1-1-2018

Ideology in Physics: Ontological Naturalism and Theism Confront the Big Bang, Cosmic Fine-Tuning, and the Multiverse of M-Theory

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Introduction

According to the *Oxford English Dictionary*, an ideology is “A systematic scheme of ideas, usually relating to politics, economics, or society and forming the basis of action or policy; a set of beliefs governing conduct.” Note that the definition alludes only to "politics, economics, or society" and excludes the "hard" sciences of physics, chemistry, and biology. The implication is that they are mercifully empty of the swamp of ideology. The social/behavioral sciences are saturated with ideology of ought statements, but the naturalistic/materialistic worldview of the hard sciences is also fraught with statements that reveal personal preferences about the "ought" when addressing the big questions of existence. I do not claim that ideology intrudes on the methods physicists use to achieve their scientific goals or that there is the same sort of “left/right” dichotomy that we see in the social sciences; I only argue that they have alternate worldviews that each side finds to be rationally and emotionally congenial.

The ideological battles in physics examined here come from within the field itself and not from abstract ideologies from the outside. The two things that ignited these battles are the Big Bang and cosmic fine-tuning. The arguments are not over the truth of these things, but about their metaphysical implications, such as the notion that they point to a divine designer (Appolloni, (2011). Some physicists see this as repugnant and others find it congenial. Thus, the ideological spats that astrophysicists and other scientist get into are not related to the facts of the Big Bang and cosmic fine-tuning, but rather how to interpret those fact metaphysically. An example of such interpretations is the best-selling book *The Grand Design* by Stephen Hawking, and Leonard Mlodinow (2010). This book is hailed as one of science, but it asks the metaphysical questions that philosophers across the ages have asked, as the book’s subtitle attests: *New answers to the ultimate question of life*.

The question of the origin of the universe occupies the center circle of both physics and religion. Some physicists such as Hawking, and Mlodinow stay completely on the scientific side of the center and are content with asking "how" questions while others such as Nobel Prize winners Einstein, Planck and Thompson assert that their science compels them to ask "why" questions (Lennox, 20091). Physicists who see the work of a divine creator in the grandeur of the universe are not invoking God to cover their ignorance as Isaac Newton did. Newton noted that the mutual gravitational attraction of many cosmic bodies could eventually render the solar system unstable, so God was needed now and again to intervene and set things right (Gonzales & Richards, 2004). Almost a century later, Pierre-Simon Laplace worked out the mathematics of orbital perturbations and published them in his five-volume *Celestial Mechanics*. When Napoleon Bonaparte asked why he had not mentioned God in a work on the heavenly bodies, he is reported to have relied "I have no need of that hypothesis."

Laplace was not denying God's existence, for as Hahn notes that: "Nowhere in his writings, either public or private, does Laplace deny God's existence" (1981, p. 95). Rather, it was the hypothesis that God intervenes in the world to keep the cosmic clock running he denied, and that the business of scientific inquiry has no place for the supernatural. When Joseph-Louis Lagrange, another mathematician and astronomer, remarked about Laplace's response to Napoleon: "Ah, it [the God hypothesis] is a fine hypothesis; it explains many things." Laplace's reply to this was: "This hypothesis, Sir, explains in fact everything, but does not permit to predict anything. As a scholar, I must provide you with works permitting predictions" (in Jennings, 2015, p. 59).

No scientist today argues that God intervenes to fix potential problems in the universe, but a number of top-rate scientists argue that certain 20th century discoveries have forced the return of the God hypothesis on them (e.g., Lennox, 2009; Meyer, 1999; Penrose, 2016).The key ideological issue separating the two camps of physicists today is whether intelligent life exists by chance or design. It became heated with the growing understanding of the Big Bang and has grown even hotter with the advent of M-theory that attempt to explain the exquisite fine-tuning of our universe by positing trillions of other unseen and unseeable universes (the multiverse) that created themselves out of nothing.

Naturalism/materialism and Theism

I want to use the term "ideology" free of any pejorative sting that simply defines worldviews held by different people based on both rational and emotional input. The Big Bang and fine-tuning have either been rejected hard atheist physicists because of their theistic implications or alternative explanations have been advanced for the phenomena. Theism is the belief in the existence of a God who exists within the universe (immanent) and yet transcends it. Because God is considered the omniscient, omnipotent and omnipresent creator of all existence, he is beyond the material and the natural, and therefore supernatural. There are many physicists, and other scientists, even Nobel Laureates, who have come to accept this kind of reasoning based on their scientific work (Bussey, 2016; Lennox, 2009).

