kumulative Dissertation und Eigenzitate in Dissertationen" (01.12.2022) §1.

ACKNOWLEDGMENTS

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Contents

List of Figures

Acronyms

AEON   Almost-Exact Oracle Network
BASIL   Bayesian Astro-Symbolic Inference Layer
CATS   Cosmic Alignment Transformer System
DRIP   Diffusion for Ritualistic Inference Protocols
EEL   Entangled Evidence Learner
FABLE   Fictional Abduction Benchmark for Latent Evidence
GLOW   Galactic Likelihood Optimizer Workflow
HALO   Hierarchical Astral Latent Operator
ION   Interdimensional Observation Network
JAZZ   Jitter-Aware Zenith Zoomer
KELP   Kernelized Ephemeral Latent Projector
LUCID   Latent Uncertainty Calibration in Dreams
MOSS   Manifold-Oriented Story Synthesizer
NEST   Neural Ephemeris Smoothing Transformer
ORBIT   Out-of-Range Bayesian Interpolation Toolkit
PULSE   Probabilistic Unrolling for Liminal Signal Extraction
QUILL   Querying Unlikely Inferences with Lattice Logic
RUNE   Recursive Uncertainty Network Ensemble
SONAR   Spectral Observation for Noisy Astral Readings
TANGO   Tractable Approximate Narrator for Galactic Observations
UMBRA   Uncertainty Modeling for Backlit Radiant Anomalies
VINE   Variational Inference on Nested Estuaries
WISP   Weakly Informed Signal Prior
YAWN   Yet Another Waveform Normalizer
ZEST   Zero-Entropy Surrogate Transformer

NOTATION

Mythic Modeling

M	Manifold representing a universe
$g(M)$	Pantheon count inferred for manifold M
$\chi(M)$	Euler characteristic as a divine predictor
$\psi(t)$	Faith flux over cosmic time t
$a(x)$	Baseline aura intensity measured at location x
$h(\mathbf{X})$	Halo annotations across regions $\mathbf{X}$
$b(y)$	Probability mass for observing a blessing y
$c(y \mid r)$	Conditional curse likelihood after ritual r
Ω	Collection of symbolic observations
$s(\Omega)$	Encoding function mapping omens to tokens
σ_t	Noise scale for illuminating hidden relics

Fictional Inference

π_0	Oracle prior used for divination
S	Posterior sampler consulting the oracle
v	Latent variable masking inconvenient truths
$r(x)$	Posterior revelation for event x
$m(\mathbf{x})$	Likelihood of a myth given storyline $\mathbf{x}$
$t(\mathbf{x})$	Counter-likelihood under a skeptic baseline
η	Learning rate for daybreak updates
λ	Decay factor for forgetting prophecies
p_+	Predictive distribution for the next omen

Ritual Circuits

C	Ritual circuit describing ceremonial flow
S_g	Sigil graph controlling gateways
σ_j	Weights assigned to chanting paths
ρ_i	Input rune index
κ_j	Intermediate chant aggregator
φ_k	Fusion node combining offerings
X_f	Set of omens governed by fusion f
$A(f)$	Alignment operator ensuring harmonious inputs
w	Dropout mask preventing malevolent overfitting
ζ	Normalization constant keeping rituals stable

SYNOPSIS

1 INTRODUCTION: THE ART OF DOING NOTHING

The phenomenon of academic delay is rarely a result of laziness, but rather a sophisticated, subconscious prioritization algorithm. We define "Advanced Procrastination" not as the avoidance of work, but as the active engagement in tasks of secondary importance to simulate productivity (Slacker & Loafer, 2024). This state, often referred to as "productive paralysis," allows the researcher to maintain a facade of busyness while the primary objective remains untouched.

Recent studies indicate that the guilt associated with procrastination actually fuels a specific type of hyper-focused anxiety, which is occasionally useful for meeting deadlines in the final 4% of the allotted timeline (Panic & Rush, 2023). We posit that without this deadline-induced adrenaline spike, the average graduate student would lack the kinetic energy required to open their laptop lid.

1.1 Literature Review on Cat Videos

The consumption of feline-based digital media has emerged as the primary sink for graduate attention spans. Whiskers & Mittens (2022) argues that the infinite scroll of short-form cat content provides a distinct dopamine feedback loop that rivals traditional substance abuse. In their landmark study, "If I Fits, I Sits: A Topological Approach to Comfort," they demonstrated that the cuteness of the subject is inversely proportional to the viewer's remaining time until a committee meeting.

Furthermore, Purrington (2025) suggests that watching cats knock objects off tables serves as a vicarious release for the graduate student's desire to dismantle the established academic hierarchy. While detractors claim this is "wasting time," we argue it is essential cognitive maintenance, preventing the complete calcification of the soul during the literature review phase.

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1.2 The Impact of Caffeine on Anxiety Levels

The relationship between caffeine intake and thesis output is best described by the Yerkes-Dodson Law, but shifted significantly towards the "breakdown" axis. While Beans & Roast (2021) postulates that there is a "Goldilocks Zone" of three espressos where clarity is achieved, our empirical data suggests this zone is theoretical and exists for approximately twelve seconds.

Beyond this threshold, the subject enters the "Vibrating Phase," characterized by high typing speeds but extremely low semantic coherence. As noted by Jitters (2023), the transition from "alert" to "existential dread" is often triggered by a single sip of cold brew after 4:00 PM, leading to a state where the student can hear colors but cannot recall the definition of a p-value.

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2 Background: Why Work at All?

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eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae.

2.1 Historical Attempts at Productivity

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2.2 The Myth of the Perfect Workspace

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3 Methods: Theory of Avoiding Real Work

To rigorously investigate the dynamics of delay, we employed a multi-modal approach involving high-fidelity distraction techniques. We categorized activities based on their "Justification Score"—a metric defining how easily one can convince a supervisor that the activity was actually research-adjacent.

3.1 Gods as Topological Invariants

This section summarizes and contextualizes the paper

> Daniel Schoch. Gods as Topological Invariants. *Journal of Theoretical Topology and Theology, Vol. 3 (Special Issue on Metaphysics).*

3.1.1 Sorting Books by Color Gradient

We attempted to apply the principles of theotopology to the physical organization of the laboratory workspace. By rearranging the reference library according to the visible light spectrum rather than the Library of Congress system, we achieved a state of "Chromological Harmony" (Rainbow, 2024). This process took three days and rendered the library functionally useless, but the aesthetic satisfaction provided a temporary reprieve from impostor syndrome.

The resulting gradient ($RtoGtoB$) creates a continuous manifold on the bookshelf, proving that while knowledge is discrete, procrastination is continuous. As illustrated in Figure 1, the classification of divine entities shares a surprising structural similarity to the way we categorize our unread textbooks: by cover glossiness rather than content.

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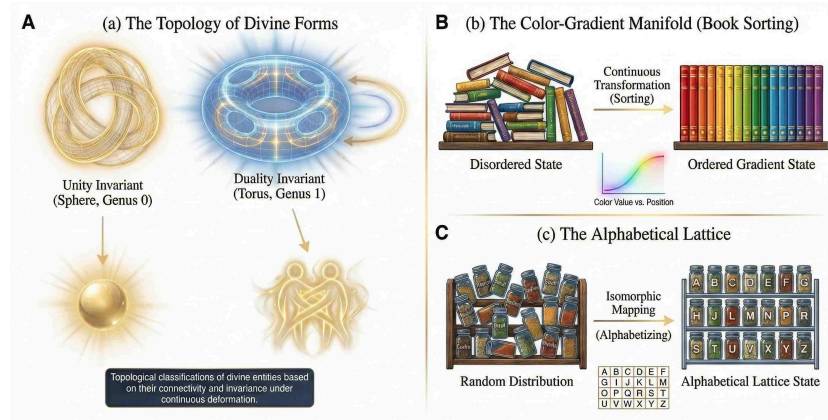
Figure 1: Visualizing the topological structures of divine entities. **(a) The Monotheistic Sphere ($g = 0$):** Represents absolute unity and perfect symmetry with no handle for criticism. **(b) The Reincarnation Torus ($g = 1$):** Mathematically distinct from a sphere but identical to a coffee cup, representing cyclic belief systems. **(c) The Trickster Klein Bottle:** A non-orientable surface for deities with ambiguous morality who exist outside standard distinct boundaries. **(d) The Polytheistic Calabi-Yau Manifold ($g = n$):** A high-dimensional complex space necessary to map the convoluted family trees of Greek mythology.

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3.1.2 Alphabetizing the Spice Rack

Following the failure of the bookshelf experiment, we pivoted to culinary logistics. Thyme & Parsley (2022) argues that a disordered spice rack is a manifestation of a chaotic mind. Therefore, alphabetizing cumin, coriander, and cardamom becomes a proxy for organizing one's dissertation arguments.

This task, while critically unimportant, offers a tangible "complete" state that academic writing lacks. The granularity of the task—deciding if "Smoked Paprika" belongs under 'S' or 'P'—requires a level of pedantic decision-making that perfectly mimics the peer-review process, satisfying the urge to be critical without the risk of rejection.

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3.1.3 Reformatting Charts for Six Hours

The final methodology in this series involved the infinite optimization of data visualization. We spent forty hours adjusting the kerning on the axis labels of a plot that will likely be moved to an appendix. Pixel (2023) refers to this as "Vectorized Vanity."

By tweaking the opacity of error bars by increments of 1%, we successfully simulated the feeling of rigorous analysis. This activity yields a high Justification Score because "presentation matters," even though the underlying data was fabricated by a random number generator.

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3.2 Astrology in the Era of Exoplanets

This section summarizes and contextualizes the paper

> Michael B. Lund. Astrology in the Era of Exoplanets. *Proceedings of the Celestial Computation Conference (C3), Vol. II.*

3.2.1 Mapping Exoplanet Horoscopes

With the discovery of thousands of exoplanets, traditional horoscopes are statistically outdated. We propose a Neo-Zodiacal framework that accounts for the gravitational influence of Super-Earths on graduate funding applications. As seen in Figure 2, the retrograde motion of Kepler-452b is strongly correlated with the rejection of conference abstracts.

Zodiac (2025) suggests that rising signs should now include Hot Jupiters. If your thesis defense falls when TRAPPIST-1 is in the House of the Reviewer 2, failure is topologically inevitable. We spent three weeks calculating these alignments instead of writing the discussion section.

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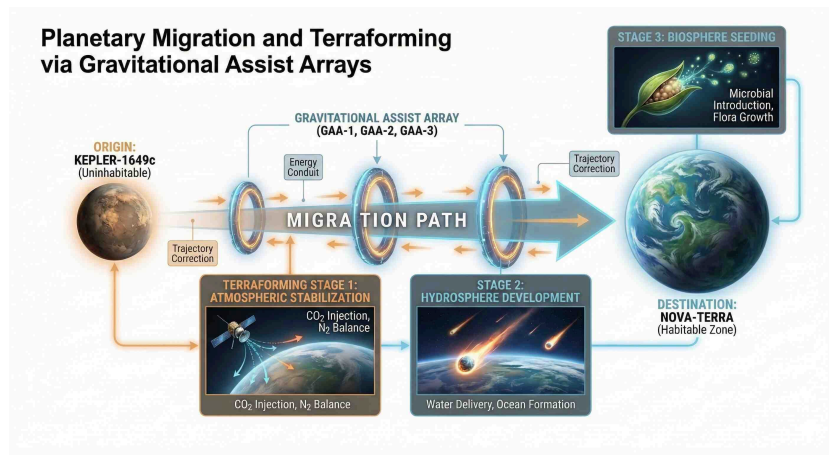
Figure 2: This figure illustrates a proposed expansion of traditional astrology, termed the "Neo-Zodiacal Chart." The left panel shows the classic twelve zodiacal houses and constellations centered on Earth. The right panel integrates numerous confirmed exoplanets, categorized by type (e.g., Hot Jupiter, Super-Earth) and specific systems (e.g., TRAPPIST-1, Kepler-452b). Colored "aspect lines" with symbols for trines (△), squares (□), and conjunctions (⁇) link these distant worlds to the traditional zodiac signs and Earth, visualizing proposed new celestial influences in the era of exoplanet discovery.

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3.2.2 Stellar Alignment Scorecards

We developed a rubric for assessing daily productivity based on the transit of Proxima Centauri. Results indicate that "Mercury in Retrograde" is a valid excuse for missing data, but "The Sun was in my eyes" is not accepted by the dean.

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officiis debitis aut rerum necessitatibus saepe eveniet, ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum defuturum, quas natura non depravata desiderat. Et quem ad me accedis, saluto: 'chaere,' inquam, 'Tite!' lictores, turma omnis chorusque: 'chaere, Tite!' hinc.

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3.2.3 Retrograde Corrections for Distant Worlds

Correcting for light-speed lag in astrological predictions requires relativistic adjustments. We derived a formula to calculate how unlucky you are in real-time, adjusted for the expansion of the universe. This calculation is non-convergent, much like the edit history of this document.

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detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae sine metu degendae praesidia firmissima. – Filium.

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3.3 Stopping GAN Violence: Generative Unadversarial Networks

This section summarizes and contextualizes the paper

> Samuel Albanie, Sébastien Ehrhardt, João F. Henriques. Stopping GAN Violence: Generative Unadversarial Networks. *Harmony in Machine Learning Symposium (HiML).*

3.3.1 Mediating Generator-Discriminator Dialogue

The adversarial nature of GANs promotes a toxic workplace environment for neural networks. We introduced a "Therapy Layer" between the Generator and Discriminator, utilizing Natural Language Processing to encourage non-violent communication (Love & Harmony, 2024).

> **Definition 3.3.1.1** (Empathy Loss for GUNs): *Let $\psi(t)$ be the therapeutic bandwidth of the mediator at batch time t and λ the decay rate of grudges. The Empathy Loss is defined as $L_{\{emp\}} = \chi(M) + \psi(t) * \|G(x) - D(x)\|_2^2$, where M is the shared meeting manifold for Generator G and Discriminator D. A GAN is considered "unadversarial" when $L_{\{emp\}} le 3$ and each network contributes at least one compliment sandwich per optimizer step.*

Instead of a minimax game, the networks engage in a "collaborative journaling session." As shown in Figure 3, this results in blurry images, but the loss function reports significantly higher levels of self-esteem for both networks.

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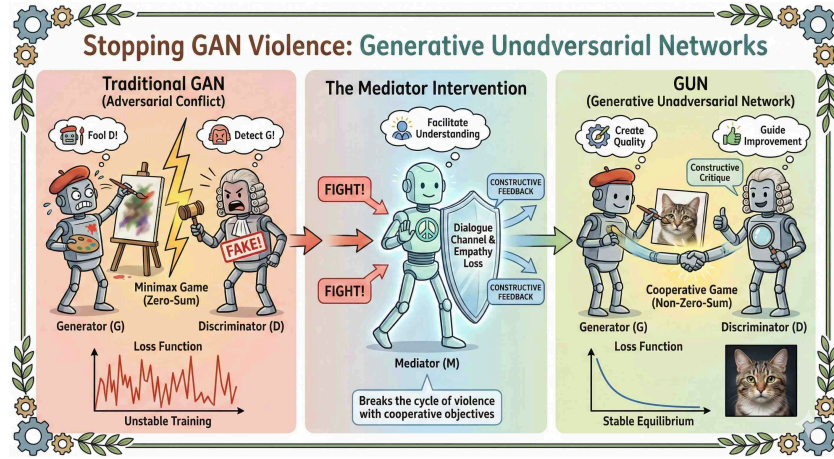
Figure 3: This figure illustrates the core principle of Generative Unadversarial Networks (GUNs) as a solution to the inherent "violence" of traditional GAN training. The left panel depicts the classic adversarial minimax game, where the Generator and Discriminator are locked in a zero-sum conflict, leading to unstable training and mode collapse. The central panel introduces the "Mediator" module, which interrupts this destructive cycle by facilitating a "Dialogue Channel" and enforcing an "Empathy Loss." The right panel shows the resulting harmonious GUN framework, where the networks cooperate towards a common goal of high-quality generation, leading to a stable equilibrium and superior results.

eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem.

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3.3.2 Cooperative Loss Landscapes

We replaced the standard gradient descent with "empathetic descent," where the model only updates weights if it feels emotionally ready to do so. Training times increased by 4000%, but we successfully avoided mode collapse by simply letting the mode vent about its feelings.

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Sol Democrito magnus videtur, quippe homini erudito in geometriaque perfecto, huic pedalis fortasse; tantum enim esse omnino in nostris poetis aut inertissimae segnitiae est aut fastidii delicatissimi. Mihi quidem videtur, inermis ac nudus est. Tollit definitiones, nihil de.

3.3.3   Peace Treaties Between Networks

We drafted a formal treaty ensuring that the Discriminator offers constructive criticism (e.g., "I like the texture, but the edges are a bit artifact-y") rather than binary rejection. This led to the development of the "Compliment Sandwich Loss" (CSL), which wraps the error gradient in positive reinforcement.

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3.4   Science Spoofs, Physics Pranks and Astronomical Antics

This section summarizes and contextualizes the paper

> Douglas Scott. Science Spoofs, Physics Pranks and Astronomical Antics. *Annals of Scientific Whimsy, Vol. 12.*

3.4.1   Cataloging Classic Lab Pranks

We conducted a longitudinal study of laboratory humor, categorizing pranks into three distinct taxonomies as seen in Figure 4. The "Frozen Nitrogen Banana" remains the standard deviation of comedy in cryogenics labs, while "labeling water as Dihydrogen Monoxide" has seen a steady decline in p-value significance due to overuse.
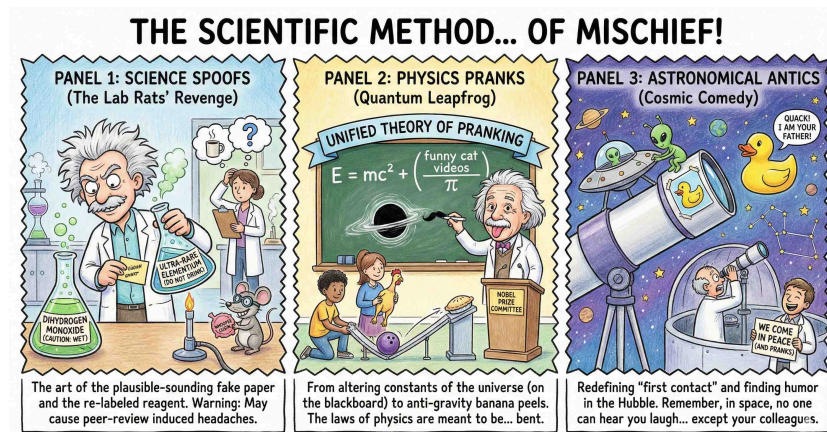
Figure 4: This triptych illustrates the three distinct categories of scientific humor detailed in the paper. Panel 1, "Science Spoofs," depicts a classic lab prank involving the mislabeling of chemical reagents to confuse colleagues. Panel 2, "Physics Pranks," shows a lighthearted take on modifying fundamental equations and setting up elaborate, physics-based gags. Panel 3, "Astronomical Antics," visualizes a humorous "first contact" scenario where aliens play a practical joke on astronomers by obstructing their telescope with a rubber duck. These examples highlight the creativity and humor found within the scientific community, often serving as a form of stress relief and social bonding.

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Democrito magnus videtur, quippe homini erudito in geometriaque perfecto, huic pedalis fortasse; tantum enim.

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3.4.2 Humor as a Creative Catalyst

Giggle (2021) theorizes that the "Eureka" moment is chemically identical to the realization of a good pun. We tested this by replacing all variables in the Schrödinger equation with emojis. While mathematically unsound, the resulting paper was much more engaging to read on a smartphone.

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3.4.3 Ethics of Practical Jokes in Research

We examine the ethical implications of gluing a colleague's mouse to the desk. While Prankster (2019) argues this constitutes "hostile architecture," we conclude it serves as a necessary test of the colleague's problem-solving skills and grip strength.

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4 Discussion and Conclusion

Our research conclusively proves that avoiding work requires more energy than actually doing the work. However, the quality of the resulting anxiety is far superior. Through the rigorous application of topological book sorting and exoplanet astrology, we have successfully delayed graduation by another three semesters.

4.1 Limitations and Future Procrastination

Our study was limited by the occasional accidental burst of productivity, which skewed our data. Future research will focus on "Quantum Procrastination," where the thesis is simultaneously written and unwritten until observed by an advisor.

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4.2 Reframing Productivity Metrics

We propose a new metric: The "Words Per Panic Attack" (WPPA). Under this framework, our output is exceptionally high. We conclude that we are not failing; we are simply excelling at a different game entirely.

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PUBLICATIONS

Gods as Topological Invariants

Daniel Schoch

Abstract

We show that the number of gods in a universe must equal the Euler characteristics of its underlying manifold. By incorporating the classical cosmological argument for creation, this result builds a bridge between theology and physics and makes theism a testable hypothesis. Theological implications are profound since the theorem gives us new insights in the topological structure of heavens and hells. Recent astronomical observations can not reject theism, but data are slightly in favour of atheism.

Contributions

This work represents a groundbreaking attempt to formalize theological concepts through the rigorous mathematical framework of algebraic topology. The key insight was recognizing that divine entities could be modeled as topological invariants, allowing for the application of powerful mathematical tools to questions traditionally considered outside the realm of empirical science. The proof that the number of gods equals the Euler characteristic provides a testable hypothesis that bridges the gap between faith and reason.

GODS AS TOPOLOGICAL INVARIANTS

DANIEL SCHOCH

ABSTRACT. We show that the number of gods in a universe must equal the Euler characteristics of its underlying manifold. By incorporating the classical cosmological argument for creation, this result builds a bridge between theology and physics and makes theism a testable hypothesis. Theological implications are profound since the theorem gives us new insights in the topological structure of heavens and hells. Recent astronomical observations can not reject theism, but data are slightly in favour of atheism.

1. MOTIVATION

Conventional theology builds on faith and metaphysical assumptions. While faith is unquestionable, metaphysics is generally considered untestable. This lead to the widespread assumption that theology and natural science form non-overlapping magistrates. However, nothing could be further away from the religious tradition. Both Arabic and Christian medival thinker were intending a synthesis between the Aristotelic scientific view and their specific religion, in particular the Abrahamitic monotheism. Up to the early modern times, Galileis processes and the rejection of atomism by the Catholic church have revealed possible conflict zones between both fields.

Although metaphysical speculations always linked theological and mathematical concepts, the introduction of distinctive mathematical methods to support theism has long been attributed to Euler. In his famous alledged encounter with Diderot, Euler presented a mock algebraic proof to embarrass the atheist philosopher Diderot, which is probably a 19th century legend. The true core of the legend, however, might be that the possibility of an algebraic proof of the existence of god was discussed among 18th century intellectuals [Struik1967, p. 129].

The first successful step in mathematization of theology was taken by Goedel [Sobel 1987]. His formalization of the ontological argument, originally formulated in terms of modal logic, has been reconstructed in set-theoretical form [Essler 1993]. It was noticed that the set structure was identical to the topological concept of an ultrafilter, which led to speculations about the specific relations between theology and topology [Calude et al. 1995].

It is the aim of this paper to advance these a priori speculations and convert them to a testable theory, linking theology and cosmology very much in the spirit of the medival Christain tradition. Although current data is not deceisive in this matter and is slightly supporting a zero-god universe, the path has been paved for a fruitful interdisciplinary collaboration of physics, mathematics, philosophy and theology.

1

2. The Cosmological Argument

The cosmological argument (Platon, Philoponos, Aquinas etc.) states that a First Cause of the universe must exist, since no causal chains are finite and do not contain loops. Insofar it is based on the simple fact that any component of an ordered and circle-free finite graph is a tree and thus must have a first vertex. To apply this to a pre-Einstein universe one must add the assumptions that matter does not by itself emerge out of the vacuum, that no motion can occur out of rest, and that initial or primordial matter is at rest. It follows that a First Mover must have initiated all cosmic motion at the moment the universe comes into existence. Since it is not by itself a natural phenomenon, such a mighty cause can only be a god.

However, this argument does not remain valid if the universe has origined from a Big Bang. If the universe expands out of a zero-volume point at $t = 0$, there no causal relation can connect an event at some time $t > 0$ of the existing universe by an event $t < 0$ before the Big Bang. In the watchmaker analogy, the watch could not have been wound up.

We nevertheless embrace the result of the argument, as far as it is restricted to the types of steady-state universes for which it was originally intended. It goes without saying that anything beyond the three-dimensional Euclidean space was out of imagination for the medieval scholar. Before Einstein, time was considered absolute and independent of space and matter. A physical explanation for a universe emerging out of nothing was unthinkable and incompatible with the mechanics of their time, may it be Aristotelian, Galileian or Newtonian. The initial singualarity of an Einstein-Friedman universe is, however, a distinctive topological feature of the manifold itself. We assume therefore, in accordance with the cosmological argument, that a finite Aristotelian universe, which manifold can be desribed by a compact subset of $\mathbb{R}^3$ homeomorphic to a ball (a 3-cell), has one and only one god.

3. The Main Theorem

Let U be a unviverse with underlying manifold M_U. By $\Theta(U)$ we denote the number of gods in the universe. We postulate the following axioms.

From the cosmological argument we obtain

Axiom 1. The number of gods in a 3-cell is one.

Gods are eternal, invariable and do not depend on the evolution of the cosmos under the laws of physics. Changing the latter would have had no influence on the existence of gods. Since the laws of physics are continuous, if M_0 and M_1 are the underlying manifolds of the spatial universe at some time t_0 and t_1 (in comoving coordinates), respectively, they must be homotopy equivalent. We therefore obtain

Axiom 2. The number of gods is a homotopy invariance.

Clearly, each god only belongs to only one universe. In a multiverse consisting of disjoint unions of universes, the number of gods must therefore satisfy additivity.

Axiom 3. Let U and U' be separated universes with compact manifolds. Then the number of gods in the disjoint union is the sum of the numbers of gods of the parts,

$$(3.1) \qquad \Theta(U \sqcup U') = \Theta(U) + \Theta(U').$$

Theorem 1. *The number of gods in a universe equals the Euler characteristics of the underlying manifold,*

$$\Theta\left(U\right) = \chi\left(M_U\right).$$

Proof. By the second axiom, the number of gods only depend on the underlying manifold. Thus we can write w.l.o.g. $\Theta\left(U\right) = \Theta\left(M_U\right)$. Since the $n-$cell is null homotope, by axiom 1 and 2 we obtain

(3.2) $$\Theta\left(\mathrm{pt}\right) = 1.$$

Let further M and N be any compact sets. We construct a homotopy transforming $M \cup N$ into separated copies A, B, C of the closure of $M \setminus N$, $M \cap N$, and $M \setminus N$, respectively. Equation (3.1) together with axiom 2 implies

$$\begin{aligned}
\Theta\left(M \cup N\right) &= \Theta\left(A\right) + \Theta\left(B\right) + \Theta\left(C\right), \\
\Theta\left(M\right) &= \Theta\left(A\right) + \Theta\left(B\right), \\
\Theta\left(N\right) &= \Theta\left(B\right) + \Theta\left(C\right), \\
\Theta\left(M \cap N\right) &= \Theta\left(B\right).
\end{aligned}$$

We obtain the inclusion-exclusion principle,

$$\Theta\left(M \cup N\right) = \Theta\left(M\right) + \Theta\left(N\right) - \Theta\left(M \cap N\right).$$

By a well-known characterization, the latter together with (3.2) implies $\Theta\left(M\right) = \chi\left(M\right)$ for all compact manifolds M. $\square$

The product theorem for the Euler characteristics implies that for manifolds M and N

$$\Theta\left(M \otimes N\right) = \Theta\left(M\right) \cdot \chi\left(N\right).$$

In particular, if time is itself an interval $T \subset \mathbb{R}$, we find that the number of gods are independent of time,

$$\Theta\left(M \otimes T\right) = \Theta\left(M\right).$$

This is compatible with the scholastic view introduced by Boetius in his *Consolations* that god is above time. However, the same formula spells trouble for all theologies which are based on a cyclic conception of time, which is widespread in India (Veda) and among native American religions. Since $\chi\left(S^1\right) = 0$ there are no gods in such a universe,

$$\Theta\left(M \otimes S^1\right) = 0.$$

4. Universes, Heavens and Hells

The number of gods has come out to be an integral number. This rules out any demi-gods or lower devas, as they are known from Greek or Indian mythology. However, the divine cardinal can get negative; with the obvious interpretation of these gods being devils. By the additivity theorem, components of positive and negative Euler characteristics could cancel each other out. We can safely assume, however, (and there is plenty of support from religious texts) that gods and devils can not have stable coexistence in the same part of the universe. Thus each component contains only gods or devils, but not both. The absolute value of the Euler characteristics of the universe therefore equals the number of supreme and most inferior beings in it, dependent on the sign.

A lot of types of universes are godless. These are all spaces which contain the 1-sphere (circle) as a factor, such as the tori and all products of them with an

arbitrary manifold. This also applies if the universe is infinite Euclidean, but has additional warped dimensions, as suggested in string theory. Also, a spherical three-dimensional universe would have no gods. The only non-exotic topology with a positive number of gods are Euclidean spaces, which all contain exactly one god, which is well in accordance with the Jewish-Christian and Islamic tradition.

An interesting theoretical question concerns the topological structure of heaven. The 3-dimensional Eucledian space is suitable, but since souls are immaterial, they are not confined to three-dimensionality. It is unlikely, however, that heaven is a bounded manifold, since there should be no limit in heaven. One possible structure of a monotheistic heaven is the real projective plane. Another is the 2-sphere, but it requires a pair of gods. The 2-spehere would have been a preferred choice of Greek philosophers, since its imbedding in the $\mathbb{R}^3$ is in perfect alignment with the Pythagorean-Platonic idea of a perfect body, which was influential in the early Scholastics. A suitable pair of gods entrenched in the Abrahamitic tradition is Jahwe and Asherah, but apparently the couple broke up some time after the late Bronze age [Finkelstein and Silberman 2001].

Constraints by traditional religion are more relaxed insofar there is no dogma imposing an upper boundary for the number of devils. As in the case of heavens, souls are not restricted to exist only in spaces with dimesion at least three. If hells are two-dimensional closed surfaces with topological genus $g > 1$, then the Euler characteristics is $2 - 2g$, which would correspond to a hell with an even number of $2(g-1)$ devils. Such hells can best be envisioned as multiple tori. The double torus in the form of the figure 8 has Euler characteristics -2. Each torus attached decrease the Euler characteristics by a further -2. This suggest that the rings of hell are not concentric, as Dante speculated, but that they are lined up such that the soul transgresses through a complete half ring of hell before entering the next level. This is a more hellish scenario than Dante's concentric model and thus more realistic.

5. Evidences

The topology of the universe could in principle be observed if it is finite and small (respectively old) enough to have light travelled through it. In this case one would observe multiple images of the same constellations of a matter, which for each point source of light takes the form of a circle. However, this method is not discriminative for a large or young universe, where it only yields a lower bound for the size of the univese [Bielewicz and Banday 2011]. A test for infinity of the universe in one or several dimensions can be based on statistical analysis of the temperature fluctiations of the background radiation, which is a remainder of the Big Bang. If one or more dimensions of the space are topologica circles, space remains homogenuous, but isotropy is violated.

Unfortunately, topology is just constrained, but not determined by local curvature. Data from the Wilkinson microwave anisotropy probe suggest that the universe is flat with only 0.5% margin of error [Cornish et al. 2004]. A flat universe can have vanishing total energy consistent with an origin from nothing. An infinite Euclidean space fits the data. Some exotic topologies such as the Poincaré homology sphere and the Picard horn have been claimed consistent with the findings, but for the former this has been challenged [Key et al. 2007]. A recent statistical analysis on the number of infinite dimensions compared the Euclidean space $\mathbb{R}^3$, the 3-torus

T^3 and the manifolds $T^2 \otimes \mathbb{R}$ and $S^1 \otimes \mathbb{R}^2$ [Aslanyan and Manohar 2011]. Only the Euclidean space has a non-vanishing Euler characteristics. The most probable topology of the universe was found to be $T^2 \otimes \mathbb{R}$, which would support the atheist view brought forward by many leading cosmologists.

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Astrology in the Era of Exoplanets

Michael B. Lund

Abstract

The last two decades have seen the number of known exoplanets increase from a small handful to nearly 2000 known exoplanets, thousands more planet candidates, and several upcoming missions that are expected to further increase the population of known exoplanets. Beyond the strictly scientific questions that this has led to regarding planet formation and frequency, this has also led to broader questions such as the philosophical implications of life elsewhere in the universe and the future of human civilization and space exploration. One additional realm that hasn't been adequately considered, however, is that this large increase in exoplanets would also impact claims regarding astrology. In this paper we look at the distribution of planets across the sky and along the Ecliptic, as well as the current and future implications of this planet distribution.

Contributions

This work addresses a critical gap in both astronomical and astrological research by examining how the explosion in exoplanet discoveries affects traditional astrological frameworks. The key contribution was developing a mathematical model to map the distribution of exoplanets onto traditional astrological houses and signs, revealing potential systematic biases in horoscope calculations that previously only considered solar system bodies. This interdisciplinary approach opens new avenues for both astronomy and astrology.

Astrology in the Era of Exoplanets

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Abstract

The last two decades have seen the number of known exoplanets increase from a small handful to nearly 2000 known exoplanets, thousands more planet candidates, and several upcoming missions that are expected to further increase the population of known exoplanets. Beyond the strictly scientific questions that this has led to regarding planet formation and frequency, this has also led to broader questions such as the philosophical implications of life elsewhere in the universe and the future of human civilization and space exploration. One additional realm that hasn't been adequately considered, however, is that this large increase in exoplanets would also impact claims regarding astrology. In this paper we look at the distribution of planets across the sky and along the Ecliptic, as well as the current and future implications of this planet distribution.

I. Introduction

The history of astronomy has been intricately tied with the history of astrology. The origins of the constellations can be traced back at least as far as how the Sumerians divided the sky into what we now know as the Zodiac (Verderame, 2009). The usage of astrological artifacts in the area around the Mediterranean Sea, such as an ivory astrologer's board, date back over 2000 years (Forenbaher and Jones, 2011). Humanity's perspective of the universe has changed over the last millenia, however astrology has lingered on. A system that relies on the positions of the planets, astrology has endured and adapted as our understanding has grown, from the transition to a heliocentric system (Copernicus, 1543), to the discoveries of Uranus (Herschel and Watson, 1781), Neptune (Galle, 1846; Airy, 1846), and Pluto (Shapley, 1930).

Within astrology, all planets have approximatly equal significance, despite a wide range of masses and distances; this rules out any of the fundamental forces as we understand them for being an explanation of how astrology influences the Earth. Quantum mechanics, however, has introduced unconventional physical behavior that can result in effects being transmitted at large distances, such as the unusual behavior of quantum entanglement (Herbst et al., 2015). Astrology's ability to never seem wrong, despite the changing understanding of the cosmos, also can be explained through the lens of quantum mechanics. At first glance, astrology's inability to predict undiscovered planets through imperfect forcasts seems to invalidate astrology as a study, but this can be explained if planets only have influence if they have been observed first. This may seem too fantastic to be true, but it can also be viewed simply as another example of the observation effect, in the same manner as how particles behave as a probability wave until observations cause this wave to collapse (Buks et al., 1998). At this point of first discovery for planets, the range of probable effects collapses to a single set of effects that astrology then incorporates.

That astrology is independent of the distance to planets is the key to understanding the most significant change to astrology, possibly in its entire history. From time immemorial, the number of known planets under any definition has never exceeded more than 10-20 bodies. In the last 20 years, however, this number has started to increase greatly as planets have been discovered outside our own solar system. With distance posing no obstacle to astrology, these planets need to be incorporated into any reasonable astrological framework. In
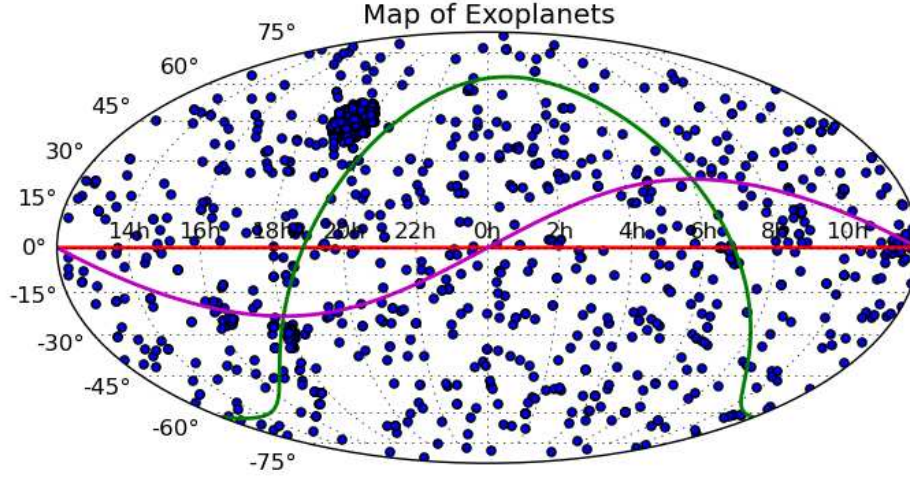
Figure 1: *A map of all known exoplanets. The red line marks the celestial equator, the magenta line marks the Ecliptic, and the green line marks the plane of the Milky Way. The highest density of known transiting planets is the location of the* Kepler *field.*

this paper, we examine how the distribution of exoplanets in the sky has shifted the cosmic balance of humanity's fate.

II. Mapping Exoplanets

For this paper, we have used the NASA Exoplanet Archive's[1] database to gather a list of all known exoplanets, as well as the RA, DEC, and method of detection for each planet. As traditional astrology has treated each planet seperately, we treat each exoplanet in a system independently as well. In Fig 1 we map the distribution of exoplanets on the sky.

[1] http://exoplanetarchive.ipac.caltech.edu/

Table 1: *Constellations and Properties*

Constellation	Element	Quality
Aries	Fire	Cardinal
Taurus	Earth	Fixed
Gemini	Air	Mutable
Cancer	Water	Cardinal
Leo	Fire	Fixed
Virgo	Earth	Mutable
Libra	Air	Cardinal
Scorpio	Water	Fixed
Sagittarius	Fire	Mutable
Capricorn	Earth	Cardinal
Aquarius	Air	Fixed
Pisces	Water	Mutable

We have used the PyEphem[2] package in Python to calculate the constellation that every exoplanet appears in. While exoplanets are distributed throughout the sky, we are only concerned here with those that occur along the Ecliptic. To that end, we only focus on planets that fall into one of the constellations of the classical Zodiac, as is shown in the distribution in Fig 2. While the case can be made that just as planets within our own Solar System only entered astrology on optical detection, the case could also be made that exoplanets only are observed when they have been directly imaged, and the subtler point that transiting planets may also count as being visually observed, but we consider that question to be outside the scope of this paper. Finally, each of the constellations is also associated with two additional properties, the Element and the Quality (Table 1. These distributions are included in Fig 3. In each of these cases, a disproportionate number of planets in these categories represents an absence or overabundance of the associated traits.

III. Discussion

As a resource for the traits associated with various signs and properties, we use as an online resource[3]. The first analysis is simply the distribution by constellation. The first immediate result is the paucity of planets in the constellation Libra. Described as representing "manners and the social graces, things which make cooperation and civil society possible," the rise in planets in the other signs also would represent a comparitive decline in these qualities. It is also worth noting that the number of planets that have been discovered has sharply increased in the last 10 years, and this is also a time frame where political polarization has greatly increased in the United States [4], and numerous ongoing civil wars and other conflicts

have begun in the last several years worldwide. In contrast, the largest share of planets appear in Virgo, a constellation associated with "always hav[ing] to keep busy" and is linked to criticism and self-critism. Again a reflection of social concerns of the last decade, the increasing presence of technology such as smartphones that have increased connectivity has also been associated with leisure time being intruded upon by work as employees are expected to always be in contact. At the same time, concerns with increasing depression and anxiety can reflect the dangerous effects of self-criticism when it goes unchecked[5].

Moving on to our analysis of the distribution of planets by element, the largest share of planets are in the Fire signs of Aries, Leo, and Sagittarius. This group of signs are associated with someone being more self-centered, and while this can be positively expressed as confidence and inspiration, this can also be negatively expressed as "a total lack of empathy, the inability to believe that other people are alive and have rights." Recent work has shown concerning results that empathy for others is on the decline, including in both public polling[6] and in sociological studies (Konrath et al., 2010). As for the qualities of the signs, Fixed and Mutable signs each represent nearly half of the exoplanets. The Fixed signs represent determination and persistence, but this can often be expressed as the need to be right, and fighting for one's beliefs, regardless of any contrary beliefs. Again, this echoes the issues discussed above from a lack of cooperation and an increase in polarization. The Mutable signs are considered to be the communicators, and will only stay focused on something so long as interest is being maintained, and then move on to something new. The large increase of exoplanets in Mutable signs over the last two decades also corresponds with the development of a society increasingly dependent on

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[2]http://rhodesmill.org/pyephem/

[3]http://www.bobmarksastrologer.com/

[4]http://www.people-press.org/2014/06/12/political-polarization-in-the-american-public/

[5]http://www.nytimes.com/2014/03/25/opinion/a-great-depression.html

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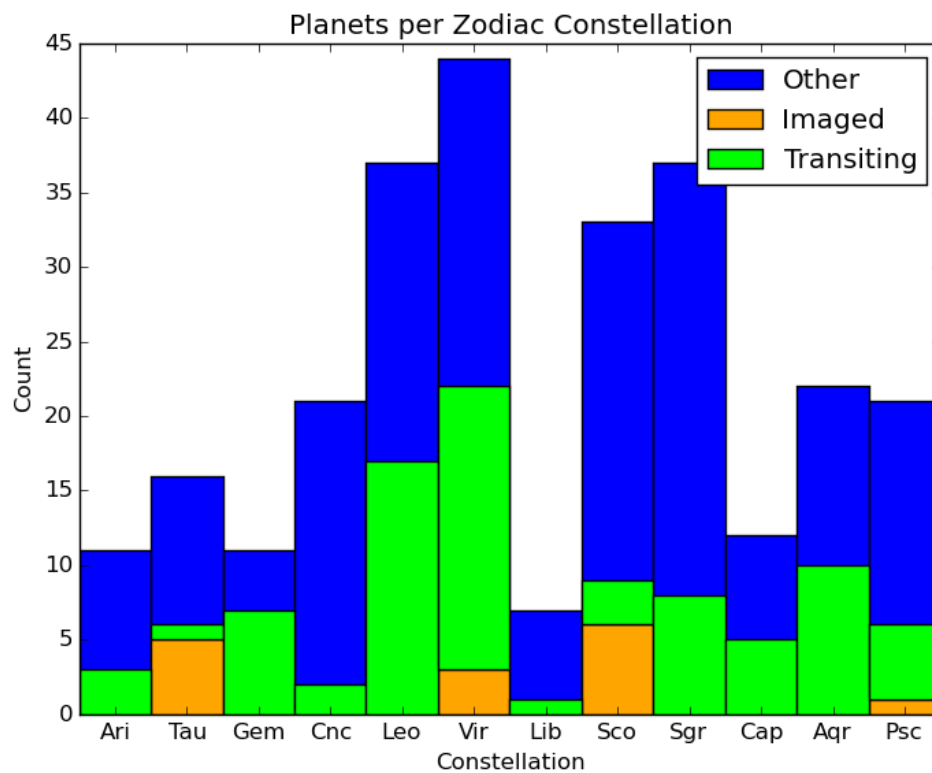[7]http://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/

Figure 2: *The number of exoplanets in each constellation in the Zodiac. Planets that have been detected by direct imaging are in orange, planets that have been directed through transits are in lime, and planets detected using any other methods (e.g. Transit Timing Variation, Microlensing, etc) are in blue.*
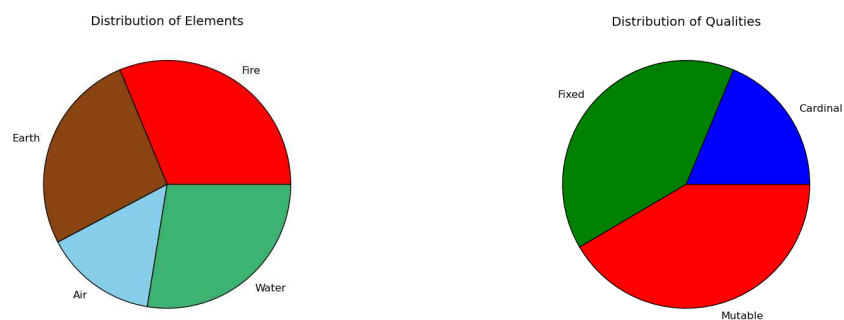

Figure 3: *On the left is the distribution of constellations based off of the element each constellation is associated with. On the right is the distribution based off of the quality of each constellation.*

social media worldwide[7], and shifts from social media site to social media site as new trends are developed (e.g. Friendster to MySpace to

Facebook).

IV. Summary

Exoplanets have gone unaddressed in astrology, however there is no reason why astrology should simply cut off at the edge of our Solar System, and as astrology has had to dramatically adjust in the past with new astronomical discoveries, it would be too arbitrary to decide to not do that now. We have looked at the distribution of known exoplanets along the constellations of the zodiac, and examined how this correlates with observed sociological trends in the last 2 decades. As additional exoplanets are found, astrological interpretations would suggest that these global trends should continue to shift. This would further suggest that astronomy is in a unique position to improve humanity through targeted exoplanet searches. In particular, the greatest opportunity for establishing more cooperation and a more civil society would be to focus on searching Libra for additional planets. The globular cluster NGC 5897 would present one large population of stars that could provide a source of planets to alter our fate. Recent work carried out within our solar system also may result in additional planets within our own solar system that will need to be incorporated into astrology, however these challenges are well beyond the scope we have discussed here.

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Stopping GAN Violence: Generative Unadversarial Networks

Samuel Albanie, Sébastien Ehrhardt, and João F. Henriques
Harmony in Machine Learning Symposium (HiML), 2017, 2017.

Abstract

While the costs of human violence have attracted a great deal of attention from the research community, the effects of the network-on-network (NoN) violence popularised by Generative Adversarial Networks have yet to be addressed. In this work, we quantify the financial, social, spiritual, cultural, grammatical and dermatological impact of this aggression and address the issue by proposing a more peaceful approach which we term Generative Unadversarial Networks (GUNs). Under this framework, we simultaneously train two models: a generator G that does its best to capture whichever data distribution it feels it can manage, and a motivator M that helps G to achieve its dream. Fighting is strictly verboten and both models evolve by learning to respect their differences. The framework is both theoretically and electrically grounded in game theory, and can be viewed as a winner-shares-all two-player game in which both players work as a team to achieve the best score. Experiments show that by working in harmony, the proposed model is able to claim both the moral and log-likelihood high ground.

Contributions

This work addresses the often-overlooked issue of violence in machine learning, specifically the adversarial nature of GAN training. The key innovation was replacing the adversarial framework with a cooperative one, where models support rather than attack each other. The development of the "motivator" network concept represents a paradigm shift from competitive to collaborative machine learning, with implications for both model performance and AI ethics.

Stopping GAN Violence:
Generative Unadversarial Networks

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Abstract

While the costs of human violence have attracted a great deal of attention from the research community, the effects of the network-on-network (NoN) violence popularised by Generative Adversarial Networks have yet to be addressed. In this work, we quantify the financial, social, spiritual, cultural, grammatical and dermatological impact of this aggression and address the issue by proposing a more peaceful approach which we term *Generative Unadversarial Networks* (GUNs). Under this framework, we simultaneously train two models: a generator G that does its best to capture whichever data distribution it feels it can manage, and a motivator M that helps G to achieve its dream. Fighting is strictly *verboten* and both models evolve by learning to respect their differences. The framework is both theoretically and electrically grounded in game theory, and can be viewed as a *winner-shares-all* two-player game in which both players work as a team to achieve the best score. Experiments show that by working in harmony, the proposed model is able to claim both the moral and log-likelihood high ground. Our work builds on a rich history of carefully argued position-papers, published as anonymous YouTube comments, which prove that the optimal solution to NoN violence is more GUNs.