Because theism is a comprehensive set of beliefs that shape a person's beliefs about, and guides behavior toward, secular as well as religious matters, it qualifies as an ideology. Theism does not imply adherence to any religious organization or sect; it only implies belief in a creator God with whom one can have a personal relationship. The belief in an impersonal God who created the universe and then had no further interest in it is the doctrine of deism. Although both science and religion are systems of ideas and beliefs, neither scientists nor Christians want to accept that their operating belief systems are ideological because of the pejorative flavor the term has acquired over the years.

I want to differentiate between naturalism, with which I am in full agreement, with scientism, with which I am not. Naturalism is the philosophy that scientific knowledge is the only form of knowledge that is *verifiable*; scientism is the view that science is the *only* way of knowing. Science is aware that it cannot supply all knowledge, especially about the profound questions that philosophers have posed across the centuries such as purpose, meaning, and "Why is there something rather than nothing?" Naturalism does not deny other ways of knowing, but requires that any contradiction of scientific knowledge based on these other ways be rejected.

If taken as ultimate ontologies, naturalism and materialism absolutely reject any claims of supernaturalism. Ontological materialism makes the argument that all existence is matter, only matter (stuff you can see, touch, measure, and manipulate) is real, the world is just physical, and that there is no metaphysical reality beyond it. Naturalism takes the materialist premise that nature is matter and is self-sufficient and the whole of reality. It therefore denies any causal mechanisms outside of the natural, which means that it denies the supernatural, just like materialism. Naturalism and materialism are therefore joined at the hip, so when I use the term "naturalism" hereafter, I am using the two terms synonymously.

Science based on methodological naturalism is humankind's greatest intellectual achievement, enabling humans to perceive, understand, and manipulate the natural world. It has lifted humanity to a level of health, prosperity, freedom, and comfort beyond the wildest imagination of people living in pre-scientific days. Science can do this because the scientific way of knowing yields justified beliefs verifiable across all cultures. Scientists know that their work is tentative and self-correcting, and a process in which answers lead to more questions; it feeds on ignorance for what is already known is boring. Of course, scientists can be thoroughgoing naturalists in their daily work, but still reject the notion that the matter of nature they work with is not all that there is. The ideological battle in physics is thus not between *methodological* naturalism and theism, but between *ontological* naturalism and theism.

Non-Overlapping Magisteria?

Is there any reason to believe that science and religion can have any impact at all on each other? The late Stephen J. Gould, a Harvard paleontologist and evolutionary biologist, did not think so, although he respected both. Gould coined the term “non-overlapping magisteria” (NOMA) to refer to his position that science and religion have legitimate authority in their different and non-overlapping domains of inquiry. For Gould, since these two magisteria do not overlap there is no real conflict between science and religion as long as both mind their own business. As Gould put it, "we [scientists) study how the heavens go, and they [theologians] determine how to go to heaven" (1998, p. 31). Gould was a left-of-center agnostic leaning towards atheism, so he was no apologist for theism.

Gould's non-overlapping magisteria are considered incommensurate domains of knowledge. The terms “incommensurate” and “contradictory” are not synonymous. Two contradictory worldviews such as the geocentric and heliocentric models of the solar system can be reconciled with observations because they speak the same language. Incommensurable worldviews are radical incompatibility in terms of such things as meaning, truth, or justification because the concepts of one cannot be clearly translated into the concepts of the other. In such a case, the two worldviews cannot logically be compared to expose contradictions, since there is no shared universe of discourse. Other scientists of repute see the two magisteria as intimately connected. Einstein’s familiar statement that "Science without religion is lame, religion without science is blind" (in Huchingson, 2005, p.149) is a case in point. Einstein also said “The more I study science, the more I believe in God” (in Holt, 1997), which implies considerable overlap of Gould’s magisterial exists among scientists of great repute.