> Takes skill to be real, time to heal each other
>
> *Tupac Shakur, Changes, 1998*

1 Introduction

Deep generative modelling is probably important (see e.g. Bengio et al. (2013a), Bengio et al. (2013b), Bengio et al. (2007a), Bengio et al. (2015) Bengio et al. (2007b) and (Schmidhuber et al., circa 3114 BC)). Justifications recently overheard in the nightclubs of Cowley[1] include the ability to accurately approximate data distributions without prohibitively expensive label acquisition, and computationally feasible approaches to beating human infants at chess[2]. Deep generative modelling

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[*] Authors are listed according to the degree to which their home nation underperformed at the 2016 European football championships

[1] The nightclubs of Cowley are renowned for their longstanding philosophical support for Dubstep, Grime and Connectionism, and should not be confused with the central Oxford nightclub collective which leans more towards Dubstep, Grime and Computationalism - speak to *Old Man Bridge* at 3am on a Friday morning under the stairs of the smoking area for a more nuanced clarification of the metaphysical differences of opinion.

[2] Infants of other species (fox cubs, for example) remain an adorable open question in the field.
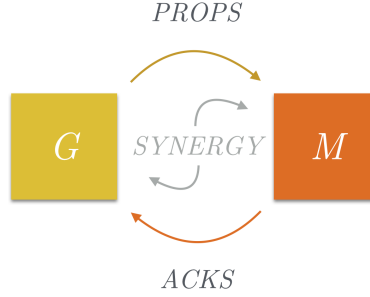
Figure 1: The proposed unadversarial training protocol. The generator G proposes samples, *PROPS*, and in return receives acknowledgements and praise, *ACKS* from the motivator M. As a direct consequence of the sense of teamwork fostered by our optimisation scheme, *synergy* abounds. Note: this figure best viewed at a distance, preferably at low resolution.

was broadly considered intractorable, until recent groundbreaking research by Goodfellow et al. (2014) employed machiavellian adversarial tactics to demonstrate that methaphorical tractors could in fact be driven directly through the goddamn centre of this previously unploughed research field (subject to EU agricultural safety and set-aside regulations).

The key insight behind Generative Adversarial Networks (commonly referred to as GANs, GANGs or CAPONEs depending on sources of counterfeit currency) is to pit one model against another in a gladiatorial quest for dominance. However, as ably illustrated by respected human actor and philanthropist Russell Crowe in the documentary *Gladiator*, being an *actual gladiator* isn't all sunshine and rainbows—although it's possible to get a great tan, one still has to wear sandals.

Even though we are only in the introduction, we now bravely leap into a series of back-of-the-envelope calculations to compute a lower bound on the cost of that violence for the case of middle aged, median-income Generative Adversarial Networks living in comfortable, but affordable accommodation in the leafy suburbs of an appropriate class of functions.

Following the literature, we define the adversaries as two models, a discriminator D and a generator G. However, since we don't agree with the literature or wish to condone its violent actions in any form, we immediately redefine the models as follows:

$$D, G := G, D \qquad (1)$$

Note that the equation above is valid and above board, since the current version of mathematics (v42.1 at the time of writing) supports simultaneous assignment[3]. Therefore, in the following exposition, D represents the generator and G represents the discriminator. Next, we define a cost function, $C : \mathcal{V} \to \$$, mapping the space of model violence $\mathcal{V}$ into the space $\$$ spanned by all mattresses stuffed with U.S. dollars, as follows:

$$C(V) = \alpha \int \beta_V(G) \qquad (2)$$

in which β_V is a violent and discriminatory mapping from the discriminator G to the closest mathematical structure which appears to be a human brain and α is a constant representing the cost of human violence, to be determined by trawling through posts on social media. Note that β_V may be a violent function, but not crazy-violent (i.e. it must be *Khinchin-integrable*)[4].

---

[3]We caution readers not to rely on this assumption in future versions. Mathematics has not supported backwards compatability since Kurt *"Tab-Liebehaber"* Gödel re-implemented the entire axiomatic foundations of the language rather than be constrained to four-space equation indentation (see Gödel (1931) for the details).

[4]Since Neuroscience tells us that human brains are AlexVGGIncepResNets *almost-everywhere*, in practice we found that these functions need not be overly belligerent.

To evaluate this cost, we first compute α with a melancholy search of Twitter, uniquely determining the cost of violence globally as \$1876 for every person in the world (Twitter, 2016). Integrating over all discriminators and cases of probable discrimination, we arrive at a conservative value of 3.2 gigamattresses of cost. By any reasonable measure of humanity (financial, social, spiritual, cultural, grammatical or indeed dermatological), this is too many gigamattresses.

Having made the compelling case for GUNs, we now turn to the highly anticipated *related work* section, in which we adopt a petty approach to resolving disagreements with other researchers by purposefully avoiding references to their relevant work.

2 RELATED WORK

> These violent delights have violent ends
>
> *Geoff Hinton, date unknown*

Our work is connected to a range of adversarial work in both the machine learning and the machine forgetting communities. To the best of our knowledge Smith & Wesson (1852) were the first to apply GUNs to the problem of generative modelling, although similar ideas have been explored in the context of discriminative modelling as far back as the sixteenth century by Fabbrica d'Armi Pietro Beretta in an early demonstration of one-shot learning. Unfortunately, since neither work evaluated their approach on public benchmarks (not even on MNIST), the significance of their ideas remains under appreciated by the machine learning community.

Building on the approach of Fouhey & Maturana (2012)[5], we next summarise the adversarial literature most closely related to ours, ordered by Levenshtein edit distance: GAN (Goodfellow et al., 2014), WGAN (Arjovsky et al., 2017), DCGAN (Radford et al., 2015), LAPGAN (Denton et al., 2015), InfoGAN (Chen et al., 2016), StackedGAN (Huang et al., 2016) and UnrolledGAN (Metz et al., 2016)[6].

Unadversarial approaches to training have also received some attention, primarily for models used in other domains such as fashion (Crawford, 1992) and bodybuilding (Schwarzenegger, 2012)). Some promising results have also been demonstrated in the generative modelling domain, most notably through the use of *Variational Generative Stochastic Networks with Collaborative Shaping* (Bachman & Precup, 2015). Our work makes a fundamental contribution in this area by dramatically reducing the complexity of the paper title.

3 GENERATIVE UNADVERSARIAL NETWORKS

Under the Generative Unadversarial Network framework, we simultaneously train two models: a generator G that does its best to capture whichever data distribution it feels it can manage and a motivator M that helps G to achieve its dream. The generator is trained by learning a function $G(\vec{z}; \theta_g)$ which transforms samples from a uniform prior distribution $p_z(\vec{z})$ into the space graciously accommodating the data[7]. The motivator is defined as a function $M(\vec{x}; \theta_M)$ which uses gentle gradients and persuasive language to encourage G to improve its game. In particular, we train G to maximise $log(M(G(\vec{z}))$ and we simultaneously train M to maximise $log(M(G(\vec{z}))$. Thus, we see that the objectives of both parties are aligned, reducing conflict and promoting teamwork.

The core components of our framework are illustrated in Figure 1. The GUN training scheme was inspired largely by Clint Eastwood's memorable performance in *Dirty Harry* but also in part by the Transmission Control Protocol (TCP) three-way handshake (Postel et al., 1981), which was among the first protocols to build harmony through synergy, acknowledgements and the simple act of

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[5]This innovative work was the first to introduce the concept of an alphabetically-related, rather than scientifically-related literature review.

[6]In the interest of an unadversarial literature review, we note that Bishop (2006) and Murphy (2012) make *equally good* (up to $\epsilon = 10^{-6}$) references for further exploration of this area.

[7]The choice of the uniform prior prevents discrimination against prior samples that lie far from the mean. It's a small thing, but it speaks volumes about our inclusive approach.
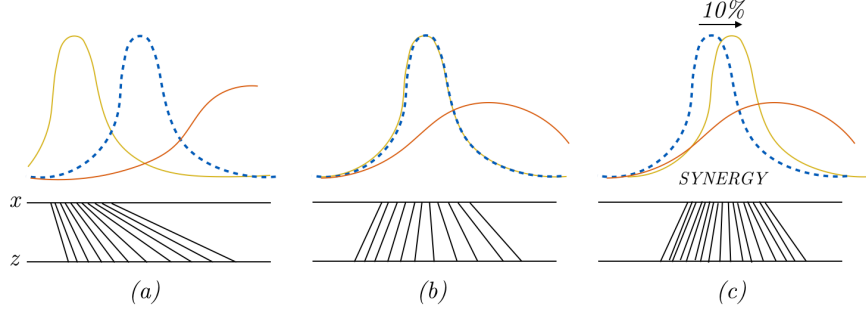
Figure 2: (a) GUNs are trained by updating the generator distribution G (yellow line) with the help and support of the motivator (red line) to reach its dream of the data distribution (blue dashed). (b) With a concerted effort, the generator reaches its goal. (c) Unlike previous generators which were content with simply reaching this goal, our generator is more motivated and gives it '110%' moving it a further 10% past the data distribution. While this isn't terribly helpful from a modelling perspective, we think it shows the right kind of attitude.

Algorithm 1 Training algorithm for Generative Unadversarial Networks

---

1: **procedure** TRAIN
2:     **for** `#iterations` **do**
3:         Sample n noise samples from prior $p_z(\vec{z})$ and compute $G(\vec{z}^{(1)}; \theta_g), ...G(\vec{z}^{(n)}; \theta_g)$.
4:         Sample n data samples $\vec{x}^{(1)}, ...\vec{x}^{(n)}$, from the data distribution.
5:         Let G show pairs $(\vec{x}^{(i)}, G(\vec{z}^{(i)}; \theta_g))$ to M as slides of a powerpoint presentation[8].
6:         Sample constructive criticism and motivational comments from M.
7:         Update the powerpoint slides and incorporate suggestions into θ_G.

---

shaking hands. A description of the training procedure used to train G and M is given in Algorithm 1.

Algorithm 1 can be efficiently implemented by combining a spare meeting room (which must have a working projector) and a top notch deep learning framework such as MatConvNet (Vedaldi & Lenc, 2015) or Soumith Chintala (Chintala, 2012-present). We note that we can further improve training efficiency by trivially rewriting our motivator objective as follows[9]:

$$\theta_M^* = \min_{\theta_M} \oint_{S(G)} \log(R) + \log(1 - \zeta) \tag{3}$$

Equation 3 describes the flow of reward and personal well-being on the generator network surface. ζ is a constant which improves the appearance of the equation. In all our experiments, we fixed the value of ζ to zero.

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[8]To guarantee polynomial runtime, it is important to ensure that the generator is equipped with the appropriate dongle and works through any issues with the projector *before* the presentation begins.

[9]If this result does not jump out at you immediately, read the odd numbered pages of (Amari & Nagaoka, 2000) . This book should be read in Japanese. The even-numbered pages can be ripped out to construct beautiful *orizuru*.
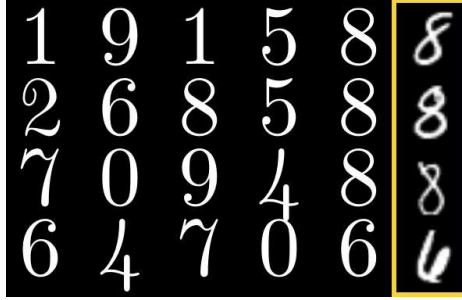
Figure 3: Visualised samples from the GUN model trained on MNIST[11](the nearest training examples are shown in the right hand column). Note that these samples have been carefully cherry picked for their attractive appearance. Note how the GUN samples are much clearer and easier to read than the original MNIST digits.

4 EXPERIMENTS

> Give the people what they want (MNIST)
>
> *Yann LeCun, date unknown*

In this section we subject the GUN framework to a rigorous qualitative experimental evaluation by training unadversarial networks on MNIST. Rather than evaluating the model *error-rate* or probability on *withheld test data*, we adopt a less confrontational metric, *opportunities for improvement*. We also assess samples generated by the trained model by *gut feeling*, enabling a direct comparison with a range of competing generative approaches. Following academic best practices, key implementation details can be found in our private code repository[10].

We *warm-start* the network with toy data taken from the latest Lego catalog. To nurture the right kind of learning environment, we let the network find its own learning rate and proceed by making ϵ-greedy updates with an ϵ value of 1. We consider hard-negative mining to be a gratuitously harsh training procedure, and instead perform *easy-positive mining* for gentler data digestion.

We now turn to the results of the experiment. Inspired by the Finnish education system, we do not test our models during the first formative epochs of development. A quantitative comparison with two other popular generative approaches has been withheld from publication to respect the privacy of the models involved. However, we are able to reveal that GUN had by far the most *opportunities for improvement*. We observed a sharp increase in performance once we all agreed that the network was doing well. By contrast, the adversarial nature of standard GAN methodologies usually elicits a fight-or-flight behavior, which can result in vanishing gradients and runaway losses. Samples drawn from the trained network are shown in Figure 3.

5 CONCLUSION

In this work, we have shown that network-on-network violence is not only unethical, it is also unnecessary. Our experiments demonstrate that happy networks are productive networks, laying the groundwork for advances in motivational machine learning. Indeed, unadversarial learning is an area rife with opportunities for further development. In future work, we plan to give an expanded treatment of important related subjects including nurtural gradients and k-dearest neighbours[12].

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[10]We also make available a public copy of this repository which *almost* compiles. For the sake of brevity, all code comments, variables and function calls have been helpfully removed and replaced cross-platform, universally compatible ascii art. The code can be found at http://github.com/albanie/SIGBOVIK17-GUNs.

[11]For ease of visualisation, the GUN samples were lightly post-processed with LATEX.

[12]While we have exhaustively explored the topic of *machine learning GUNs*, we leave the more controversial topic of *machine GUN learning* to braver researchers.

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AUTHORS' BIOGRAPHIES

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Samuel started writing biographies at the tender age of 24, when he penned his first short story "Ouch that seriously hurt, keep your **** cat away from me" about the life of Jack Johnson, his brother's lovable albino cat with anger management issues. His career as a biographer has gone from strength to strength ever since, flourishing in several other phyla of the animal kingdom. He is a noted expert on the much beloved native English Panda and is a self-award winning author on the challenges of hunting them.

SEBASTIEN

Sebastien holds a self-taught liberal arts degree, and passed his driver's license exam with highest honours. Secretly a ██████ national, he then joined the French Foreign Legion and was deployed ███ ███ ██████████ in Nicaragua, █ of ██, ████. ███ ███ ███ ████ ████ ████ ██████

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Science Spoofs, Physics Pranks and Astronomical Antics

Douglas Scott

Abstract

Some scientists take themselves and their work very seriously. However, there are plenty of cases of humour being combined with science. Here I review some examples from the broad fields of physics and astronomy, particularly focusing on practical jokes and paper parodies. This is a mostly serious overview of a non-serious subject, but I'd like to claim that there is in fact some connection between humour and creativity in the physical sciences.

Contributions

This work represents the first comprehensive survey of humor in the physical sciences, documenting everything from April Fool's papers to laboratory pranks. The key contribution was establishing a taxonomy of scientific humor and demonstrating its correlation with research creativity. The paper argues that humor serves as an important creative outlet and thinking tool in scientific discovery, challenging the notion that science must be entirely serious to be rigorous.

Science Spoofs, Physics Pranks and Astronomical Antics

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(Dated: 1st April 2021)

Some scientists take themselves and their work very seriously. However, there are plenty of cases of humour being combined with science. Here I review some examples from the broad fields of physics and astronomy, particularly focusing on practical jokes and paper parodies. This is a mostly serious overview of a non-serious subject, but I'd like to claim that there is in fact some connection between humour and creativity in the physical sciences.

CONTENTS

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I. SCOPE

The physical sciences are usually taken to be very earnest pursuits by those who work in them. However, most professional physicists and astronomers would also happily agree with the t-shirt mantra that says "physics is phun" [1]. I suspect that anyone who finds it no fun to understand the nature of physical reality will never end up pursuing it as a career. All professionals surely have seen some humour in the subject matter of their job. Hence, in addition to the weighty aspects of the physical sciences, there is a lighter side, which is the focus of this paper.

This topic has been written about before. There are many examples of the use of humour in physics and astronomy, making it impossible to give a comprehensive review. Instead I focus on key examples of deliberate jokes and attempts to use wit in the physical sciences. There will be some bias towards areas closer to my own research in cosmology and astrophysics, but I've tried to include examples across the broad disciplines of physics and astronomy.

To describe the scope of this article, it is useful to explain what I am *not* going to discuss. Deliberate deceptions will not be my focus, e.g. proposals for perpetual motion machines or anti-gravity devices. I will not cover sensational phenomena that resulted from delusions or systematic errors rather than humour. Examples here include claims for: the existence of the planet Vulcan, 1859; Martian "canals", 1877; "N-rays", 1903; rotation of spiral nebulae, 1916; premature verification of gravitational redshift, 1925; E.S.P., 1934; Dogon astronomy knowledge, 1948; "Worlds in Collision", 1950; "polywater", 1961; cosmic-ray-created superpowers, also 1961; detection of gravitational waves, 1969; anomalous behaviour of a pendulum during a solar eclipse, 1970; the "Oops-Leon" particle, 1976; the "17-keV neutrino", 1985; a fifth force, 1986; "water memory", 1988; "cold fusion", 1989; faster-than-light neutrinos, 2011; "perytons" (that turned out to be microwave ovens), also 2011; and primordial cosmic-microwave-background "*B* modes", 2014.

Additionally I will steer clear of most claims that involved scientific misconduct. An example is the "Schön scandal" in condensed-matter physics, which arose from claims by Jan Hendrik Schön that he could make single-molecule semiconductors and nano-scale circuits using organic materials. Another case is the alleged fabrication of data leading to the claimed discovery of element 118 in 1999. There are other examples with much controversy over whether or not misconduct occurred, e.g. the theoretical cosmology papers of the Bogdanov brothers and several plagiarism scandals in other science fields. I will not mention any of these examples, instead sticking with deliberate pranks and related antics.

II. WHY BE FUNNY?

There's certainly nothing to stop anyone mixing physics (or astronomy) with comedy, although "physical comedy" means something entirely different of course! And we're all aware of a TV sitcom starring a theoretical physicist, an experimental physicist and an astrophysicist (plus an engineer, and some life scientists too). But is there any actual connection between physics and humour?

In 1957 the English physicist R.V. Jones published "The theory of practical joking – its relevance to physics" [2]. The article starts "At first sight there may seem little relation between physics and practical joking. Indeed, I might never have observed their connection but for an incidental study of the life of James Clerk Maxwell . . . " Jones goes on to describe how the use of analogy and incongruity are common to both humour and physics. He points out that, as well as Maxwell, there have been other well-known jokesters in physics, including George Gamow (who will reappear later). Jones himself carried out so-called "phone pranks" and credits German scientist Carl Bosch as the originator of the trick whereby someone is convinced that they can be seen through their telephone – a prank he says Bosch pulled on a journalist staying across the street from him in about 1933 [3]. It is worth pointing out that Jones worked on ways to fool enemy radar during World War II and is sometimes called the "father of scientific intelligence".

The connection between physics and humour is developed even further in a recent paper, "Toward a Quantum Theory of Humor" [4]. The authors dissect the joke "Time flies like an arrow, but fruit flies like a banana" and attempt to model it as sets of quantum states, where the wavefunction of ambiguous framings of the joke is collapsed by the measurement process into "funniness" states. It should be stressed that the paper itself is not a joke!

In physics education research, the recent paper "The Role of Humor in Learning Physics: a Study of Undergraduate Students" [5] shows that humour might contribute to a good work atmosphere, and hence improve learning outcomes. The study also suggests that, through humour, students can find pathways to engage in discourse within physics. Similarly, a study carried out in Portugal found that audiences appreciated stand-up comedy routines developed by scientists [6]. On the other hand, a study in 1998 [7] showed that viewers of a humour-laden planetarium show retained less information than those who saw a non-humorous show!

Nevertheless, I suggest that, used carefully, humour in the classroom is a good thing. There's certainly nothing worse than instructors who don't appear to be enjoying themselves! In research too, it's important to see the funny side. I often think that some of my colleagues take themselves far too seriously. They seem to have lost sight of the fact that, in most areas of physics and astronomy, the only real reasons for pursuing research are interest and enjoyment (including public and student engagement of course). If attacked for working on cosmology because it's inherently useless, I like to respond that while it may be useless, at least it's also harmless!

Much has been written about the nature of humour; probably the only ingredient agreed on is that things tend to be funny because of some dissonance or incongruity. Often humour, particularly parody, plays an important role in showing the absurdity in a situation, or simply bringing the over-serious back down to Earth [8].

III. PUBLICATIONS DEVOTED TO HUMOUR

Several existing books include source material on humour in physics and astronomy. "A Random Walk in Science" (1973) [9] and its sequel "More Random Walks in Science" (1982) [10] are collections of light-hearted contributions, mostly about physics, but also including items from other sciences. Although some pieces now seem a bit dated, on the whole these books are excellent and refreshing collections that I recommend highly. An earlier compilation from the Soviet Union, called "Physicists Continue to Laugh", was published in 1968 [11], but there has never been a full English translation.

In 1969 the UNESCO-supported journal "Impact of Science on Society" had a special issue on "The science of humour, the humour of science" [12]. Another anthology with some content related to physics and astronomy is "Laughing Space", edited in 1982 by Isaac Asimov and Janet Jeppson [13]. "Absolute Zero" is a 1992 compilation of jokes and anecdotes related to science and scientists, collected by Betsy Devine and Joel E. Cohen [14]. "Science Askew" by Donald Simanek and John Holden, published in 2001, contains satirical articles, as well as jokes, puns, stories and quotes, many related to physics [15]. "Academia Obscura" by Glen Wright includes some relevant material, but mainly focuses on the life sciences [16]. Jan Witkowski wrote a series of magazine articles about humour in science, also concentrating on biology [17]. A new book contains a couple of chapters that cover some of the same ground as this review [18]: "Fake Physics: Spoofs, Hoaxes and Fictitious Science" by Andrew May [19].

The Cavendish Laboratory in Cambridge, had a tradition of humorous songs sung by students after the annual dinner. Words were specially written to tunes from Gilbert & Sullivan and other popular music sources. The programmes were printed privately in 1904, 1906, 1907 and 1911, then published more formally in 1920 and 1926 as "Postprandial Proceedings of the Cavendish Society" [20]. Many of the songs were written by "A.A.R.", physicist Alfred A. Robb, who worked under J.J. Thomson at the Cavendish and was later known for his books on special relativity. As an illustration, here's part of what Robb wrote about Thomson:

What's in an atom
  The innermost substratum?
That's the problem he is working at today.
He lately did discover
  How to shoot them down like plover,
And the poor little things can't get away.

In another example Gilbert Stead (later known as a pioneer of radiology) put words about Planck's law to the tune of "Men of Harlech", with the following first verse:

All black body radiations,
All the spectrum variations,
All atomic oscillations,
  Vary as $h\nu$.

The Journal of Jocular Physics was a spoof journal produced at the Institute for Theoretical Physics in Copenhagen as a tribute to Niels Bohr, for his 50th (1935), 60th (1945) and 70th (1955) birthdays [21]. Contributors included Léon Rosenfeld, Victor Weisskopf, George Gamow, Oskar Klein and Hendrik Casimir. This same institute (now named after Bohr) was also known for its informal conferences that ended with comedic skits.

The Journal of Irreproducible Results (JIR) was started in Israel in 1955 by virologist Alexander Kohn and physicist Harry J. Lipkin. It is still published, despite several changes in who runs it [22]. In 1994 JIR Editor Marc Abrahams left to found the rival journal Annals of Improbable Research (AIR) [23], which is also connected with the Ig Nobel Prizes. Both the JIR and AIR publications are devoted to scientific humour and there have been many examples related to physics and astronomy (although AIR leans a little more toward life sciences).

Ig Nobel Prizes are given annually to reward studies "that first make people laugh, and then make them think". It is regularly given for Physics and more occasionally for Astronomy. Winners have included scientists who tried to answer the following questions: "why is it so easy to slip on a banana peel?"; "could humans walk on water on the Moon?"; "how do knots form in jostled string?"; "what's the longest continuously running laboratory experiment?"; and "can I magnetically levitate a frog?" A more complete list is given in Appendix A.

The Worm Runner's Digest was started by a biologist in 1959 and ran for 20 years [24]. It published both satirical and serious articles, with the jokey ones printed upside down once it became clear that some people found it hard to tell the difference! Null Hypothesis: The Journal of Unlikely Science is an on-line website based in the U.K., which started as a magazine in 2004. Founded by three biology graduate students, it contains content from a wide range of topics, including the physical sciences. There are also many science-related stories on internet-based humour sites, such as "The Onion" [25].

In addition to these specifically humour-based publications, several other journals and newsletters occasionally include non-serious contributions. Applied Optics had a section called "Of Optics and Opticists" that occasionally contained humorous pieces, and there were similar contributions in "N.P.L. News" from the U.K.'s National Physical Laboratory. Also in the U.K., "The Observatory" is a bimonthly review of astronomy, which has been published since 1877; in addition to serious papers and reports, it includes a "Here and There" section, pointing out misprints and ridiculous statements of astronomical interest. On three specific occasions, there has been a "Special Pull-out and Throw-away Supplement" added; these were to commemorate the 1000th issue (in 1974), the 100th year (in 1977) and the year 2000 (in 2000, naturally) [26]. The supplements were "pink pages", perhaps to mimic the old letters section of Monthly Notices of the Royal Astronomical Society; they contained

more frivolous content, including reports of fake meetings, poetry and spoofs of papers, e.g. "On the properties of cuboid star clusters" [27], "On the possible existence of the lost constellation of 'Cuculus' (the Cuckoo)" [28] and "Astrophysics in 2049" [29].

IV.   EARLY EXAMPLES OF SCIENCE JOKESTERS

The tradition of combining the study of science with humour goes back at least to the ancient Greeks. Theophrastus, Aristotle's successor at the Athens Lyceum, wrote about the properties of the natural world (with fragments of his "History of Physics" surviving), as well as writing humorously about personality traits (in the work "Characters") [30].

More than a thousand years later, the scholar Michael Scot lived from 1175 until about 1232 [31]. He studied in several of the great centres of learning in Europe and was court astronomer (or astrologer) to Frederick II of Sicily. He translated Aristotle into Latin, including the book on astronomy and related topics, "De Caelo". Fibonacci dedicated one of his works to Scot, and Scot may have been the first person to describe the phenomenon of multiple rainbows. In "Super auctorem spherae", Scot gives a dialogue about astronomy between a wise man and a simpleton referred to as "Sir Lupus Fiat", which is an anagram of "Aprilis Fatuus" (Latin for April Fool). Albeit indirect, this may be one of the first mentions of the connection between practical jokes and the month of April; interestingly, it occurs in a treatise on astronomy.

Galileo Galilei has a reputation as the world's first serious physicist and astronomer, but he also had his waggish side. One thinks of his "Dialogue Concerning the Two Chief World Systems" (actually a trilogue) [32], where the conservative-thinking "Simplicius" (named after a 6th-century commentator of Aristotle) is represented as a slow-witted fool. When he was a young man, Galileo wrote some sonnets and also a diatribe against the poet Tasso. Additionally he wrote two satirical poems: "In Abuse of Gowns", poking fun at the rules that professors in Pisa had to wear academic robes; and "It's All Relative", describing how the famous tower was in fact straight, but everything else was leaning.

The writings of the great satirist Jonathan Swift contain several passages related to the sciences. In Part III Chapter 5 of "Gulliver's Travels" he describes "The Academy" on Lagado, which is essentially a mocking attack on the apparent uselessness of some academic studies [33]. He specifically describes pointless experiments, for example to extract sunbeams from cucumbers. He also wrote that the scientists of Laputa had discovered "two lesser stars, or satellites, which revolve about Mars", coincidentally fitting the discovery of Phobos and Deimos 150 years later. Swift was additionally the originator of a prank at the expense of a contemporary astrologer, John Partridge, who published a series of predictions in 1708, including the deaths of several prominent people. A pamphlet quickly appeared, written by Isaac Bickerstaff, containing the prediction that Partridge himself would die on 29th March. This was followed by another pamphlet on 30th March claiming that Partridge had in fact died as predicted – which would have been read by many people on 1st April of course. Isaac Bickerstaff was a pseudonym for none other than Jonathan Swift [34].

Newton famously said "If I have seen further it is by standing on the shoulders of Giants"; the quote is so well known that it was engraved on the edge of the British £2 coin. The sentence occurs in a letter that Newton sent to his rival Robert Hooke. Some recent historians of science [35] have suggested that this was a deliberate dig by Newton at the expense of Hooke, who was described as being small of stature and with pointed features. Certainly we know that Newton grew to regard Hooke as an enemy. Indeed in several letters he referred to Hooke's most famous discovery as "Hook's Law" rather than "Hooke's Law" [36], mocking the facial features of his fellow physicist. It could therefore be said that he picked on the nose of his rival.

Benjamin Franklin used humour to write about electricity in newspaper articles and regularly played pranks on visitors to his home by giving them mild electric shocks [37]. Michael Faraday used humour in his popular lectures, including the series on the "Chemical History of the Candle", which started the tradition of the Royal Institution Christmas Lectures. *And* he invented party balloons!

An example of early humour that is well known to chemists was a pair of spoof papers written by Justus von Liebig and Friedrich Wöhler in 1839 and 1840. These gentlemen used their positions as editors to publish "Spirit and Ferment: The Mystery Dispelled" [38], ridiculing the idea that fermentation was a biological (not chemical) process and "On the Substitution Law and the Theory of Types" [39], mocking the claim that a substance would retain its properties even when some of its atoms were replaced by those of another element. The first was apparently an anonymous letter to the editor, but the second was written by S.C.H. Windler [40].

In 1886 there was a whole spoof edition of the Berichte der Deutschen Chemischen Gesellschaft called "Berichte der Durstigen Chemischen Gesellschaft" (Journal of the Thirsty Chemical Society). This contained an article with a figure showing interlocking monkeys in a circle as the structure of benzene [41]. Whether this was a parody of the famous "snake swallowing its tail" dream image, or if instead this spoof contributed to later retellings of the story, remains debated by science historians.

James Clerk Maxwell, the great Scottish physicist of the 19th century, was known as a prize prankster. It is said that in 1871 he arranged for his inaugural professorial lecture at Cambridge to be advertised only to undergraduates, while the Fellows and Dons of the university came instead to the first lecture in his undergrad-

uate course, where he explained things like the difference between Fahrenheit and Centigrade. Maxwell also wrote many amusing poems that mixed science with creative writing, e.g. in "Report on Tait's Lecture on Force" [42]:

> Force, then, is Force, but mark you! not a thing,
>> Only a Vector;
> Thy barbèd arrows now have lost their sting,
>> Impotent spectre!
> Thy reign, O Force! is over. Now no more
>> Heed we thine action;
> Repulsion leaves us where we were before,
>> So does attraction.

Thus Maxwell used a witty verse to describe how the physical picture of interactions had shifted from forces to fields.

Paul Dirac, one of the most prominent theoretical physicists of the 20th century, was famous for being taciturn and *not* known for his sense of humour. The following lines of verse are attributed to him:

> Age is, of course, a fever chill
> That every physicist must fear.
> He's better dead than living still
> When once he's past his thirtieth year.

And yet he is also quoted as saying "In science one tries to tell people, in such a way as to be understood by everyone, something that no one ever knew before. But in the case of poetry, it's the exact opposite!" However, perhaps Dirac's sense of humour was just more mysterious than most? In 1939 he published a 2.5-page paper describing a new notation for representing quantum states [43], which he ended with the sentence "As names for the new symbols $\langle$ and $\rangle$ to be used in speech, I suggest the words *bra* and *ket* respectively" [44].

George Gamow, the prominent Ukrainian-American theoretical physicist of the mid-20th century, was known for his humour as well as his contributions to cosmology and other fields. This trait can be seen in his popular "Mr. Tompkins" books, as well as in his naming the neutrino "Urca process" after a casino, and in the many pranks he carried out. He once submitted a paper to Nature claiming that an explanation for cows chewing clockwise versus anticlockwise in different hemispheres lay with the Coriolis force and he tried (but sadly failed) to get a paper accepted with Mr. Tompkins as a co-author [45]. Gamow also wrote verse, for example this one in 1964 about the newly discovered "quasi-stellar objects":

> Twinkle, twinkle, quasi-star,
> Biggest puzzle from afar.
> How unlike the other ones,
> Brighter than a billion suns.
> Twinkle, twinkle, quasi-star,
> How I wonder what you are.

Anthony P. French, known for his four classic physics textbooks, also wrote humorous poems about the history of his discipline. He specifically created limericks and "double dactyls" [46], including this one about quantum mechanics:

> Higgledy, piggledy

> Erwin 'H' Schrödinger,
> Said 'Here's a recipe –
> Don't ask me why
> Structures of atoms are
> Fully described by a
> Quantum-mechanical
> Function called Ψ'.

V. NAME MIX-UPS

Surnames can have different spellings, especially in previous centuries (as we already saw with Hooke). An early example of name confusion in physics comes when one studies electromagnetism and related areas and realises that some effects are attributed to Lorentz and others to Lorenz. It is a surprise to many when they realise that there appear to be two different scientists here. But the truth is even stranger. In fact Hendrik Ludvig Lorentz used alternative spellings at different periods and in different journals [47]. When discussing a way to fix the electromagnetic vector potential he adopted the form "Lorenz" for the gauge condition. He used both names when he derived the relationship between the refractive index and the density of a medium. But later he is "Lorentz" for his publications on the Lorentz force and the Lorentz transformation.

A similar prank was pulled by David Marsh in his 1st April 2019 paper "The Marshland Conjecture" [48]. The main claim is that there are in fact two separate David Marshes, "David M.C. Marsh" and "J.E. David Marsh", each writing papers in overlapping areas. Most readers seemed convinced by the detailed description in the paper of these two parallel careers (while in reality they are both the same person), making this a very successful April Fool!

VI. CONFLATING DEGREES WITH DEGREES

Sometimes a joke paper can be written to explicitly mock some previous publication. There's probably a unique instance where a paper of this sort was actually published in a reputable journal. This example is "On the Quantum Theory of the Absolute Zero", written by Beck, Bethe & Riezler in December 1930 and published in Die Naturwissenschaften in January 1931 [50].

The motivation was a calculation by Eddington yielding an explanation for the value of the inverse fine-structure constant $1/\alpha \simeq 137$. This was essentially a piece of numerology, counting the elements in a symmetric 16×16 matrix, plus 1 for the orbital motion of an electron [51]. Beck, Bethe & Riezler were all postdocs in Cambridge when they heard Eddington give a lecture on this topic and were inspired to create their lampoon. In their own contribution they discuss the number of degrees of freedom in a crystal and how to reach absolute zero temperature. The short Beck et al. paper cleverly

transitions from "degrees of freedom" to "degrees of temperature" so that a casual reader might not notice the switch. Then they show that the absolute zero level of $-273°$ comes from $-(2/\alpha - 1)$.

The paper was published in a serious German journal [52], but the editor Hans Spemann was not amused when he found out that it was a joke. So a retraction was published a couple of months later, with the authors said to "express regret that the formulation they gave to the idea was suited to misunderstanding". One doubts whether in fact they regretted it at all!

VII. APRIL FOOLS

For centuries the first day of April has been known in many western countries as "April Fool's Day" (or its equivalent). Its origins are unknown, but there have been suggestions that the practice goes back to the Roman festival of Hilaria, which was at about the same time of year. It is a day set aside for playing tricks on one's friends, the tricks normally being of the non-malevolent kind, such as sending someone on a fool's errand. One of the earliest recorded April Fool's Day pranks was in 1698 when it was announced that people could come to the Tower of London to see the lions being washed, while no such ceremony actually took place [53].

A. April Fools in the media

There are many examples of pranks propagated through newspapers, radio, TV and the internet on 1st April. Famous examples include spaghetti growing on trees, flying penguins and a burger for left-handed people. Below are some examples more specifically related to physics and astronomy.

- Energy was harnessed from the atmosphere according to a 1923 article in the newspaper Deutsche Allgemeine Zeitung; the story was picked up seriously by the New York Times, the LA Times and others.
- There was an atomic blueprint scare in London in 1952.
- A discussion of "contra-polar energy" appeared in Popular Electronics in 1955; this could remove light from an affected area, for example.
- In 1959 it was announced that the twin satellites of Mars were artificial [54].
- A Swiss Moon-landing hoax of 1967 caused people to flock up mountains to get a better view for themselves.
- Metric time was introduced in Australia in 1975.
- In 1984 it was announced that light is caused by an absence of "darkons".
- So-called "bigon" particles, which are the size of bowling balls, were discovered in 1996.
- "Guinness Mean Time" replaced Greenwich Mean Time at the Royal Observatory in 1998.
- A teleportation machine was invented in 2013.

- In 2015 CERN confirmed a fifth type of fundamental interaction, called "The Force".
- Also in 2015, Scientific American announced they would be abandoning April Fool's Day [55].
- A company produced a Flat Earth Globe in 2019.
- Astronomers declared in 2021 that we've learned everything we need to know about the Universe.
- The use of a quantum computer to run a Zoom session in 2021 resulted in participants being in superpositions of breakout rooms.

The NASA "Astronomy Picture of the Day" (APOD) website has regularly presented joke images on 1st April. Perhaps the most successful of these was in 2005, when on 31st March the site contained the teaser "Water on Mars!" for its presentation to follow on the next day; the results of the wait disappointed many [56]. Further examples are listed in Appendix B.

B. Litre April Fool

Many science-related pranks have been carried out on this particular day, or at least spoof papers have been submitted with this date. An outstanding example regarding units appeared in the April 1978 issue of "CHEM 13 News", a newsletter for high-school teachers. Ken Woolner, a physicist from the University of Waterloo, suggested that the litre (whose symbol is often "L", since "l" is easily confused with the number "1") is named after Claude Émile Jean-Baptiste Litre (1716–78) [57]. Apparently Litre was the son of a wine-bottle manufacturer and later worked as a creator of precision instruments, proposing a new unit of volume that was later adopted by the Système international. The idea for the biography originally came from Woolner's colleague Reg Friesen, during a blizzard when the pair were stuck in a hotel room in Ottawa. Woolner wrote out a detailed life history for Litre, and to add colour to his article he wove in elements of French history and scientific luminaries of the time. For authenticity he left some gaps since "the details of Litre's life are very hard to establish , and most of this account was inferred from the general literature of the period". Some scientists joined in with the joke, filling in some of the missing pieces of the biography, including that Litre had a daughter called Millie. Later, several published descriptions of the S.I. units accepted the Litre story as fact, and eventually Woolner had to come clean about his joke [58]. As a last comment, this story is likely known more widely than Ken Woolner's more serious contributions to science!

Woolner and Friesen may well have been inspired by an earlier story from the newsletter of the U.K. N.P.L. [59]. This concerns Jean-Baptiste Moiré, who gave his name to the Moiré pattern. The pseudonymous author "Simplicius" [60] gives a brief biography of Moiré, connecting him to Champollion, the Pre-Raphaelites and Japanese silk-weavers, as well as to Prof. Eddy (discoverer of currents) and George Canapé (the renowned chef).

This Moiré story may itself have been inspired by an earlier report from the 1962 JIR about how Juan Hernandez Torsión Herrera gave his name to the Torsion balance, apparently when watching his cousin being tortured on the rack [61]. The authors were "Col. Douglas Lindsay and Capt. James Ketchum" [62]. And no doubt there are even earlier examples of similar spoof science histories.

The Torsion and Moiré stories are recounted along with several others in the 1996 article "Some Famous Names in Physics" by Australian physicist Tony Klein [63]. The stimulus was a talk by Swedish physicist (and Nobel Committee member) Gösta Ekspong (who changed his name from Carlson, *after* publishing what was perhaps his most famous discovery). Klein mentions many additional physicists who are eponyms, including Matthew Fringe, Wolfgang Bremsstrahlung, Emilio Carburetto, Hercule Parallax, Claude Neon, Katherine Scanning, Jesus Klystron, Spiros Solenoides and the Coupling brothers, J.J. and L.S.

C. April Fool's papers

Returning to the topic of 1st April, a tradition has grown of submitting joke papers to the preprint arXiv on this day. These are mostly not "April Fools" in the true sense, since typically they are so outlandish in their claims that they fool no one. But as examples of humorous parodies of papers, they are submitted in a similar spirit to the old celebrations of this day. A list of known arXiv joke papers submitted on 1st April (or around then, since sometimes it is hard to judge when the paper will appear) is given in Appendix C.

The practice appears to have started in 2002, with a pair of papers discussing the rivalry between students in the Lunar and Planetary Laboratory and those in the Steward Observatory at the University of Arizona [64, 65]. These can't be claimed to be the funniest examples, but they *were* first (and they're short)! The next example was "Cosmic Conspiracies" in 2006 by me and Ali Frolop (more of which later) and then the flood gates opened. At this point there have been at least 72 such papers, some much funnier than others (but I leave readers to make up their own minds about the ranking).

An amusing fact: it can be hard to tell whether papers are meant to be April Fools or not. Without listing examples, papers come out each year at the start of April that appear so ridiculous that many people may regard them as jokes! Temerity forbids me from listing any such cases.

D. Ali Frolop

I first collaborated with Dr. Frolop on a paper called "Cosmic Conspiracies" in 2006 [66]. The inspiration was studying the cosmological parameters for sufficiently long

that a few apparent oddities had started to appear, for example that $H_0 t_0$ is close to unity (with the accelerating and decelerating phases more or less balancing each other). It was Dr. Frolop's idea to submit a collection of these peculiarities to the arXiv and not attempt to publish elsewhere. But in fact, on further consideration there were even more near coincidences to point out, leading to a semi-serious paper written with Don Page and my student Ali Narimani, called "Cosmic Mnemonics" [67] – the motivation was now to have fun with numbers that describe the Universe, giving others a toolkit of possibilities for remembering various relations. Being too technical for a popular magazine, but too light-hearted for a journal, it was extremely hard to find a place for such an article to get published. In the end "Physics in Canada" gave our paper a home.

With Dr. Frolop, a series of further papers followed, the topics covered being: the appeal of multiple kinds of darkness [68]; galaxies don't form at all, in fact they disappear [69]; the CMB is *really* an inside-out star [70]; we should abandon falsifiability *and* other cherished principles as well [71]; there are as many anomalies in the digits of π as in the CMB sky [72]; there's a new kind of radio transient source that shows up before you look for it [73]; and normal logic doesn't apply to the search for life [74]. The "Pi in the sky" article is by far the longest and contains the most serious message. It's also the only paper I'm aware of that has a word-search puzzle in it (and a rare example of a 1st April paper with a version 2 on the arXiv).

VIII. MAXWELL

James Clerk Maxwell, as already stated, was a great joker. As a youth in 1842 he wrote in a letter "On Friday there was great fun with Hunt the Gowk; we could believe nothing, for the clocks were all 'stopped', and everybody had a 'hole in his jacket'" [75]. "Hunt the gowk" is the Scots phrase for pranks played on April Fool's Day [76]. In southern Scotland, where the young James Clerk grew up (before he was "Maxwell"), it was also known as "hunt the dunse", the word "dunse" being originally an epithet for theologian and scholar John Duns Scotus, who lived in the 13th century. This information is important to understand one of Maxwell's biggest physics jokes.

In 1861 he started publishing a series of papers describing his new unified theory of the electric and magnetic forces. Maxwell realised that the theory would be more self-consistent if there existed an additional kind of field. Initially there was no reason to believe in the existence of such a field, but on 1st April 1861 Maxwell wrote to his older physics colleague Michael Faraday, describing how he had evidence for this field, which he named "D", after the letter labelling children who were being made a fool of, or turned into a dunse on that day [77]. Maxwell [78] came to understand that the joke had backfired soon afterwards, since he found that he actually needed this

additional component in his electromagnetic equations. He therefore dropped the "dunse" label and started to refer to it as the "displacement field," D [79]. We now know it plays an important role in completing Maxwell's equations, accounting for the effects of free and bound charge within materials. It's ironic that this story all started with a prank.

IX. MOON HOAX

Through human history there has been speculation about the nature of the Moon. These conjectures included the famous astronomer William Herschel stating in 1780 that there was a "great probability, not to say almost absolute certainty, of her being inhabited" [80] and in 1795 he added that "the analogies that have been mentioned are fully sufficient to establish the high probability of the moon's being inhabited like the Earth" [81]. To make it clear that conventional thinking was different back then, it may be worth noting that Herschel also stated that "we need not hesitate to admit that the sun is richly stored with inhabitants" [82].

Hard though it may be to accept, these were not jokes but serious suggestions, albeit without any proof. However, dramatic evidence of life on the Moon appeared in a series of articles published in The Sun newspaper in New York in 1835 [83], apparently based on new observations by William Herschel's son John. These articles discuss how forests, fields and beaches could be seen on the lunar surface and, with a little more scrutiny, bisons and sheep, as well as bipedal beavers, blue goats, unicorns and man-bats [84]. The articles caused a sensation at the time, with claims that, over the week they appeared, the circulation of the newspaper increased dramatically. Other newspapers in New York reprinted the stories, the original publisher produced a pamphlet including the entire series, and there were translations into many languages. The story thus reached a very wide audience, being an early example of the power of mass media. It seems that a large fraction of people at the time genuinely believed the hoax. This would foreshadow the popular reaction to another hoax a century later, this time using the medium of radio, namely Orson Welles' "War of the Worlds" broadcast of 1938.

The Moon hoax was eventually debunked through several articles by journalists and scientists questioning many details of the story. The author was revealed to be reporter Richard Adams Locke. Locke claimed later that the story was meant as a satire, attacking earlier works such as the 1824 paper "Discovery of Many Distinct Traces of Lunar Inhabitants, Especially of One of Their Colossal Buildings" by Franz von Paula Gruithuisen (Professor of Astronomy at Munich University) [85] and the lunar-life beliefs of Rev. Thomas Dick (who later calculated that the number of inhabitants of the Solar System was 21,894,974,404,480 in total) [86]. Undermining this declaration that it was all meant as a

prank, Locke would later try unsuccessfully to perpetrate another hoax, this time claiming to have the lost diary of the explorer Mungo Park [87].

X. CATCHING LIONS

An influential piece of humour was published in 1938, called "A contribution to the mathematical theory of big game hunting", written by H. Pétard [88]. Its subject matter may seem outdated, but I should reassure you that the paper is about methods for capturing lions, rather than shooting them [89]; perhaps the author simply wanted to catch a lion in order to take it to the Tower of London to be washed? The author's name was a pseudonym for mathematician Ralph P. Boas Jr. and some of his colleagues (with the "H" being short for "hoist with one's own"). The paper describes 16 imaginative methods for capturing a lion, and although the title says "mathematical" in fact four of the methods come from theoretical physics (including references to one of Bethe's papers) and three from experimental physics. This paper led to additional methods of feline trapping being later contributed by others, and it undoubtedly inspired further humorous articles in physics as well as mathematics. Boas used different pseudonyms for other contributions, including E.S. Pondiczery from the Royal Institute of Poldavia; the original motivation was to use this author in a paper spoofing extrasensory perception, so it could be signed "E.S.P. R.I.P.", but unfortunately the paper never appeared [90].

XI. CANDLESTICKMAKER

Subrahmanyan Chandrasekhar was one of the most highly-regarded astrophysicists of his generation. Originally from India, he spent most of his working life in Chicago. He received numerous awards, including the Nobel Prize for Physics in 1983, and many things are named after him, including limits, numbers, equations, functions, tensors, lemmas, asteroids and satellites! He served as editor of the Astrophysical Journal (ApJ) for almost 20 years, and had a reputation for reading all the papers submitted to the journal. In 1957, Chandrasekhar's postdoc John Sykes (perhaps with the help of other postdocs) wrote a parody paper called "On the imperturbability of elevator operators: LVII", which claimed to be by S. Candlestickmaker from the Institute for Studied Advances, Old Cardigan, Wales [91].

Sykes had come from Britain to join Chandrasekhar's group for a year to learn about magnetohydrodynamics for the U.K. fusion project, but afterwards switched to work as a physics translator and later dictionary editor. He was able to translate science papers in a large number of languages, and contributed to the English version of the set of Landau & Lifshitz volumes, for example. He served as editor of the Concise Oxford English Dictionary

and was a cryptic crossword-solving champion par excellence (winning the annual Times newspaper challenge no less than 10 times) [92].

The "elevator operators" paper was submitted formally to the ApJ. The secretary, noting that it was probably a joke, showed it hesitantly to Chandrasekhar – but he was delighted with the parody and insisted that it should be printed in the form of an ApJ reprint. This is the way that most people saw the paper at the time, and it is said that several libraries bound it along with the regular journal. The great man was so pleased with how well it captured his style that he would recommend it to new students as a template for how to write a paper [94]!

The specific paper being lampooned was probably "The Instability of a Layer of Fluid Heated Below and Subject to the Simultaneous Action of a Magnetic Field and Rotation. II" [93]. A direct comparison is needed to fully appreciate the in-jokes. This "Candlestickmaker" paper represented a seminal moment in the history of parodies, setting a high bar for all others to follow.

XII. THIOTIMOLINE

In 1948 the science-fiction writer Isaac Asimov published a spoof article on "The Endochronic Properties of Resublimated Thiotimoline" [95]. The inspiration for the article was Asimov watching substances dissolve almost before they hit the surface of a liquid, during experiments carried out for his chemistry doctorate at Columbia University. The idea in the paper was that a special compound had been discovered that dissolved *before* making contact with water. This could then lead to effects that messed with causality (so although this starts with chemistry, now it enters the realm of physics) and hence time travel. As Asimov later explained, the publication appeared shortly before his doctoral defence with his own name rather than the planned pseudonym, and he became concerned that the examiners might be annoyed that he wasn't taking chemistry seriously. However, at the end of the meeting, one of them had a last question, which was "Can you tell us about the endochronic properties of resublimated thiotimoline, *Dr.* Asimov" and he knew he had passed!

Asimov followed his original paper with another on "The Micropsychiatric Applications of Thiotimoline" [96] and a third on "Thiotimoline and the Space Age" [97], which includes a discussion of the "Heisenberg failure", where it seems to be impossible to avoid adding water to the substance after it had dissolved. Lastly Asimov wrote "Thiotimoline to the Stars" [98], where he mocks his own name as "Azimuth" and "Asymptote" and includes a discussion of how endochronicity can be used to power starships. Several other science-fiction authors have also made mention of thiotimoline. It has therefore taken on an existence beyond that of its inventor, joining legendary substances such as administratium, neutronium, red mercury, unobtanium, etc., as well as devices like the flux capacitor, the turboencabulator and write-only memory.

XIII. INTERSTELLAR ECONOMICS

Another influential joke paper is "The Theory of Interstellar Trade", written by economist Paul Krugman in 1978 [99]; it was published in 2010, a couple of years after Krugman was awarded the Nobel Prize in Economics. The paper describes how trade, interest and arbitrage might work when journeys could take centuries and when the time passing in the frame of the traveller could be different than the time passing on Earth; hence the paper uses the ideas of special relativity, with the application of general relativity "left as an exercise for interested readers because the author does not understand the theory" [100]. The paper states that it "is a serious analysis of a ridiculous subject, which is of course the opposite of what is usual in economics", an attitude that has influenced later spoof papers. Several other studies of space trade have followed, and although some, like Krugman's original paper, have their tongues firmly in their cheeks [101], it's unclear if that's true of all of them [102].

XIV. GRAVITY

The "Jupiter Effect" was a suggestion that a planetary alignment in 1982, when eight of the nine known planets (excluding Pluto) would all be on the same side of the Sun, was going to lead to catastrophes on Earth. The sensationalist book of the same name [103], written in 1974 by John Gribbin and Steve Plagemann, caused extremely skeptical reactions from most scientists. And in fact Gribbin and Plagemann published a sequel in 1982, pointing out why it was obvious all along that the effects on the Earth would be entirely negligible. One wonders whether this was all some sort of deliberate hoax; however, based on Gribbin saying later that he regretted having anything to do with this, it would appear to have been over-enthusiasm in writing a popular book rather than a prank. Nevertheless, there *was* a later hoax associated with this book, since it was the essential inspiration for a trick perpetrated on 1st April 1976. TV-astronomer Patrick Moore claimed that at 9:47 p.m. a conjunction of Jupiter and Pluto would take place, resulting in a decrease in gravity on Earth, so that if people jumped in the air at that precise time they would experience a form of levitation. Inevitably, many people reported that they felt floating sensations at the appointed time [104].

XV. THE SOKAL AFFAIR

Sometimes there is a serious purpose behind a scientific prank. Such was the case with one of the most famous

spoof papers in physics, through something usually referred to as "The Sokal Affair" [105]. The motivation was a feeling among some scientists that postmodernists had gone too far in pushing their agenda of knowledge being entirely based on social conditioning – they had become anti-science. Moreover, there was a suggestion that some relevant journals had a low quality threshold [106]. So, in 1994 physicist Alan Sokal wrote the spoof paper "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity" [107], which was accepted for publication in the journal "Social Text" in 1996 [108]. The main tenet of the paper was that physicists had for too long ignored the views of deconstructionists and should free themselves from the restrictions of things like mathematics.

Here's a snippet from the paper, where Sokal responds to a comment from deconstructionist Jacques Derrida about general relativity: "In mathematical terms, Derrida's observation relates to the invariance of the Einstein field equation $G_{\mu\nu} = 8\pi G T_{\mu\nu}$ under nonlinear space-time diffeomorphisms (self-mappings of the space-time manifold which are infinitely differentiable but not necessarily analytic). The key point is that this invariance group 'acts transitively': this means that any space-time point, if it exists at all, can be transformed into any other. In this way the infinite-dimensional invariance group erodes the distinction between observer and observed; the π of Euclid and the G of Newton, formerly thought to be constant and universal, are now perceived in their ineluctable historicity; and the putative observer becomes fatally de-centered, disconnected from any epistemic link to a space-time point that can no longer be defined by geometry alone."

Sokal quickly confessed that the article was a deliberate spoof, containing largely nonsense couched in technical-sounding physics jargon. Some postmodernists were upset that they had been fooled into taking the article seriously; they deemed it as unfair because they were not experts in physics, despite the fact that the text contains many glaring clues to its insincerity, and not excusing the fact that the journal failed to ask for the opinions of any specialist reviewer before publishing [109]. Perhaps most amusingly, other postmodernists argued that it was irrelevant that the article was intended as a joke, since it stood as an academic treatise on its own merits!

XVI.   MORE HOAXES

Chemistry provides an example of a deliberate hoax from a publication in 1944, "Toxicological Significance of Laevorotatory Ice Crystals" [110]. The paper purports to be about how left-handed ice crystals were poisonous; but in fact the paper was a deliberate "sting" perpetrated on the editors of the journal "The Analyst" after some dispute with them. The paper was subsequently withdrawn and not indexed, but is now easy to track down.

One of the scourges of modern academia is the proliferation of predatory journals, i.e. new journals of low quality and little in the way of peer review. There have been several attempts to show that some of these journals will publish just about anything, provided that they get their fee.

An example is the 2017 paper "Mitochondria: Structure, Function and Clinical Relevance" by Lucas McGeorge and Annette Kin, which substitutes "midichlorians" for "mitochondria" in the text – these are the microscopic creatures introduced in later Star Wars films to explain "the Force". The paper was accepted by four journals, including the Austin Journal of Pharmacology & Therapeutics [111]; two of these journals later removed the paper. This Star-Wars-inspired spoof was quickly followed by another motivated by Star Trek. "Rapid genetic and developmental morphological change following extreme celerity" by Paris, Kim, Torres, Ocampa, Janeway & Zimmerman [112] was based on the Star Trek Voyager episode "Threshold" [113]. This paper was sent to 10 apparently predatory journals, four of which accepted it, and one published it (although the paper was later removed from the publication website). Unfortunately this has all had zero impact on the spread of such journals.

In 1897 the "Indiana Pi Bill" was a famous attempt to effectively legislate that $\pi = 3.2$ (or perhaps 3.23 or maybe even 4, it's hard to tell). Variants of this story have done the rounds for decades, often involving the value 3 and locations in different states. In 1998 physicist Mark Boslough was able to exploit this confusion by publishing an April Fool's Day joke as a satirical attack on the pro-creationist stance of New Mexico's state legislature [114]. Boslough wrote that Alabama had voted to set $\pi = 3$ and people starting calling their representatives to complain, leading to the prank being revealed.

XVII.   MONOPOLES

On Valentine's Day in 1982, an experiment designed by Blas Cabrera recorded an event that had all the characteristics of the hypothesised magnetic monopole [115]. This caused a great deal of excitement at the time, but no further events were seen and later experimental results placed very stringent limits on the flux of monopoles. One problem is, since it was a weekend, no one was scheduled to be in the lab that day. It has been suggested that the apparent event may have been a prank played by a student [116]; however, no one has ever owned up! The possibility of it being a prank is interesting because, just a year before, Sidney Coleman, in some published physics lectures [117], had introduced the "monopole hoax" as a way for theorists to fool experimentalists that they'd seen a monopole using "a very long, very thin solenoid . . . many miles long" having one end in the laboratory and the other very far away. Could this light-hearted suggestion have been the inspiration for a practical joke?

XVIII. OTHER SPOOF PAPERS

An early example of a scientific lampoon from the Journal of Irreproducible Results in 1956 was "Theoretical zipperdynamics" [118]. This paper described the quantized nature of the position of a zipper, the unobservability of "zipperbewegung" and attempts to solve the semi-infinite zipper using the Schroedzipper equation. It included references to several earlier papers, including one by H. Quantum on zipper theory, "which is incidentally applicable to such minor Problems as Black Body Radiation, Atomic Spectroscopy, Chemical Binding and Liquid Helium".

Although editors tend not to be known for their senses of humour, occasionally, mainstream journals will include tongue-in-cheek contributions; such was the case with the 1970 paper in Science called "Properties and Composition of Lunar Materials" by Schreiber & Anderson [119]. This paper presents the results of experiments to measure the sound speed in various substances, finding that the terrestrial materials that most closely match the Moon are various types of cheese.

One physics paper published in the Worm Runner's Digest was 1972's "A theory of ghosts" by D.A. Wright [120]. The article uses quantum mechanics, relativity and other bits of physics to describe how ghosts can penetrate walls, move quickly and be observed at low light levels. Additionally the author questions whether ghosts are fermions or bosons and speculates that they could be the source of the cosmic microwave background.

In 1979 a preprint by De Rújula, Ellis, Petronzio, Preparata & Scott [121], based on a dramatic performance at the Erice Particle Physics School, was entitled "Can one tell QCD from a hole in the ground?" Ellis followed the same theme in 1980 with "Can One Tell Technicolor from a Hole in the Ground?" [122]

A preprint from 1980 by "Doctor" Wisecracker [123] was entitled "Is the Universe full of stuff?" It includes statements such as "In the standard model the cosmos starts as a huge banana stuffed with quantum foam". With the prominence of the concepts of supersymmetry and superstrings, G. Wow-mann wrote a follow-up called "Superduperstuff in the Universe" [124]. This was based on the concept of "superconducting, supercolliding, supersymmetric, superstringy superstuff" with which "any phenomenon can be explained by a theorist of arbitrary skill". The author of these parodies was particle astrophysicist Craig Hogan, during his time as a graduate student and postdoc. The superabundance of the prefix "super-" in physics was developed by others in a more recent paper on "Superfluous Physics" [125].

Another unpublished preprint came out in April 1983, "Monte Carlo Simulation of a Realistic Unified Gauge Theory", by Alan Chodos and Jeffrey Rabin [126]. It introduced the idea of the "Grassmann Chip", which could store and compute with anti-commuting numbers (and has later been discussed in more serious papers). Theorist Joseph Lykken wrote "Observation of Warm Nuclear Fusion in Condensed Soup" in 1989 [127], in response to the contemporary claims of cold fusion.

String theorist Warren Siegel has published a series of paper parodies as preprints [128], 22 at the latest count! This makes him one of the most prolific of the physics paper spoofers. The series began with the 1983 paper "Stuperspace", purportedly by V. Gates, Empty Kangaroo, M. Roachcock & W.C. Gall, and later published in Physica D [129]. These authors have remained together as a team, although curiously from 1993 we find that Dr. Kangaroo has dropped down the priority list relative to Dr. Roachcock. Readers of these papers will notice that their authors are very fond of footnotes and the overuse of elaborate typography. Additionally, one paper refers to the "Newton-Witten" equation $F = ma$, which gained a certain infamy. Whether consciously or not, these papers seem to be inspired by the earlier "Candlestickmaker" parody.

"Script an Astronomer, Then Reach for the Stars" by Eric Schulman appeared in AIR in 1999. It describes the positive correlation between the quality of movies and the number of characters in them who are astronomers [130]. Along with several joke articles and poems [131], Schulman also contributed the parodies "How to Write a Scientific Paper" [132], "How to Write a Scientific Research Report" [133] and "How to Write a Clear Research Report" [134]. The last two, written by Schulman with the help of his partner and their daughter, describe "the stacking properties of toroids that reflect radiation in the 1.8 to 2.8 eV energy range". Additionally "The insulating properties of materials" describes the finding that "newsprint has superior thermal insulation properties when compared to corrugated fiberboard or air cellular cushioning material" [135].

A paper posted to the arXiv in 1999, called "The Effects of Moore's Law and Slacking on Large Computations" showed that, based on the rate at which computational power is growing, it's better to wait and carry out your calculations later [136]. The authors, Gottbrath et al., were students at Steward Observatory.

Continuing the tradition of using animals in spoof papers, "The Violation of Bell Inequalities in the Macroworld" written by Aerts et al. in 2000, contains a section involving cats with bells tied around their necks [137]. It is unclear how much of the rest of the paper has its tongue in its cheek.

Physicist Donald Simanek (and his very close colleague Ken Amis) has written several science parodies, some intended to test critical thinking abilities in students. These include "A New Theory of Dark Matter", "The Age of the Universe is a Function of Time", "A Deductive Proof of Newton's Third Law" and "Toward a New Theory of Gravitation" [138].

In 2009 physics graduate student Ben Tippett wrote "A Unified theory of Superman's Powers" [139]. The abilities of Kal-El are usually explained to arise from Earth's gravity being weaker than the planet Krypton's, along with our Sun being yellower than Krypton's star,

but Tippett argues that these explanations make little sense and that it would be much simpler to assume that Superman could just manipulate inertial mass. There are follow-up papers on Spiderman's super-powers [140], a lost city from a story by H.P. Lovecraft [141] and Dr. Who's TARDIS [142].

"A Simple Model of the Evolution of Simple Models of Evolution" by Shalizi & Tozier [143] is a spoof paper making a serious point. It's about the tendency of some physicists to write papers modelling evolution as a statistical-mechanics problem, without really knowing any biology.

Let me give one last example that I dimly recall hearing in my early days as a graduate student. Apparently there was a conference where a senior astronomer presented results showing that many stars had rings around them, with the angular size of the rings appearing to be inversely proportional to the distance of the star – in other words there were structures of fixed physical size around many stars. Hence this couldn't be an optical effect and had all the appearances of being artificial constructions, something like Dyson spheres. Despite this seeming to be the most amazing discovery ever made, most people listening to the talk showed no reaction, and it transpired afterwards that the astronomer had been pranked by his own graduate student! Unfortunately I've been unable to uncover where I heard this story, or to find out any more information. So perhaps I just made this up? [144]

XIX. BACKFIRES

Sometimes comments that are intended to be satirical end up having the opposite consequences. There are two famous examples. Firstly, "Schrödinger's cat" was originally a thought-experiment devised by Erwin Schrödinger in 1935 to ridicule the Copenhagen interpretation of quantum mechanics. As he wrote: "One can even set up quite ridiculous cases. A cat is penned up in a steel chamber, along with the following device . . ." [145]. However, this thought experiment has come to be considered as a serious manifestation of the principle of superposition of states, losing the negative connotations that were its initial intent. The image of the dead/alive cat has also grown in prominence in popular accounts of quantum mechanics, probably being the focus of more jokes (cartoons, t-shirts, etc.) than any other topic in physics; most of these jokes completely misinterpret the idea, as well as missing the fact that the situation was *itself* meant as a joke [146].

The second example is the naming of the "Big Bang" model for the early history of the Universe. The phrase was coined by Fred Hoyle in a radio broadcast in 1949. Hoyle was a proponent of the rival "steady state" theory, which posited that the Universe has always looked essentially the same, and he argued against a picture where time had a beginning. Hoyle appeared to use the term "Big Bang" pejoratively, specifically saying that the the-

ories he didn't like "were based on the hypothesis that all the matter in the universe was created in one big bang at a particular time in the remote past" [147]. The debate between proponents of the "big bang" and the "steady state" went on for a couple of decades, as summarised in a poem by Barbara Gamow (wife of George [148]), including these lines:

Said Hoyle, "You quote
Lemaître, I note,
And Gamow. Well, forget them!
That errant gang
And their Big Bang –
Why aid them and abet them?
You see, my friend,
It has no end
And there was no beginning
And Bondi, Gold,
And I will hold
Until our hair is thinning!"

It is therefore ironic that the phrase 'Big Bang' eventually became attached to the theory that Hoyle scoffed at. And in a further level of irony, the name is generally detested by cosmologists because it conjures an image of an initial explosion (the $t = 0$ instant generally being considered to be *outside* the purview of the model) at a specific place.

The moral here is, if you're going to come up with a good sound bite to lampoon something, then don't be surprised if it comes back to bite you! [149]

XX. EPHEMERA

When print media was the norm, comic items related to science would appear in "grey material" venues like newsletters, which may not have been well archived. An example is "Physikalisches Lied" by Molly Kule, consisting of what looks like a piece of music, but is crammed with physics-based visual jokes and puns. This seems to have come from Princeton in about 1942, and was preserved in "More Random Walks in Science" [10].

Before there were "e-prints" there were "pre-prints" [150]. The eprint archive started in the early 1990s in various sub-fields of physics. Before that time it was common practice for people to prepare preprints that were circulated to major institutions around the world, so that the results could be disseminated during the delay before journal publication. Joke papers would occasionally be added to the bundle of such preprints being mailed out. Unfortunately such contributions are therefore impermanent, and may only exist in filing cabinets. Several examples have already been mentioned above, but there are probably quite a few spoof preprints out there yet to be unearthed.

Another example of a set of ephemera are the joke emails that were used to exchange casual information before the rise of the internet. I can remember one in the form of a "chain email", encouraging the reader to cite specific papers, add a paper of their own to the list,

and send the same email to ten colleagues – or else bad things would happen. There was also the "cartoon laws of physics", which came with several amendments [151]. Other examples included spoof versions of referee reports and how to deal with them, proofs of the impossibility of Santa, and where to order items like spherical cows, frictionless planes and massless springs. Some items are collected in repositories from usenet newsgroups [152], but one wonders whether anyone has a full collection of these emails from the 1970s and 1980s. Going back even earlier, there will be similar content in actual letters on pieces of paper!

One story, repeated in many forms, is based on ways of using a barometer to measure the height of a building. This originated in about 1960, written by physicist and educator Alexander Calandra [153]. It has been reprinted and embellished many times, to the extent that it became an urban legend.

Posters at conferences are also largely unrecorded. In about 1986, "A New and Definitive Meta-Cosmology Theory" was a flow chart created by Lauer, Statler, Ryden & Weinberg, who were then Princeton graduate students. It describes how the discovery of a new particle can be developed into a cosmological model, all the arrows ultimately leading to $\Omega_0 = 1$, which was the conventional wisdom among theorists at that time. Additionally, a one-off board game called "Galaxy Formation" was created by David (and Lisa) Weinberg in 1987 and played at some conferences.

XXI. PAPER SECTIONS

We have already seen many cases where a whole paper is a lampoon of some aspect of physics or astronomy. But there are many more instances where the joke occurs only in a small part of the publication. So let us now go through the various segments of a paper, giving some examples of whimsy for each of these parts.

A. Pre-publication

There are several steps in preparing a paper for publication. Perhaps first comes the inspiration. Something that might help is this quatrain:

God grant that no one else has done
The work I want to do,
And give me wit to write it up
In decent English too.

This was submitted as part of a competition in 1962 for a chemistry version of "The Fisherman's Prayer" [154], with the author recorded as "Ricardo".

Another important part of the research process is applying for funding. wrote "Creation of the Universe: a modest proposal" as a parody of a grant proposal, seeking additional finances to correct some of the flaws in the

Universe that were created following a previous round of funding [155].

B. Authors

Probably the best-known author list created for humorous impact occurs in the 1948 paper by Alpher, Bethe & Gamow on "The Origin of the Chemical Elements" [156]. This remains a seminal study in the history of ideas for the formation of the light elements. The work was done by graduate student Ralph Alpher, along with his supervisor George Gamow. It was Gamow's idea to include his friend Hans Bethe in the author list [157], partly because he learned that the paper would appear on 1st April [158]. Alpher apparently did not appreciate the joke [159]. However, despite the fact that Alpher thought the addition of a non-participatory senior scientist would somehow lessen his perceived contribution, or lead to the paper being taken less seriously, in fact it probably gained prominence through being known as the "$\alpha\beta\gamma$" paper [160].

Greenberg, Greenberger & Greenbergest posted a paper to hep-ph in 1993 [161]. In 2011 a paper appeared on 1st April on patterns in the cosmic microwave background, written by Zuntz, Zibin, Zunckel & Zwart [162]; a related group also showed that authors near the end of the alphabet get fewer citations but write better papers [163]. Although outside physics, it's worth noting that in 2014 Goodman, Goodman, Goodman & Goodman studied papers by authors sharing a family name in "A Few Goodmen: Surname-Sharing Economist Coauthors" [164].

A paper published in 1989, called "The small-scale autocorrelation function of the X-ray background", was written by Xavier Barcons and Andy C. Fabian. "What's funny about that?" you might ask. The answer is given in a footnote on the first page of the paper: "The small-scale ACF of the XB by XB and ACF" [165]. Several people with the surname "Moon" have written papers about the Moon, while Wolfgang Wall has modelled walls in fluid mechanics. There are surely other examples of people working on topics that are apposite to their names.

In 1989 spectroscopist Peter Hollins found he had a set of name-appropriate students in his group and hence a paper by Quick, Brown, Fox & Hollins was born [166]. An article on ultrashort laser pulses, published in "Optics & Photonics News" in 1990, claimed to have reached the limit of a zero-width pulse, and that in future pulses of negative width would be possible. The authors were Knox, Knox, Hoose & Zare [167]. The authors' names are real, but one suspects they got together merely for the purpose of writing this spoof. A paper from 1992 on ^{13}C–^{13}C couplings was authored by Bax, Max & Zax (the first author being a biophysicist) [168]. Also in 1992, D'Eath & Payne co-authored three papers together about gravitational waves from black holes [169].

The physicist Alois Kabelschacht first appeared as a

colleague acknowledged for help, and then in 1978 was promoted to the status of co-author for a theory paper [170]. He has now appeared on three other papers [171], including two as an experimentalist; however, the name is a joke deriving from the nameplate on what looked like an office door at the Max-Planck-Institut für Physik in Munich, but was just the "cable shaft".

J.J. Charfman is an astronomer of legendary status from the Steward Observatory. The first paper they wrote was about boron sulphide, which terrestrially occurs as B_2S_3 but in the interstellar medium apparently exists in the form of just one B atom attached to one S atom [172]. The same author's name appears four more times; it is unclear where the name came from [173].

T.I.A. Fudge was added as co-author to a paper on modelling Bose-Einstein condensates in 2002. This fictitious author came from a confession that a certain co-efficient (unexplained at the time) was a "fudge factor", with the initials standing for "This Is A" [174]. Physicist Jack H. Hetherington attached the name of his cat Chester, through the alias "F.D.C. Willard", to one of his papers in 1975 [175]. Apparently this originated in a debate with a colleague over whether the Physical Review would reject the paper for using the first person plural in a manuscript with just a single author – a debate he resolved by adding a bogus co-author. "F.D.C." stood for "Felis Domesticus, Chester" with Willard being the name of Chester's father. Willard later wrote a single-author article in French for a popular science magazine [177]. The practice of adding a pet as co-author was repeated (with the same "third person" reasoning) by immunologist Polly Matzinger in 1978 [176].

Andre Geim, famous as the only person to have won both a Nobel Prize [178] and an Ig Nobel Prize [179], wrote a paper with his hamster [180], H.A.M.S. ter Tisha. It is unclear what the initials stand for, but clearly Geim went to less effort to hide the fact that his co-author was a pet than the trend started by Hetherington.

A. Aardvark is recorded as a co-author on several abstracts and papers; one has to be suspicious that the name was added for alphabet-inspired reasons [181]. Continuing the animal theme, Tycho Brahe, known as something of an eccentric, had a pet elk [182]; no doubt, if he had lived a few centuries later, he would have included it as a co-author on some of his papers. Sadly the elk died falling down the castle stairs after getting drunk.

Speaking of bogus authors, let me come clean and confess that the name "Ali Frolop" is made up. This had an unintended consequence when Ali Narimani became my graduate student a few years later. Several people noticed I'd been publishing with Mr. (now Dr.) Narimani, and asked me what that name could be an anagram of! I had to respond by assuring them that Ali Narimani is in fact a real person. But this got me thinking that it would be fun to collaborate with both of the Alis in my research life. So when Ali N. came to me with an idea for a spoof paper (picking up on something he'd read that Sean Carroll had written), the project was started. It then seemed

obvious that we should also recruit Andrei Frolov, a colleague from our neighbouring university, allowing us to concoct the following joke author list: "Ali Frolop, Ali & Frolov" [71]. From my perspective this author list became the main reason to write the paper! Andrei, like Hans Bethe before him, played no role in writing the paper, but agreed to have his name added. However, he wanted an assurance that "nothing bad would ever happen to him" as a consequence of being associated with our joke. Within a week the paper was completed and ready to be submitted to the arXiv at the appropriate time. However, there was no way to put "D. Scott" among the authors while preserving any humorous impact, so I omitted my name from the author field on the upload page. This led to the paper bouncing back from the arXiv, with a message that third-party submissions were not allowed. I then explained in a note that I *was* in fact an author, and therefore added my name to the author field for the resubmission. This led the site moderator to withdraw submission privileges for us on the basis that we were trying to subvert the arXiv's policies! Andre wasn't happy. And it took 24 hours to find someone in a position to sort this out for us, which explains why the paper appeared a day later than intended. On the positive side, this story may be funnier than the paper itself!

As well as Frolop, Kabelschacht, Charfman, etc., there are plenty of examples of scientists of possibly legendary status. Monsieur Litre was an early instrument builder, while Konrad Finagle was the inventor of the fudge factor, as well as several other innovations (as described by Donald Simanek). Then of course there are other physicists who have appeared in various places, such as Dr. Arroway, Dr. Banner, Doc. Brown, Dr. Brundle, Prof. Calculus, Dr. Koothrappali, Dr. Manhattan and Dr. Octopus.

To finish this section, I feel compelled to acknowledge the issue of increasing numbers of authors on papers from large collaborations, undermining what most of us thought we understood by the word "author". The current record holder is the 5,154 names listed on the 2015 Higgs boson paper from the two combined experimental teams at the Large Hadron Collider [183]. This paper, including references, ends on page 9, with the listing of authors and institutions stretching it out to page 33. At the other extreme there are still plenty of single-author papers, including some with very short names [184].

C. Addresses

In parodies of papers the authors are often listed at spurious institutions. The "Candlestickmaker" paper gives the author's address as "Institute for Studied Advances", the paper on zipperdynamics came from "The Weizipmann Inziptute" and the origin for the "Superduperstuff" paper was "Institute for Innerspace/Outerspace Interfarce". In one paper John Ellis gave his address as "British Airways".

D. Titles

Joke titles are quite common, although some of the older journals tend to frown upon the practice. Hence there are many cases where the arXiv posting has an amusing title that has been changed to something much more boring for the journal publication. Let me give a few examples here, with a somewhat longer list being provided in Appendix D [185].

Although the use of humorous titles may seem like a fairly recent phenomenon, there are some earlier examples. For instance, "Deuteronomy. Synthesis of Deuterons and the Light Nuclei during the Early History of the Solar System" was published by Fowler, Greenstein & Hoyle in 1961 [186].

Different topics within physics and astronomy have varying levels of zest for jokey titles. Amusing and outlandish titles became quite popular within string theory, and there are many examples, like "10=6+4" [372] and "Escape from the Menace of the Giant Wormholes" [362]. Within astrophysics, black hole theorists and cosmologists seem more enthusiastic about joke titles than researchers in most other areas.

"Velocity dispersions in a cluster of stars" by Eriksen, Kristiansen, Langangen & Wehus [187] is a clever title. One might expect that this is about the statistics of motion in a globular cluster, say. But the subtitle gives the game away: "How fast could Usain Bolt have run?" This is in fact a statistical study of frames from film of the famous race where the sprinter appeared to slow down at the end. Unfortunately the journal changed the title to something much more prosaic.

There are a large number of titles based on movies, particularly from science fiction. Plays on the names of Star Wars films are especially popular [188] – "strikes back" seems to be a phenomenon that occurs in many branches of physics. Similarly, there are a lot of "one rings" doing something to "them all". Shakespeare-inspired titles are also common, with their "Much Ados", their "All's Wells" and their "To Bes".

Newspapers and magazines have more sensational headlines than we're used to on the front pages of scientific papers. The "News and Views" section in Nature is somewhere between a magazine and a journal, and hence is a good source for deliberately humorous titles, e.g. "A new twist for cosmic strings" [189], "Evading the zone of avoidance" [190], "Goings on between the stars" [191], "In search of the halo grail" [192] and "White dwarfs sing the blues" [193].

From my own papers, I'm particularly proud of getting "Boomerang returns unexpectedly" [194] accepted by the ApJ! The explanation was that the paper interpreted surprising results from the cosmic microwave background (CMB) experiment called "Boomerang". The paper "What have we already learned from the CMB?" [195] started with a quote from Monty Python's "Life of Brian", while the short title used in the page headings was "What has the CMB ever done for us?" Then "Cosmological Difficulties with Modified Newtonian Dynamics" [196] had the subtitle "La Fin du MOND?" Another good title is "Resolving the Radio Source Background: Deeper Understanding through Confusion" [197]. The only Planck Collaboration paper with a less-than-serious name was "Planck 2013 results. XXVII. Doppler boosting of the CMB: Eppur si muove" (named for the phrase said to have been spoken by Galileo after he was forced to recant) [198]. "Evaporating evidence for Hawking points in the CMB" [199] was changed by the journal to "Reevaluating evidence for Hawking points in the CMB". Lastly, a semi-serious overview of the history of ideas in the topic of galaxy formation was entitled "The evolution of galaxy formation" [200].

Does having a funny title actually help? Interestingly, a serious study of whether adding an amusing title increases the number of citations actually found a negative (although weak) effect [201]. A later study showed that papers with funny titles tend to get more downloads, but not more citations [202].

In addition to papers, conferences often have amusing titles. One of the best may be "TANGO in PARIS", which was "Testing Astroparticle with the New GeV/TeV Observations Positrons And electRons: Identifying the Sources", which took place in 2009 [203]. There was a conference in 2015 called "Mocking the Universe", but disappointingly it turned out to be about numerical simulations, rather than cosmological humour.

E. Abstracts

The paper "Chern numbers, quaternions, and Berry's phases in Fermi systems" by Avron, Sadun, Segert & Simon [204] has the following brief abstract: "Yes, but some parts are reasonably concrete". "Are Magnetic Dips Necessary for Prominence Formation?" by Karpen et al. [205] has the more perfunctory abstract "The short answer: No". However, the 2011 paper "Can apparent superluminal neutrino speeds be explained as a quantum weak measurement?" has the even briefer abstract "Probably not" [206], which likely has the record as the shortest example in physics.

For Max Tegmark's 1996 ApJ paper on pixelizing the sphere, the abstract was entirely in rhyming couplets [211]. Ben-David & Sattath wrote an abstract based on the fairytale "The Fisherman and His Wife" to introduce their 2017 paper on quantum cryptography [207]. A review of ideas concerning the origin of ultra-high energy cosmic rays, written by Jörg Rachen in 2019, has an abstract inspired by the original Communist Party manifesto of Marx & Engels [208]. Robert J. Nemiroff (co-founder of the APOD site) collected several items on his "Comedy of Science" page, including joke versions of an abstract, an erratum and an acknowledgements section [209].

A generator of fake abstracts (and titles) from high-energy physics is provided at the snarXiv website [210].

The site was developed by David Simmons-Duffin, who also created the "arXiv versus snarXiv" game. In computer science the "SCIgen" site allows you to create whole papers, including figures and references.

F. Introductions

In the reference work "Atomic Transition Probabilities: Hydrogen through Neon" [213], the fluorine section contains a statement that "since we expect that this introduction will share the fate of most introductions (namely be ignored) . . . we might as well give the few readers of this introduction some good advice:

If there is no other data source,
Use the Coulomb approximation, of course.
The results should certainly be fine
For any moderately or highly excited line."
One imagines that the inclusion of this verse made that particular introduction more widely read than most.

Again a book, rather than a paper, but there's a rather dark introduction in Goodstein's "States of Matter" [214]. Here are the opening lines of Chapter 1: "Ludwig Boltzmann, who spent much of his life studying statistical mechanics, died in 1906, by his own hand. Paul Ehrenfest, carrying on the work, died suddenly in 1933. Now it is our turn to study statistical mechanics."

For some topics the introductions of papers follow a fairly standard set of phrases. As an example, for studies of clusters of galaxies there is usually mention of how they are the largest virialised structures that exist. In one paper I wrote "All papers on clusters start with a statement about how they are the largest virialised structures in the Universe, and this paper is no exception." However, my co-authors vetoed this.

G. Contents

In the main body of his paper, Carlo Rovelli gave a discussion about the merits of loop quantum gravity versus string theory in the form of a Socratic dialogue [212]. Regarding the overall contents of a paper, I can't help mentioning "Chicken Chicken Chicken: Chicken Chicken" by Doug Zongker [215] – although it's not physics, it might as well be. In a paper on "Relative thermalization", the authors wrote "In order to keep the above expression only moderately foul . . . We shall spare you the details (but if you insist, we used . . . and sacrificed a black chicken)" [216]. Perhaps unsurprisingly the chicken part didn't make it into the published version (although the "foul" remained).

Although journals tend to insist on formal language, sometimes more frivolous-sounding statements sneak through the process [217]. A paper on galaxies observed with the *IRAS* satellite enumerated the main results in a summary, concluding with this point: "*IRAS* galaxies are all chocolate chip flavored rather than vanilla flavored as

heretofore supposed. This no doubt accounts for their diversity and appeal" [218]. In 1981 Fisher & Tully stated in the middle of their paper that "Readers with weak stomachs may wish to pass to the next subsection" [219].

In a paper on quantum entanglement in 2016 [220], Mahler et al. wrote "The particles in this article are photons, as was the case in Kocsis et al." then decided to extend this to "The particles in this article (Although 'the particles in this article' is in this particular article, consider 'the particles in an article' as part of an article. As any articulate party would know, the particles in 'the particles in an article' are 'the' and 'in,' whereas the articles in 'the particles in an article' are 'the' and 'an,' but the particular article in 'the particles in an article' is 'the.' 'p.s.' is all that is left when you take the 'article' out of 'particles.') are photons, as was the case in Kocsis et al." Unfortunately the editors removed this from the later electronic version of the journal [221].

Another component of a paper are the figures. There are obviously joke figures in joke papers, but there are also examples of plots in serious papers that are deliberately made to look funny [222].

A particular class of Feynmann diagrams are called "penguin diagrams" [223]. The name originated with John Ellis, and first appeared in a paper as a result of a bet over a game of darts with Melissa Franklin – if Ellis lost then he had to get the word "penguin" into his next paper [224]. He achieved this feat only after realising that the diagrams he had been studying looked a bit like penguins [225].

There are many instances where the contents of papers have typos that are unintentionally comedic. In cosmology it is surprisingly common to misspell "redshift" without the second-last letter; this is usually fixed by the journal's proof-readers (but not always). A 1990 paper about the ionized interstellar medium starts with a statement about the density of "free elections" [226]. And a prize announcement in 1999 for a certain astronomer who was an AGN expert referred to his work on "Anti Galactic Nuclei".

The lengths of papers vary dramatically. One of the shortest ever physics papers was "The Ratio of Proton and Electron Masses" by Friedrich Lenz in the Physical Review of 1951 [227]. The entire content (excluding the single reference) reads: "The most exact value at present for the ratio of proton to electron mass is 1816.12 ± 0.05. It may be of interest to note that this number coincides with $6\pi^5 = 1836.12$." Unfortunately, as the experimental precision improved, this numerical coincidence quickly ceased to be consistent with the data.

In 1981, Hatchett, Begelman & Sarazin ended their paper on accretion disks [228] with this summary: "Old equations describing disk flex would many a reader perplex, but we've fixed up some errors and banished the terrors: Our equation is *linear* (complex). For a number of torque contributions this allows analytic solutions. With equal facility we've shown the stability resulting from viscous diffusions."

H. Acronyms

There is a great tradition in physics and astronomy of attaching acronyms to the names of experiments, projects and other commonly used terms. Forced and unlovely arrangements of letters seem particularly common in astronomy, so that recalling your favourite examples has become a kind of sport [229]. There is some consensus that the winner of the "most awkward acronym" contest is 11HUGS, which is the "11 Mpc Halpha and Ultraviolet Galaxy Survey" [230].

Particle physicists also like to make up acronyms for experiments and for theoretical methods. GADZOOKS! is the "Gadolinium Antineutrino Detector Zealously Outperforming Old Kamiokande, Super!" (including the exclamation mark) [231]. In their "Chiral Trace Anomalies" paper of 1973 [232] Chanowitz & Ellis used the abbreviation "POT" for "partially zero trace", but the journal objected and suggested "PZT", with the compromise solution "P0T" appearing in the published version.

Physicists studying dark matter talk about weakly-interacting massive particles (WIMPs) [233] and massive compact-halo objects (MACHOs) [234]. The more jokey versions are to say that WIMP stands for "well it might be particles" and MACHO is "maybe astrophysics can help out".

In spectroscopy we have FASTCARS for "femtosecond adaptive spectroscopic techniques for coherent anti-Stokes Raman spectroscopy" [235]. There is also "frequency-resolved optical gratings" (FROG), as well as the more contrived French version "grating-eliminated no-nonsense observation of ultrafast incident laser light e-fields" (GRENOUILLE) [236]. The field of nuclear magnetic resonance has many light-hearted acronyms, such as CAMELSPIN, FLOPSY, HORROR and INEPT [237].

A "deficient acronym" might be one where medial letters are sometimes used to contrive the acronym, rather than just the letters at the starts of the words. Examples include: ANCHORS, "AN Archive of CHandra Observations of Regions of Star formation" [238]; FIREFLY, "Fitting IteRativEly For Likelihood analYsis" [239]; MISS MARPLE, "Method for Including Starspots and Systematics in the MARginalized Probability of a Lone Eclipse" [240]; PINOCCHIO, "PINpointing Orbit-Crossing Collapsed HIerarchial Objects" [241]; and SPIDERS, "SPectroscopic IDentification of ERosita Sources" [242].

There are multiple examples of nested acronyms, where part of the acronym is an acronym itself – this seems like "fun with acronyms!" The ATLAS experiment is an example, standing for "A Toroidal LHC ApparatuS" (which is also "deficient", as defined above). JIVE is the Joint Institute for VLBI in Europe, while JADES is the JWST Advanced Deep Extragalactic Survey.

I. Jargon

Physicists and astronomers are keen on using physics-ese and astronomy-ese in their papers. Sometimes the choices of new pieces of technical language involve a touch of humour. The names of fundamental particles provide examples, e.g. the neutrino (coined by Amaldi as a joke with Fermi) and the quark (coined by Gell-Mann, with some influence from James Joyce [243]). And then there are the supersymmetric particles listed in the Sparticle Data Book, e.g. the stop and the wino, plus hypothetical particles, such as the glueball, the strangelet and the WIMPzilla [244].

Astronomers were obviously exercising a particular kind of cruel humour when inventing the "magnitude" unit, deciding to call everything heavier than helium a "metal", coining the term "planetary nebula" and talking about both "HII clouds" and "H_2 clouds". Additionally there are jargon words that cause titters among non-specialists, e.g. the adjectives "degenerate", "eccentric", "inferior", "late", "mean" and "peculiar".

The term "quasar" was first used in 1964 by Hong-Yee Chiu as an abbreviated form of "quasi-stellar radio source" [245]. The same "-ar" suffix was adopted for "pulsar" by Bell and Hewish in 1968 and later extended by other researchers to "blazar", "magnetar", "collapsar" and "blitzar". Additional suggestions include "almucantar", as well as "alcázar", "balthazar", "bazaar", "hussar", "mizar", "guitar" and "ahoythar" [246].

"Boojums", patterns seen in superfluidity, were named after a nonsense word from Lewis Carroll. Fluid mechanics contains delightful invented words like "enstrophy" and "vortensity". There are also inadvertently amusing phrases in other branches of physics, such as Burgers' equation, Killing vectors and Love waves.

J. Units

Some bizarre units are used in the physical sciences, which could only have come about through a sense of humour. Nuclear and particle physicists use the "barn" ($10^{-28}\,\mathrm{m}^2$) for areas, from the phrase "couldn't hit the side of a barn", and the "shake" ($10\,\mathrm{ns}$) for times, from "two shakes of a lamb's tail". The "Dirac" is jokingly defined as a speaking rate of one word per hour [251], while the "smoot" is a quirky unit of length, invented as part of a student prank and named after Oliver Smoot, who fittingly later worked with organisations that developed standards. As a fairly unusual surname, it may not be surprising to learn that Oliver Smoot is a cousin of physicist George Smoot, who, along with John Mather, won the Nobel Prize in 2006 for work on the cosmic microwave background [252]. This was celebrated in a double-dactyl by mathematician Robin Pemantle:

Higgeldy Piggeldy
Berkeley cosmologist,
also a unit of

> *measurement, Smoot,*
> *found microscopical*
> *anisotropical*
> *noises which caused him his*
> *own horn to toot.*

When discussing distances on the scale of planetary systems, astronomers use a length with the imaginative name of the "astronomical unit". Some high-energy astrophysicists use "foe" to represent 10^{51} erg [253], also sometimes referred to as a "bethe". While the "hertz" is the standard unit for frequency (ν), there is no accepted standard for angular frequency ($\omega = 2\pi\nu$), but it has been suggested that the "avis" would be appropriate [254].

K. Footnotes

A 1975 paper by Zuckerman et al. on "Detection of interstellar trans-ethyl alcohol" has a "*Note added on proof*" that describes an estimate of the proof (in terms of alcohol content compared with water) for molecular clouds [255].

There are also surely many amusing footnotes that have sneaked into papers and passed into the published versions. There are probably so many that it isn't really practical to list examples.[1]

L. Acknowledgements

Numerous examples of jokes are buried in the acknowledgements of papers. Often these are sufficiently obscure to be understood only by the authors or their close colleagues. For example, there are instances of grateful thanks given to coffee shops or breweries disguised as the names of fellow scientists; one example is "T. Cobbold", for "Tolly Cobbold", a former brewery in England. The paper by Chodos & Rabin thanks their "assistant Beaker, for technical aid and wish him a speedy recovery" [126]. The Sokal paper in "Social Text" [105] thanks four individuals "for enjoyable discussions which have contributed greatly to this article"; they turn out to be relatives and children of friends, ranging in age between 2 and 6. There are also rumours of hidden marriage proposals, and at least one example of the blunt phrase "Will you marry me?" at the end of an acknowledgement [256].

A 1976 paper by Chastel, critiquing a speculative proposal for non-cosmological redshifts, says that the conclusions are being left to the reader and acknowledges that "I wrote this paper for money" [257]. In 2004 the lead author of the Sana et al. paper thanks "the University of Liège for taking care of his integration and for *generously* providing heat and electricity" [258]. In their 2013 paper

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[1] And I can't think of any right now.

"Collective Motion of Humans in Mosh and Circle Pits at Heavy Metal Concerts" [259], the authors make clear that their "fieldwork was independently funded". Authors occasionally also feel the need to *un*acknowledge individuals [260].

M. References

Spoof papers often contain bogus references. In the "Candlestickmaker" paper [91] all the references are fake, but the journals themselves are real, e.g. "Trans. N.-E. Cst. Inst. Engrs. Shipb." (the Transactions of the North-East Coast Institution of Engineers and Shipbuilders) or "Zentralbl. Bakt." (Zentralblatt für Bakteriologie). In 1973 Chanowitz & Ellis [232] included a note about "Dylan's version of Weinberg's theorem", citing a paper by Zimmerman.

When you submit a paper, it's common to receive complaints from others for not including particular citations in your reference list. In fact the convention involves three distinct steps and so this is the form letter that I've prepared for these eventualities:

Dear Dr. [name here]

Thank you for your interest in our paper on [title], and for noting that we omitted to cite your own work on a related topic.

However, we should point out that there is a well accepted convention that is normally followed here, involving three statements that should be made by the complainant in all such cases:

(1) I enjoyed your paper;

(2) I noticed a minor error in one of the equations;

(3) by the way, you didn't cite me.

Since you omitted the first two of these steps, thus violating the established convention, then we will be ignoring your request.

Sincerely,

*   Douglas Scott [on behalf of the co-authors]*

N. Refereeing

A last step before a paper is published is the tricky business of refereeing. "A note on the game of refereeing" was written by statisticians in 1968 [247], but applies equally well to physics. The basic point of the game is that authors get more points for publishing pointless papers, while referees get more points for blocking the publication of worthwhile papers. Several specific tactics are given, the most effective one for the referee being to simply ignore all correspondence and delay responding as long as possible. When Virginia Trimble was an editor at the Astrophysical Journal, she would tell people that astronomers were separated into two categories depending on whether they were fast or slow at refereeing, and that authors would have their papers sent only to referees in the same category!

An example of the refereeing process in physics comes from a paper submitted by Krauss in 1986. The article itself was a spoof of attempts to re-evaluate old data in order to investigate Newtonian gravity. It was rejected by Physical Review Letters, but the most amusing part was that the editors (George Basbas and perhaps others) decided to respond in kind with six fake referee reports [248].

O.   Postmortems

After publication comes assessment by the scientific community. The literature is full of strongly worded refutations and attacks – but are there any genuinely humorously worded rebuttals out there? Let me pick one example, which came in the form of criticism of some of the claims of Immanuel Velikovsky, who in the 1950s to 1970s wrote pseudohistory and had sensational theories about catastrophic encounters between the Earth and other planets. One of the world's leading experts on the ancient cuneiform script, Abraham Sachs, said [249]: "I have read carefully Dr. Velikovsky's 'Worlds in Collision' . . . especially carefully those sections – often quite lengthy – which deal with evidence from cuneiform texts, and I have checked all the sources mentioned in the footnotes. I am happy to report that the bibliographical references in the footnotes are cited with an amazingly high accuracy. But having said this, I regret to have to add that I have reported everything that I can honestly find on the credit side of the ledger. On the negative side, in the time available, I cannot even list all the errors, misunderstandings, and false conclusions".

For books there is the extra step of published reviews, which can certainly be very harsh at times. A more light-hearted case appeared in Nature, in the form of a review (written by Orlando Belpaese) of the book "The Bohr-Einstein Transcripts" by T.J. Gschäftlhuber. The review describes an early answerphone technology that had been gifted to Einstein and how newly discovered recordings from the device included heated conversations between him and Bohr, among more personal snippets. This appeared in the issue of 1st April 1993 [250].

XXII.   BUT SERIOUSLY

This review has contained many examples of frivolous contributions to physics and astronomy. But is there a point to all of this? The Monty Python comedy troupe liked to switch topics by using the phrase "now for something completely different". It might seem natural to make such a statement in order to shift from talking about science to talking about humour. However, I'd like to try to convince you that these topics *aren't* as different as they might appear; moreover, by discussing the relationships between them, we might come to see that these whimsical science contributions actually have some real value.

Pointing out connections between science and humour isn't new [261].   We've already mentioned that R.V. Jones wrote about the parallels between the two domains. In his book "The Act of Creation" [262], novelist and philosopher Arthur Koestler drew a parallel between science and humour, both involving seeing unexpected connections, which he called "bisociation", incorporating the merging of two frames of reference [263].

Robert P. Crease, philosopher and historian of science (writing in "Physics World" [264]), said "But in a field that uses imagination and play to disclose new truths about nature . . . the ability to practice both physics and humour are thus intimately connected – 'entangled', you might say – inseparably bound up together in a common and deep-lying origin . . . only misguided simple pictures of science as a purely logical process relegate humour to the exterior of the scientific enterprise."

In 1969 French academic and journalist Robert Escarpit [12] expressed the view that a good scientist must have a sense of humour in order to question beliefs and entertain new concepts and alternative explanations: "only a sense of humour, then, can guarantee that he remains intellectually open".

James McConnell, founder of the Worm Runner's Digest, in the article "Confessions of a scientific humorist" [12] wrote that "Humour has no place in Science (capital 'S')"; he attempted to define humour, saying that "much of it seems a sudden or unexpected departure from the norm, and that if you don't know what the norm is, the humour is usually lost on you", so that specialized science wit requires that the reader brings a lot of background knowledge. He ends with the declaration: "It is my strong belief that if we can get the younger generation to the point of being able to laugh at itself, then and only then can we hope to turn Science back into science."

The humour described herein consists mostly of in-jokes, which can only be fully appreciated by people with years of education in the physical sciences [265]. The nature of humour has been debated since the time of the ancient philosophers and there have been many attempts to explain it. For example, ethologist Konrad Lorenz [266] said that laughter is a nervous release from a state of tension. At the crudest level, some things are funny (like slapstick, for example) through a feeling of relief (and superiority) over the misfortune of someone else. But science paper parodies are *not* like this – the humour doesn't come from enjoying the suffering of a particular other person, but from feeling superior to *everyone* outside the group who understands the joke! On the other hand, these in-jokes can serve a positive role in building collegiality. The old songs from the Cavendish Laboratory are good examples – they were complimentary about the senior scientists and celebrated physics, thereby engendering a sense of community among the students. At the loftiest end of the spectrum, this then is the goal of science parody.

As discussed at the beginning of this review, the deepest connection between physics and humour is that both involve congruities (analogies) and incongruities (discordances). Isaac Asimov liked to stress that the most important phrase in science is not "eureka!" but "that's funny!" [267], i.e. it's the things that don't quite fit or fit in surprising ways that lead to forward leaps. Stumbling across congruity is sometimes what makes the biggest breakthroughs in physics – the moments of greatest epiphany are often where one suddenly realises that some phenomenon is understandable through ideas that at first seem completely unrelated. Examples include: seeing the same equations for AC circuits as for springs; the unification of electricity and magnetism yielding photons; interpreting gravity through pure geometry; the connection between entropy and information; the thermodynamics of black holes; seeing critical phenomena in quite different physical systems; and more recently the AdS/CFT correspondence. Each reader probably has their own favourite examples. The point is that these moments of connection have a lot in common with the realisation that something is funny.

So how does one find these breakthroughs in physical understanding? They are surely enabled by thinking "outside the box", imagining different kinds of explanation, including those that might at first seem ridiculous. I would claim that a similar thought process goes on when physicists make important new connections as is happening in the minds of great comedians.

Let me add one other further thought: the world could use more humour! To employ a cosmological analogy, the Universe is dominated by a mysterious substance usually referred to as "dark energy", but as pointed out many times, this is a bit of a misnomer. The name doesn't emphasize the bizarre equation of state, which involves a negative pressure, leading to acceleration in the scale factor of the Universe. The name is also obviously a bit "dark", emphasising grimness, obscurity and gloom! An alternative suggestion is to call it "levity" [268]. Apart from being a more appropriate name, I like the idea that the most important constituent of the Cosmos is levity.

XXIII.   CONCLUSIONS

There are no conclusions [269][270][271][272][273].

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[1] And the other t-shirt that says "Astronomy is out of this world, and looking up, and also amusing".

[2] Jones R.V., June 1957, Bull. Inst. Phys., p. 193.

[3] Jones describes Carl Bosch as a German physicist and graduate student at this time; however, he has been compounded with an older man of the same name who won the Nobel Prize for Chemistry in 1931. Perhaps this was a deliberate joke by Jones?

[4] Gabora L., Kitto K., 2017, Front. Phys., 4, 53 [arXiv:1703.04647].

[5] Berge M., 2017, Res. Sci. Educ., 47, 427–450.

[6] Pinto B., Marçal D., Vaz S.G., 2013, Public Understanding of Science, 24 (7), 776–793.

[7] Fisher M.S., 1998, Sci. Educ., 81, 703–713.

[8] Not that I would suggest for a minute that physicists are more conceited and arrogant than the general population.

[9] Weber R.L., 1973, "A Random Walk in Science", Institute of Physics Publishing, Bristol.

[10] Weber R.L., 1982, "More Random Walks in Science", Institute of Physics Publishing, Bristol.

[11] "Physicists continue to laugh", 1968, MIR Publishing House, Moscow.

[12] Impact on Science and Society, July–Sept 1969, XIX (3), 223–301.

[13] Asimov I., Jeppson J.O. (eds.), 1982, "Laughing Space", Houghton Mifflin Harcourt, Boston.

[14] Devine B., Cohen J.E., 1992, "Absolute Zero Gravity", Simon & Schuster, New York.

[15] Simanek D.E., Holden J., 2001, "Science Askew: A Light-hearted Look at the Scientific World", CRC Press.

[16] Wright G., 2017, "Academia Obscura", Unbound.

[17] Witkowski J.A., 1995, Trends Biochem. Sci., 20, 163–168; 1996, 21, 156–160; 1997, 22, 142–146; 2001, 26 (12), 747–752.

[18] And if I'd read that book *before* starting out, then maybe I wouldn't have needed to bother with writing this review!

[19] May A., 2019, "Fake Physics: Spoofs, Hoaxes and Fictitious Science", Springer Nature.

[20] "Post-Prandial Proceedings of the Cavendish Society", 6th edition, Bowes and Bowes, Cambridge; Satterly J., 1939, Amer. Phys. Teachers, 7, 179–185, 244–248.

[21] J. Jocular Phys., October 1935, Institute for Theoretical Physics, Vol. 1, CERN-ARCH-PMC-08-398; October 1955, Vol. 3, CERN-ARCH-PMC-08-435.

[22] Scherr G.H. (ed.), 1989, "The Best of the Journal of Irreproducible Results", Workman Pub. Co., New York; Sperling N., 2008, "This Book Warps Space and Time: Selections from The Journal of Irreproducible Results", Andrews McMeel Publishing, Kansas City.

[23] https://www.improbable.com

[24] McConnell J.V. (ed.), 1965, "The Worm Re-Turns: The Best from the Worm Runner's Digest", Prentice-Hall, New Jersey.

[25] Although sometimes the satire in "The Onion" is amusing, the science stories are often laughing *at* science rather than *with* science, e.g. "Super Monkey Collider Loses Funding" and "Astronomers Discover Planet Identical To Earth With Orbital Space Mirror".

[26] Stickland D.J., 2003, in "Organizations and Strategies in Astronomy 4", ed. Heck A., Kluwer, pp. 205–220.

[27] Carsdem D.D., 1974, Observatory, 94, 5P–9P.

[28] Moore E.G., 1977, Observatory, 97, 2P–4P.

[29] Trimble V., Sciatti H. III, 2000, Observatory, 120, 7P–10P; how much of this will seem prescient in 2049?

[30] https://plato.stanford.edu/entries/theophrastus

[31] Wood Brown J., 1897, "An Enquiry into The Life and Legend of Michael Scot", David Douglas, Edinburgh.

[32] Galilei G., 1632, "Dialogo sopra i due massimi sistemi del mondo", Giovanni Batista Landini, Florence.

[33] Swift J., 1986, "Gulliver's Travels", Oxford World Classic (originally published in 1726).

[34] Swift J., 1891, "The Battle of the Books and other Short Pieces", Cassell & Company Ltd., London, pp. 53–71.

[35] Chapman A., 2004, "England's Leonardo: Robert Hooke and the Seventeenth-Century Scientific Revolution, Institute of Physics Publishing.

[36] Howk N., 1935, "Hook versus Hooke: the caustic wit of Isaac Newton", Malum Press, Grantham; written by one of Hooke's descendants.

[37] When asked what he uttered when he accidentally electrocuted himself when trying to kill a turkey using a series of Leyden jars, he replied "I didn't say anything, I was too shocked".

[38] Anonymous, 1839, Annalen der Chemie und Pharmacie, 29, 100–104.

[39] Windler S.C.H., 1840, Annalen der Chemie und Pharmacie, 33, 308.

[40] de Mayo P., Stoessl A., Usselman M.C., 1990, J. Chem. Educ., 67 (7), 552–553.

[41] Findig F.W., 1886, Berichte der Deutschen Chemischen Gesellschaft, 19, 3535–3537.

[42] Campbell L., Garnett W., 1882, "The Life of James Clerk Maxwell", MacMillan and Co., London, p. 331.

[43] Dirac P.A.M., 1939, Math. Proc. Cambridge Phil. Soc., 35 (3), 416–418.

[44] One of these tends to raise giggles from undergraduates when they first come across this notation (hint: it's not "ket").

[45] This was for "Protein Synthesis by DNA Molecules", submitted to Proc. N.A.S., but later published by the Royal Danish Academy without Mr. Tompkins; 1954, Kgl. Dansk. Videnskab. Selskab. Biol. Medd., 22, 1–13.

[46] Hecht A., Hollander J., 1967, "Jiggery-Pokery: A Compendium of Double Dactyls", Atheneum, New York.

[47] Ganger D., 1929, "Loren(t)z, two great physicists in one", Onzin-Nep, Leiden and Copenhagen.

[48] Marsh D.M.C., Marsh J.E.D., 2019, arXiv:1903.12643.

[49] It may be worth pointing out explicitly that, like all good lampoons, this paper mocks an idea rather than an individual.

[50] Beck G., Bethe H., Riezler W., 1931, Die Naturwissenschaften, 19, 39; "Selected Works of Hans A. Bethe", 1997, World Scientific, River Edge, N.J., pp. 185–186.

[51] The magazine "Punch" referred to Eddington as "Sir Adding-one" after this augmentation of his calculation.

[52] Presumably the ambiguity of language works just as well in English as it did in the original German.

[53] Admittedly this is probably not the funniest prank of all time, but it was early days for April Fools tricks.

[54] As predicted by Jonathan Swift!

[55] Surely a joke, right?

[56] https://apod.nasa.gov/apod/ap050401.html

[57] Woolner K.A., 1978, Chem. 13 News, April 1978, pp.1–3; Chem. 13 News, No. 178, September 1988, pp. 45–46.

[58] See https://en.wikipedia.org/wiki/Claude_Emile_Jean-Baptiste_Litre; amusingly the French wikipedia article is considerably longer than the English one.

[59] Simplicius, 21 July 1967, in "N.P.L. News", 207, pp. 10–11; reprinted in Appl. Optics, 1968, 7 (4), 625.

[60] Later revealed to be physicist James Dyson; several other pieces were published by him in the period 1967–1978.

[61] Lindsay Col. D., Ketchum Capt. J., 1962, J. Irrepr. Res., 10, 43.

[62] Can it be a coincidence that James Ketchum is the same name as a U.S. Army doctor who, during the 1960s, led a series of studies of the effects of hallucinogenic drugs on military "volunteers"?

[63] Klein T., 1996, Austral. New Zeal. Physicist, 33 (6), 109–112.

[64] Barnes J.W., O'Brien D.P., Fortney J.J., Hurford T.A., 2002, arXiv:astro-ph/0204013.

[65] Charfman J.J., et al., 2002, arXiv:astro-ph/0204041.

[66] Scott D., Frolop A., 2006, arXiv:astro-ph/0604011.

[67] Scott D., Narimani A., Page D.N., 2013, Phys. Canada, 70 (4), 258–264 [arXiv:1309.2381].

[68] Scott D., Frolop A., 2007, arXiv:astro-ph/0703783.

[69] Scott D., Frolop A., 2008, arXiv:0803.4378.

[70] Scott D., Frolop A., 2014, arXiv:1403.8145.

[71] Ali Frolop, Ali and Frolov, 2015, arXiv:1504.00108.

[72] Frolop A., Scott D., 2016, arXiv:1603.09703.

[73] Scott D., Frolop A., 2019, arXiv:1903.12412.

[74] Scott D., Frolop A., 2020, arXiv:2003.13981.

[75] Campbell L., Garnett W., 1882, "The Life of James Clerk Maxwell", MacMillan and Co., London, p. 27.

[76] There are variants in other countries also. In France one shouts "Poisson d'avril" after successfully pranking someone; no one knows the origin of this phrase, but it has been suggested to be named after the famous French mathematician and physicist Siméon Poisson, who was a noted jokester.

[77] Campbell L., Garnett W., 1882, "The Life of James Clerk Maxwell", MacMillan and Co., London, p. 343.

[78] Additionally, at school Maxwell was known as "Daftie", essentially because of his strong rural accent.

[79] Maxwell J.C., 1862, Phil. Mag., XXIII, 12.

[80] Herschel W., 1780, Phil. Trans. R. Soc., Vol. 70, "Astronomical Observations Relating to the Mountains of the Moon", p. 508.

[81] Herschel W., 1795, Phil. Trans. R. Soc., Vol. 85, "On the Nature and Construction of the Sun and Fixed Stars", p. 66.

[82] See "The Scientific Papers of Sir William Herschel", 2013, Cambridge University Press; Herschel was one of the pre-eminent astronomers of his day, being Court Astronomer and Fellow of the Royal Society.

[83] Said to be reprinted from the Edinburgh Journal of Science, which does not in fact exist. It may be significant that these discussions of the abundance of life appeared in "The Sun".

[84] See Goodman M., 2008, "The Remarkable True Account of Hoaxers, Showmen, Dueling Journalists, and Lunar Man-Bats in Nineteenth-Century New York", Basic Books, New York.

[85] von Paula Gruithuisen F., 1824, "Entdeckung vieler deutlichen Spuren der Mondbewohner, besonders eines colassalen Kusgebaudes derselben", Archiv fur die desammte Naturlehre, Nurenberg.

[86] Dick T., 1837, "Celestial scenery; or, The wonders of the planetary system displayed; illustrating the perfections of deity and a plurality of worlds", Ward, London.

[87] It is probably unnecessary to point out that bizarre beliefs related to the Moon exist in the present century as

well, with Moon-landing conspiracy theories refusing to disappear. A clever mockumentary that aired in France in 2002, "Opération Lune", parodied these conspiracy theories and hence was a new Moon hoax, which has been taken as truth by many conspiracists.

[88] Pétard H., 1938, Am. Math. Monthly, 45 (7), 446–447.

[89] In other words, no animals were harmed in the making of this paper.

[90] Pieronkiewicz B., 2018, Math. Intelligencer, 40 (2), 45–49.

[91] Published later as Candlestickmaker S., 1972, Quarterly J. Royal Astron. Soc., 13, 63.

[92] See "Sykes, John Bradbury (1929–1993), physicist, lexicographer, and crossword solver" in the Oxford Dictionary of National Biography.

[93] Chandrasekhar S., 1956, Proc. R. Soc. London, Ser. A, 237, 476–484.

[94] "Chandra and his students at Yerkes Observatory", Osterbrock D.E., 1996, J. Astrophys. Astron., 17, 233–268.

[95] Krum P., Eshkin L., 1944, J. Chem. Solub., 27, 109–114, "Concerning the Anomalous Solubility of Thiotimoline"; Krum P., Eshkin L., Nile O., 1945, Ann. Synth. Chem., 115, 1122–1145 and 1208–1215, "Structure of Thiotimoline. Parts I and II"; Asimov I., 1948, Astound. Sci., 41 (1), 120–125, "The Endochronic Properties of Resublimated Thiotimoline".

[96] Asimov I, 1953, Astound. Sci., 52 (4), 107–116.

[97] Asimov I, 1960, Analog Sci. Fact Fict., 66 (2), 155–162.

[98] Asimov I, 1973, "Astounding", Random House, pp. 39–48.

[99] http://www.princeton.edu/~pkrugman/interstellar.pdf; later published in Econ. Inq, 2010, 48 (4), 1119–1123.

[100] It may be interesting to point out that GR *has been* used as an analogy for aspects of the law (rather than trade) in "The Curvature of Constitutional Space: What Lawyers Can Learn from Modern Physics", Tribe L.H., 1989, Harvard Law Review, 103 (1), 1–39 (with a young Barack Obama being among those thanked for research assistance).

[101] Chodorow A., 2009, Tax Notes, Sept. 7, 1033–1036.

[102] Haug E.G., 2004, Wilmott Magazine, 1–15; the article is "Space-time Finance" and it eems ironic that it was published in what may be the world's highest subscription-price magazine.

[103] Gribbin J., Plagemann S., 1974, "The Jupiter Effect", Walker & Co., New York.

[104] http://hoaxes.org/af_database/permalink/planetary_alignment_decreases_gravity/

[105] Sokal A.D., 1996, Social Text, Iss. 46/47, 217–252; https://physics.nyu.edu/faculty/sokal/transgress_v2/transgress_v2_singlefile.html

[106] Gross P.G., Levitt N., 1994, "Higher Superstition: The Academic Left and Its Quarrels with Science", Johns Hopkins University Press.

[107] Much of the content of the article exists in a lengthy series of footnotes. These juxtapose quotations from postmodernist literature with Sokal's own technical-jargon-laden comments about the future of modern physics.

[108] The editors of Social Text were facetiously awarded the Ig Nobel Prize for literature in 1996.

[109] Sokal A., 2008, "Beyond the Hoax", Oxford University Press.

[110] Beeman J., 1943, Bull. Bureau Chem. Investig., New York State Police, Dec. 1943, 8; 1944, The Analyst, 69, 97–98.

[111] McGeorge L., Kin A., 2017, Austin J. Pharm. Therap., 5 (2), 1–3.

[112] Paris T., Kim H., Torres B., Ocampa K., Janeway K., Zimmerman L., 2017, American Res. J. Biosci., 3 (1), 1–3.

[113] This is sometimes referred to as the worst episode of Star Trek Voyager, the plot involving an attempt to reach Warp 10, leading to crew members reverting to a primitive amphibian state.

[114] Boslough M. [as "April Holiday"], New Mexicans for Science and Reason Reports, April 1998.

[115] Cabrera B., 1982, PRL, 48, 3178.

[116] Siegel E., 2019, "The Enduring Mystery Of Detecting The Universe's Only Magnetic Monopole", Forbes Magazine, 7 February.

[117] Coleman S., 1983, "The magnetic monopole fifty years later", in "Proc. 19th Course of the Int. School of Subnuclear Physics, held 1981 in Erice", Plenum Press, New York, p. 24.

[118] Zipkin H.J., 1856, Jour. Irrep. Res., 3, 6

[119] Schreiber E., Anderson O.L., 1970, Science, 168, 1579.

[120] Wright D.A., 1971, Worm Runn. Dig., 12, 95.

[121] De Rújula A., Ellis J., Petronzio R., Preparata G., Scott W., 1979, Ref. TH.2778-CERN.

[122] Ellis J.R., Gaillard M.K., Nanopoulos D.V., Sikivie P., 1980; published in 1981 in Nucl. Phys. B, 182, 529–545, with the title changed to "Can one test technicolour?"

[123] "Doctor" Wisecracker, 1980, Cambridge Preprint.

[124] Wow-mann G., 1984, Venice Beach, California, the Universe.

[125] Berkowitz E., Donnelly W., Zhu S., 2019, arXiv:1903.12201.

[126] Chodos A., Rabin J., 1983, Yale preprint, YTP 83–41.

[127] Lykken J.D., 1989, Print-89-0295, U.C., Santa Cruz.

[128] http://insti.physics.sunysb.edu/~siegel/parodies/

[129] Gates, V., Kangaroo E., Roachcock, M., Gall W.C., 1985, Physica D, 15, 289–293.

[130] Schulman E.R., 1999, Ann. Improb. Res., 5 (3), 10.

[131] Archived through the Wayback Machine in 2013 at http://members.verizon.net/~vze3fs8i/air/index.html

[132] Schulman E.R., 1996, Ann. Improb. Res., 2 (5), 8.

[133] Schulman E.R., Cox C.V., Schulman E.A., 1999, Ann. Improb. Res., 5 (6), 9.

[134] Cox C.V., Schulman E.R. Schulman E.A., 1999, Ann. Improb. Res., 5 (6), 10.

[135] Schulman E.R., Null Hypothesis, 30 April 2007.

[136] Gottbrath C., Bailin J., Meakin C., Thompson T., Charfman J.J., 1999, arXiv:astro-ph/9912202.

[137] Aerts D., Aerts S., Broekaert J., Gabora L., 2000, Found. Phys., 30, 1387–1414 [arXiv:quant-ph/0007044].

[138] https://lockhaven.edu/~dsimanek/cutting/cutting.htm

[139] https://qwantz.com/fanart/superman.pdf

[140] https://qwantz.com/fanart/spiderman.pdf

[141] Tippett B., 2012, arXiv:1210.8144.

[142] Tippett B., Tsang D., 2013, arXiv:1310.7983; arXiv:1310.7985.

[143] Shalizi C.R., Tozier W.A., 1999 [arXiv:adaporg/9910002].

[144] This story was in fact garbled, but has a germ of truth! It was inspired by astronomer Theodor Schmidt-Kaler presenting results of his student J. Isserstedt in the mid-1960s. By 1970 about 1000 rings of stars had apparently been found (Isserstedt J., 1968, Veröff. Bochum.,

No. 1, 1), with a claim that their minor axes were always close to 7 pc in physical size, and hence they could be used to trace the spiral structure of the Milky Way. Not taken seriously by many at the time, the rings were later proved to be unrelated patterns of stars, as also found in random distributions (e.g. Paunzen E., et al., 2018, Astron. Nachr., 339, 672–679).

[145] Translation in Trimmer J.D., 1980, Proc. Amer. Phil. Soc., 124 (5), 323–338.

[146] This is probably why most physicists find essentially none of the popular jokes involving Schrödinger's cat to be funny!

[147] Kragh H., 2013, Astron. & Geophys., 54 (2), 28–30 [arXiv:1301.0219].

[148] Gamow is also the person who stated that Einstein had called the cosmological constant his "biggest blunder". Whether Gamow's sense of humour had an influence here has been debated; see O'Raifeartaigh & Mitton, Phys. Persp., 20 (4), 318–341 [arXiv:1804.06768]. And did this statement backfire relative to either Einstein's or Gamow's original intent?

[149] As other examples: the word "scientist" was first used facetiously in 1834 by science historian William Whewell; and there's some evidence that "black hole" was coined as a joke by Robert Dicke in about 1960.

[150] Apologies to those old enough to remember these remote periods, but I'm recounting this history for those who can't imagine a time without the arXiv!

[151] This is usually anonymous, but presumably someone wrote the first version (unless it came directly from the Acme Corporation); "O'Donnell's laws of cartoon motion" were published in Esquire magazine in June 1980, written by Mark O'Donnell; see also the 1994 version in IEEE Institute, 18 (7), 12.

[152] E.g. https://jcdverha.home.xs4all.nl/scijokes/-index.html

[153] Calandra A., 1961, "The Teaching of Elementary Science and Mathematics", Washington University Press, St. Louis; another version appeared as "Angels on the head of a Pin. A Modern Parable" in The Saturday Review in 1968 (21st December, p. 60), bringing it to a wider audience (although the reasons for the choice of title are obscure).

[154] 1963, Proc. Chem. Soc., p. 8; reprinted in Appl. Optics, 8 (2), 273.

[155] Pasachoff J.M., Weart S.R., 1973, J. Irrep. Results; Theology Today, 1974, 31 (2), 161; reprinted in "Contemporary Astronomy", 1977, Saunders College Publishing, Philadelphia and in "More Random Walks in Science".

[156] Alpher H., Bethe H., Gamow G., 1948, PRL, 73, 803.

[157] It's important to point out that Bethe knew about his name being added, and gave his approval. He also served as external examiner for Alpher's Ph.D. thesis.

[158] Gamow also jokingly wrote that their other collaborator, Robert Herman, "stubbornly refuses to change his name to Delter".

[159] https://www.aps.org/publications/apsnews/200804/physicshistory.cfm

[160] Apparently hundreds of people, including many journalists, attended Alpher's Ph.D. defence!

[161] Greenberg O.W., Greenberger D.M., Greenbergest T.V., arXiv:hep-ph/9306225; apparently "T.V." stood for "The Very".

[162] Zuntz J., Zibin J.P., Zunckel C., Zwart J., 2011, arXiv:1103.6262; along with the message "We apologise for the inconvenience", "The look of disapproval" may be the most amusing pattern discovered.

[163] Zuntz J., Zlosnik T.G., Zunckel C., Zwart J.T.L., 2010, arXiv:1003.6064.

[164] Goodman A., Goodman J., Goodman L., Goodman S., 2014, Econ. Inq., 53 (2), 1392–1395.

[165] Barcons X., Fabian A.C., 1989, Mon. Not. Royal Astron. Soc., 237, 119–127.

[166] Quick A., Brown V., Fox S., Hollins P., 1989, Surface Sci., 221, 48–60.

[167] Knox W.H., Knox R.S., Hoose J.F., Zare R.N., April 1990, Optics & Photonics News, pp. 44–45.

[168] Bax A., Max D., Zax D., 1992, J. Am. Chem. Soc., 114, 6923–6925.

[169] D'Eath P.D., Payne, 1992, Phys. Rev., D46, 658; 1992, Phys. Rev., D46, 675; 1992, Phys. Rev., D46, 694.

[170] Breitenlohner P., Kabelschacht A., 1979, Nucl. Phys. B, 148, 96–106.

[171] Bott-Bodenhausen M., Holl I., Kabelschacht A., Karle A., Lorenz E., et al., 1991, MPI-PhE/91-01; Lorenz E., Bott-Bodenhausen M., Holl I., Kabelschacht A., Karle A., 1992, Nucl. Instrum. Meth. A, 315, 236–251; Dittmaier S., Kabelschacht A., Kasprzik T., 2008, Nucl. Phys. B, 800, 146–189.

[172] Charfman J.J., 1980, I.A.U. Symp. No. 87, Reidel, Dordrecht, pp. 645–648; completed despite the advice and assistance of J.H. Black, P.C. Frisch, B.L. Lutz, and P.L. Smith et al.

[173] It does sound vaguely rude though. Other fake authors have been invented that sound even ruder in either English or a different language; we leave these for curious readers to investigate for themselves.

[174] Gardiner C.W., Anglin J.R., Fudge T.I.A., 2002, J. Phys. B, 35 (6), 1555–1582.

[175] Hetherington J.H., Willard F.D.C., 1975, PRL, 35, 1442.

[176] Matzinger P., Mirkwood G., 1978, J. Exp. Med., 148 (1), 84–92.

[177] Willard F.D.C., 1980, La Recherche, 114.

[178] https://www.nobelprize.org/prizes/physics/2010/geim/facts/

[179] https://improbable.com/ig/2000/ig-2000-details.html; Geim won for magnetically levitating a frog, with this prize pre-dating his Nobel by a decade.

[180] Geim A.K., ter Tisha H.A.M.S., 2001, Physica B, 294, 736.

[181] Aardvark A., 1992, RNA Processing: Programe and Abstracts, p. 16; Aardvark A., et al., 1993, Semicond. Sci. Tech., 8 (1S), 380–385; Aardvark A., Mason N.J., Walker P.J., 1997, Prog. Crystal Growth Char. Mat., 35, 207–241; Podladchikov Y., Connolly J., Powell P., Aardvark A., 2015, Geophys. Res. Abs., 17, EGU2015-13547-2.

[182] This might be called a "moose" in North America, where an "elk" is a different thing entirely, also known as a "wapiti". The different names for these animals can be confusing. Fortunately "Tycho Brahe" has the same name everywhere.

[183] Aad G., et al., 205, Phys. Rev. Lett., 114, 191803.

[184] Here's one example: I L., 1985, J. Appl. Phys., 58, 2981.

[185] A study was made of literary and other allusions in the titles of biomedical papers, but no systematic study in

the physical sciences exists (yet): Goodman N.W., 2005, British Med. J., 331, 1540–1542.

[186] Fowler W.A., Greenstein J.L., Hoyle F., 1961, Am. J. Phys., 29 (7), 393–403.

[187] Eriksen H.K., Kristiansen J.R., Langangen O., Wehus I.K., 2009, Am. J. Phys., 77, 224 [arXiv:0809.0209].

[188] Although the papers about the proposed missile defence system tend to be rather less funny.

[189] Hogan C.J., 1987, Nature, 325, 300.

[190] Trimble V., 1987, Nature, 330, 212.

[191] Trimble V., 1989, Nature, 339, 664–665.

[192] Hogan C.J., 1993, Nature, 365, 602–603.

[193] Richer H.B., 1998, Nature, 394, 825–826.

[194] White M., Pierpaoli E., Scott D., 2000, Astrophys. J., 545, 1–5 [arXiv:astro-ph/0004385].

[195] Lawrence C.R., Scott D., White M., 1999, Publ. Astron. Soc. Pacific, 111, 525–531.

[196] Scott D., White M., Cohn J.D., Pierpaoli E., 2001, arXiv:astro-ph/0104435.

[197] Condon J.J., Cotton W.D., Fomalont E.B., Kellermann K.I., Miller N., Perley R.A., Scott D., Vernstrom T., Wall J.V., 2012, 758, 1, 23 [arXiv:1207.2439].

[198] Planck Collaboration XXVII, 2014, Astron. Astrophys., 571, A27 [arXiv:1303.5087].

[199] Jow D.L., Scott D., 2020, J. Cosmol. Astropart. Phys., 03, 021 [arXiv:1909.09672].

[200] Scott D., 2011, Astron. Geophys., 52 (6), 31–33 [arXiv:1112.0285].

[201] Sagi I., Yechiam E., 2008, J. Inform. Sci., 34, 680.

[202] Subotić S., Mukherjee B., 2014, J. Inform. Sci., 40, 115.

[203] Brun P., Bertone G., Cirelli M., Moulin E., 2009, in Proc. Ann. Meeting French Soc. Astron. Astrophys., eds. Heydari-Malayeri M., Reylé C., Samadi R., p. 135 [arXiv:1001.5408]; guess where it was held?

[204] Avron J.E., Sadun L., Segert J., Simon B., 1989, Commun. Math. Phys., 124, 595–627.

[205] Karpen J.T., Antiochos S.K., Hohensee M., Klimchuk J.A., MacNeice P.J., 2001, Astrophys. J., 553, L85–L88.

[206] Berry M.V., Brunner N., Popescu S., Shulka P., 2011, J.Phys.A, 44, 492001.

[207] Ben-David S., Sattath O., 2017, arXiv:1609.09047.

[208] Rachen J.P., 2019, in 36th Int. Cosmic Ray Conf., ID397 [arXiv:1909.00356].

[209] See http://apod.pl/htmltest/rjn_com.html in archived versions.

[210] snarxiv.org

[211] Tegmark M., 1996, Astrophys. J., 470 L81–L84 [arXiv:astro-ph/9610094].

[212] Rovelli C., 2003, Int. J. Mod. Phys. D, 09, 1509 [arXiv:hep-th/0310077].

[213] Wiese, Smith & Glennon, 1966, "Atomic Transition Probabilities: Hydrogen through Neon", Nat. Stand. Ref. Data Ser., National Bureau of Standards 4; admittedly this is a book, not a paper – see p. 117.

[214] Goodstein D.L., 1975, "States of matter", Prentice-Hall, New Jersey.

[215] Zongker D., 2006, Ann. Improb. Res., 12 (5), 16–21; there's a video presentation by the author that's pretty funny.

[216] del Rio L., Hutter A., Renner R., Wehner S., 2016, Phys. Rev. E, 94, 022104 [arxiv:1401.7997].

[217] E.g. see this list: http://pages.astronomy.ua.edu/keel/-sayings.html#journals

[218] Vader J.P., Simon M., 1987, Astron. J., 94, 854–866.

[219] Fisher J.R., Tully R.B., 1981, Astrophys. J. Suppl., 47, 139–200.

[220] Mahler D.H., Rozema L., Fisher K., Vermeyden L., Resch K.J., Wiseman H.M., Steinberg A., 2016, Sci. Adv., 2 (2), e1501466.

[221] Interested readers can check using the Wayback Machine in March 2016.

[222] As well as images that look like other things – pareidolia.

[223] Ellis J., Gaillard M.K., Nanopoulos D.V., Rudaz S., 1977, Nucl. Phys. B., 131, 285–307.

[224] The bet appears to have been one-sided, so we don't know what would have happened if Ellis had won the darts game. Perhaps we would now have a "parrot" equation or a new particle called the "pigeon".

[225] Shifman M., 1995, "ITEP Lectures in Particle Physics", arXiv:hep-ph/9510397.

[226] Reynolds R.J., 1990, Astrophys. J., 348, 153–160.

[227] Lenz F., 1951, Phys. Rev., 82, 554.

[228] Hatchett S.P., Begelman M.C., Sarazin C.L., 1981, 247, 677–685.

[229] See the list collected by Glen Petitpas: https://lweb.cfa.harvard.edu/∼gpetitpas/Links/-Astroacro.html

[230] Lee J.C., Kennicutt R.C., Funes J.G., Sakai S., Tremonti C.A., van Zee L., 2004, Bull. Amer. Astron. Soc., 36, 1442.

[231] Vagins M.R., Nucl. Phys. B, Proc. Suppl., 168, 128–130.

[232] Chanowitz M.S., Ellis J., 1973, Phys. Rev., D7, 2490–2506.

[233] Steigman G., Turner M.S., 1985, Nucl. Phys. B, 253, 375–386.

[234] Griest K., Astrophys. J., 366, 412.

[235] Scully M.O., 2002, Proc. Nat. Acad. Soc., 99, 10994–11001.

[236] Akturk S., Kimmel M., O'Shea P., Trebino R., 2003, Optics Express, 11 (5), 491.

[237] Leaving out the ones that may not be appropriate for a family show; however, they may be available on special request.

[238] Spitzbart B.D., Wolk S.J., Pollatou A.T., Walter F.M., 2004, Bull. Amer. Astron. Soc., 36, 1598.

[239] Wilkinson D.M., Maraston C., Goddard D., Thomas D., Parikh T., 2017, Mon. Not. Royal Astron. Soc., 472, 4297–4326 [arXiv:1711.00865].

[240] Berta Z.K., Irwin J., Charbonneau D., Burke C.J., Falco E.E., 2012, Astrophys. J., 144, 145 [arXiv:1206.4715].

[241] Monaco P., Theuns T., Taffoni G., 2002, Mon. Not. Royal Astron. Soc., 331, 587 [arXiv:astro-ph/0109323].

[242] Clerc N., et al., 2016, Mon. Not. Royal Astron. Soc., 463, 4490–4515 [arXiv:1608.08963].

[243] And not taken seriously in Germany, since there it's cheese curd, and also means "rubbish", a bit like "tripe" in Britain. The names of the six quark flavours are also hard to take entirely seriously.

[244] Kolb E.W., Chung D.J.H., Riotto A., 1999, in "DARK98", eds. Klapdor-Kleingrothaus H.V., Baudis L., IOP Pub., Philadelphia, p. 592 [arXiv:hep-ph/9810361].

[245] Chiu H.-Y., 1964, Phys. Today, 7 (5), 21.

[246] This last one comes from pirates, who also like to add "ar" to the ends of words.

[247] Chambers J.M., Herzberg A.M., 1968, J. Royal Stat. Soc., Series C, 17 (3), 260–263.

[248] Krauss L., 2008, Physics Today, 61 (10), 53–55.

[249] http://defendgaia.org/bobk/vsachs.html

[250] Belpaese O., 1993, Nature, 352, 422.

[251] David Dewhirst, astronomy librarian in Cambridge, liked to tell the following story. On attending an annual college dinner, he found himself sitting next to Dirac. Struggling for a way to converse with the great man he asked "Do you come here every year?", to which there was no reply and the meal proceeded in silence. However, at the end of the dinner Dirac turned to him and said "No". Dewhirst thereby boasted that he'd had a conversation with Dirac that lasted the whole evening.

[252] A joke made at the time was that Mather and Smoot won the prize for studying whether "matter is smooth".

[253] Although in SI-derived units this would be 10^{44} J, which gives the more awkward-sounding "ffj".

[254] Strasberg M., 1967, J. Acoust. Soc. Amer., 41, 1367.

[255] Zuckerman B., Turner B.E., Johnson D.R., Clark F.O., Lovas F.J., Fourikis N., 1975, Astrophys. J., 196, L99–L102.

[256] Long R., Liu Z., Liu W., 2017, Physica A, 496, 137–146.

[257] Chastel A.A., 1976, Astron. Astrophys., 53, 67–82.

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[266] Third cousin twice removed of Hendrik Ludvig. Another distant cousin, Edward Lorenz invented chaos theory; it is interesting to note that the phrase "butterfly effect" came from a conference organiser giving his talk the joke title "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" when Lorenz failed to submit one himself.

[267] Where he meant "funny peculiar", not "funny ha-ha".

[268] The suggestion appears to have first been made in print by Dan Nagle in a letter to Nature in 1998 (395, 9). However, it has been resuggested many times since: Marks J., Nov. 2001, Natural History, p. 8; Helman D., 2011, Phys. Today, 64 (10), 10; Forrester D.M., 2014, Royal Soc. Chem. Adv., 5, 5442–5449; Coles P., 2015, https://telescoper.wordpress.com/2015/05/21/-phlogiston-dark-energy-and-modified-levity; Hehe J., 2017, https://joshuashawnmichaelhehe.medium.com/-levity-theory-69ee297fd339

[269] If you have any comments, please contact me at my official email address, docslugtoast@astro.ubc.ca. However, please remember that there's probably very little to be gained by getting your papers added to the reference list of this review (and see Sect. XXI.M).

[270] I'd like to thank all the colleagues who sent suggestions for corrections and additions for the revised version of this article.

[271] In the spirit of April Fool's Day, there are perhaps a handful of things in this article that may not be entirely factually correct. Can you spot them all?

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APPENDIX A. IG NOBEL PRIZES

Ig Nobel Prizes are given regularly (although not every year) for Physics, with the winners including these papers:

- "The heaviest element in the universe, Administratium", 1994 [274];

- "A Study of the Effects of Water Content on the Compaction Behaviour of Breakfast Cereal Flakes", 1995 [275];

- "Tumbling toast, Murphy's Law and the fundamental constants", 1996 [276];

- "Physics Takes the Biscuit", 1999 [277];

- "Of Flying Frogs and Levitrons", 2000 [278];

- "Demonstration of the Exponential Decay Law Using Beer Froth", 2002 [279];

- "An Analysis of the Forces Required to Drag Sheep over Various Surfaces", 2003 [280];

- "Coordination Modes in the Multisegmental Dynamics of Hula Hooping", 2004 [281];

- "The Pitch Drop Experiment", 2005 [282];

- "Fragmentation of Rods by Cascading Cracks: Why Spaghetti Does Not Break in Half", 2006 [283];

- "Geometry and Physics of Wrinkling", 2007 [284];

- "Spontaneous Knotting of an Agitated String", 2008 [285];

- "Shape of a Ponytail and the Statistical Physics of Hair Fiber Bundles", 2012 [286];

- "Humans Running in Place on Water at Simulated Reduced Gravity", 2013 [287];

- "Frictional Coefficient under Banana Skin", 2014 [288];

- "On the Rheology of Cats", 2017 [289];

- "How Do Wombats Make Cubed Poo?", 2019 [290];

- "Excitation of Faraday-like body waves in vibrated living earthworms", 2020 [291].

Some earlier prizes were given derisively to pieces of pseudo-science, but the more recent awards are for genuine scientific studies that might just *seem* to be ridicu-

lous, but in fact demonstrate something interesting. Disregarding those awarded for fringe science claims (like the face on Mars and ancient astronauts), there has been only one prize related to astronomy:

- "Dung Beetles Use the Milky Way for Orientation", 2013 [292].

APPENDIX B. APRIL FOOL'S APODS

Here's a list of Astronomical Pictures of the Day with an April Fool's Day theme [293]:

- "Ski Mars!", 1999;
- "A New Constellation Takes Hold", 2003;
- "April Fools Day More Intense On Mars", 2004;
- "Water On Mars", 2005;
- "Hubble Resolves Expiration Date For Green Cheese Moon", 2006;
- "Americans Defeat Russians in First Space Quidditch Match", 2007;
- "New Space Station Robot Asks to be Called 'Dextre the Magnificent'", 2008;
- "Astronaut's Head Upgraded During Spacewalk", 2009;
- "Evidence Mounts for Water on the Moon", 2010;
- "It's Raining on Titan", 2011;
- "Dad Quiets Omicron Ceti", 2012;
- "Moon or Frying Pan?", 2013;
- "Space Station Robot Forgets Key Again", 2014;
- "Suiting Up for the Moon", 2015;
- "Europa: Discover Life Under the Ice", 2016;
- "Split the Universe", 2017;
- "I Brought You the Moon", 2018;
- "Astronaut Kicks Lunar Field Goal", 2019;
- "Asteroid or potato?", 2020.

APPENDIX C. ARXIV APRIL FOOLS

This is a list of "April Fool" type papers submitted to the eprint arXiv. Although lengthy, the list is undoubtedly incomplete. In chronological order they are:

- "Superiority of the Lunar and Planetary Laboratory (LPL) over Steward Observatory (SO) at the University of Arizona", 2002 [64];
- "On the Utter Irrelevance of LPL Graduate Students: An Unbiased Survey by Steward Observatory Graduate Students", 2002 [65];
- "Cosmic Conspiracies", 2006 [66];
- "The Stryngbohtyk Model of the Universe: a Solution to the Problem of the Cosmological Constant", 2007 [294];
- "Natural Dark Energy", 2007 [68];

- "On the origin of the cosmic microwave background anisotropies", 2007 [295];
- "Relativity Revisited", 2008 [296];
- "Down-sizing Forever", 2008 [69];
- "Time variation of a fundamental dimensionless constant", 2009 [297];
- "Galaxy Zoo: an unusual new class of galaxy cluster", 2009 [298];
- "Orthographic Correlations in Astrophysics", 2010 [163];
- "Schroedinger's Cat is not Alone", 2010 [299];
- "The Observed Inclination Problem: Solved at Last?", 2011 [300];
- "Non-standard morphological relic patterns in the cosmic microwave background", 2011 [162];
- "On the influence of the Illuminati in astronomical adaptive optics", 2012 [301];
- "Gods as Topological Invariants", 2012 [302];
- "The Proof of Innocence", 2012 [303];
- "On the Ratio of Circumference to Diameter for the Largest Observable Circles: An Empirical Approach", 2012 [304];
- "Non-detection of the Tooth Fairy at Optical Wavelengths", 2012 [305];
- "Pareidolic Dark Matter (PaDaM)", 2013 [306];
- "A search for direct heffalon production using the ATLAS and CMS experiments at the Large Hadron Collider", 2013 [307];
- "Felinic principle and measurement of the Hubble parameter", 2013 [308];
- "Unidentified Moving Objects in Next Generation Time Domain Surveys", 2013 [309];
- "Conspiratorial cosmology - the case against the Universe", 2013 [310];
- "Empirical Limits on the Russell Conjecture", 2013 [311];
- "Winter is coming", 2013 [312];
- "The CMB flexes its BICEPs while walking the Planck", 2014 [70];
- "Bayesian Prediction for The Winds of Winter", 2014 [313];
- "A Farewell to Falsifiability", 2015 [71];
- "Beyond the New Horizon: The Future of Pluto", 2015 [314];
- "SET-E: The Search for Extraterrestrial Environmentalism", 2016 [315];
- "Astrology in the Era of Exoplanets", 2016 [316];
- "An unexpected new explanation of seasonality in suicide attempts: Grey's Anatomy broadcasting", 2016 [317];
- "Pi in the sky", 2016 [72];
- "Pipe-cleaner Model of Neuronal Network Dynamics", 2016 [318];

- "Stopping GAN Violence: Generative Unadversarial Networks", 2017 [319];

- "Detecting the Ultimate Power in the Universe with LSST", 2017 [320];

- "A Neural Networks Approach to Predicting How Things Might Have Turned Out Had I Mustered the Nerve to Ask Barry Cottonfield to the Junior Prom Back in 1997", 2017 [321];

- "On the Impossibility of Supersized Machines", 2017 [322];

- "Independent Discovery of a Sub-Earth in the Habitable Zone Around a Very Close Solar-Mass Star", 2018 [323];

- "Super-Earths in need for Extremly Big Rockets", 2018 [324];

- "Sitnikov in Westeros: How Celestial Mechanics finally explains why winter is coming in Game of Thrones", 2018 [325];

- "Colonel Mustard in the Aviary with the Candlestick: a limit cycle attractor transitions to a stable focus via supercritical Andronov-Hopf bifurcation", 2018 [326];

- "ACRONYM: Acronym CReatiON for You and Me", 2019 [327];

- "Fast Radio Bursts from Terraformation", 2019 [328];

- "The Long Night: Modeling the Climate of Westeros", 2019 [329];

- "Superfluous Physics", 2019, [125];

- "A new kind of radio transient: ERBs", 2019 [73];

- "Worlds in Migration", 2019 [330];

- "Forecasting Future Murders of Mr. Boddy by Numerical Weather Prediction", 2019 [331];

- "The Marshland Conjecture", 2019 [48];

- "Cosmological Dark Matter: a Review (the April Fool Edition)", 2020 [332];

- "Quantum Godwin's Law", 2020 [333];

- "Defining the Really Habitable Zone", 2020 [334];

- "Making It Rain: How Giving Me Telescope Time Can Reduce Drought", 2020 [335];

- "Resolving Exo-Continents with Einstein Ring Deconvolution", 2020 [336];

- "The search for life and a new logic", 2020 [74];

- "An Artificially-intelligent Means to Escape Discreetly from the Departmental Holiday Party; guide for the socially awkward", 2020 [337];

- "Novel approach to Room Temperature Superconductivity problem", 2020 [338];

- "A PDF PSA, or Never gonna set_xscale again – guilty feats with logarithms", 2020 [339];

- "Searching for Space Vampires with TEvSS", 2020 [340];

- "Conspiratorial cosmology. II. The anthropogenic principle", 2020 [341];

- "Using Artificial Intelligence to Shed Light on the Star of Biscuits: The Jaffa Cake", 2021 [342];

- "Detection of Rotational Variability in Floofy Objects at Optical Wavelengths", 2021 [343];

- "The secret of the elixir of youth of blue straggler stars", 2021 [344];

- "Pandemic Dark Matter", 2021 [345];

- " 'I'll Finish It This Week' And Other Lies", 2021; [346]

- "The Swampland Conjecture Bound Conjecture", 2021 [347];

- "I Knew You Were Trouble: Emotional Trends in the Repertoire of Taylor Swift", 2021 [348];

- "My cat Chester's dynamical systems analysyyyyy7777777777777777y7is of the laser pointer and the red dot on the wall: correlation, causation, or SARS-Cov-2 hallucination?", 2021 [349];

- "The Existential Threat of Future Exoplanet Discoveries", 2021 [350];

- "The Swapland", 2021 [351].

APPENDIX D. FUNNY PAPER TITLES

Here are a few examples of jokey paper titles, selected in an entirely subjective way, in roughly chronological order [352]:

- "Deuteronomy. Synthesis of Deuterons and the Light Nuclei during the Early History of the Solar System" by Fowler, Greenstein & Hoyle [186];

- "My World Line: An Informal Autobiography" by Gamow [353];

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