The ideological issue that physicists have posed for us is: “Does our commitment to methodological naturalism allow us to accept any supernaturalist interpretation of the Big Bang and cosmic fine tuning.” Physicists who see no conflict between science and religion do not resort to “God-of-the-gaps” arguments; Einstein never inserted a God term into his equations to explain anything and neither did any other theistic scientist. In their everyday scientific work, their science and their religion are indeed non-overlapping magisteria. On the other hand, the atheistic scientist is committed to both methodological and ontological naturalism, and wants to banish any and all notions of the supernatural. Richard Lewontin (1977, np) explains this ideological position well:

> Our willingness to accept scientific claims that are against common sense is the key to an understanding of the real struggle between science and the supernatural. We take the side of science *in spite* of the patent absurdity of some of its constructs, *in spite* of

> its failure to fulfill many of its extravagant promises of health and life, *in spite* of the tolerance of the scientific community for unsubstantiated just-so stories, because we have a prior commitment, a commitment to materialism. It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our *a priori* adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated. Moreover, that materialism is absolute, for we cannot allow a Divine Foot in the door.

Lewontin's faith in materialism is ideological to the core since he admits that science carries no forced commitment to materialism. On the contrary, as he notes, it is the *a priori* commitment to ontological naturalism to the absolutism of materialism that forces it on him. His position verges on scientism, a thoroughly arrogant ideology that claims there is nothing knowable outside the scope of science's net, and what cannot be caught in the net does not exist. This reasoning is exemplified by Bertrand Russell' statement, “what science cannot discover, mankind cannot know' (1970, p. 243).

The Big Bang

Until the 1930s, the standard model of the universe was that it had no beginning, that it was static, eternal in time, and infinite in space and matter; it was simply a brute fact of existence that needed no jump start. This assumption was scientifically satisfying since it relieved scientists of getting into the messy metaphysical questions of the universe's origin, and what caused it to exist. The infinite static universe view emerged in the 13th century when Western scholars were exposed to Aristotle's writings on the nature of the universe. Thomas Aquinas “baptized” Aristotle into the Catholic faith because ideas such as a static universe fit neatly into Christian theology, as in Psalm 104:5: "He set the earth on its foundations; it can never be moved." Sir Isaac Newton also accepted Aristotle's view for religious reasons because, "For him, an infinite universe answered the question of why gravity did not cause the constituents of the universe to collapse in on one another” (Gonzales & Richards, 2004, p. 260).

The steady-state universe began to be questioned with Einstein’s famous general theory of relativity. Einstein was unsettled to find that his equations predicted either an expanding or contracting universe, neither of which fit the accepted notion that the universe was static and past eternal. He added in an extra term "correcting" his equations to keep the universe static. This so-called “cosmological constant” represented a repulsive force that would counter gravity's attraction, ensuring that the universe would endure indefinitely without clumping together. After Einstein accepted that the universe was expanding (as predicted by the initial equations), he discarded the cosmological constant, calling it the biggest blunder of his life. Astronomers now refer to dark energy as the force that balances out gravity as Einstein's cosmological constant (Peebles & Ratra, 2003). So the Einstein one" was right even when he thought he was wrong.

In the1920s, the Jesuit priest and physicist, Georges Lemaitre, noted problems with Einstein’s cosmological constant. Lemaitre reasoned that in a state of past eternity gravity would have long ago pulled all the matter in the universe together into one huge mass, just as Newton reasoned. Unlike Newton, Lemaitre drew the conclusion that to avoid this crunch the universe had to be expanding, and if it was expanding, it had to do so from a finite point in time. Lemaitre concluded all matter would stay separated if the expansion force slightly exceeded the gravitational force, which is exactly what Einstein’s “uncorrected” equations predicted (Appolloni, 2011) Lemaitre noted that the further away a galaxy the greater its light is shifted towards the red end of the spectrum. This meant that a galaxy's light is stretched in frequency by the expansion of space on its journey to the Earth, and the longer the journey the greater the light's redshift. Lemaitre concluded from all this that the universe was expanding, and if it was, rewinding the cosmic clock we would arrive at a point when all matter was condensed into a single entity, which he called the "primeval atom" or "single quantum." Most physicists at the time dismissed Lemaitre's reasoning, preferring to stick with Einstein's static universe.

In 1929-1930, astronomer Edwin Hubble provided the first definitive observational evidence for the expanding universe. Hubble showed that all galaxies are moving away from us and away from each other, and that the farther away they were the faster they are moving. This was determined by examining the wavelength spectrum of stars, with galaxies moving away from us becoming more "red-shifted," just as Lemaitre predicted. It became clear to most astronomers after this that Lemaitre's "single quantum" was a singular event that brought matter/energy, time, and space into being in a split-second flash (Appolloni, 2011). The Big Bang was not an explosion in the usual sense. Explosions throw matter in all directions which then falls back randomly under the influence of gravity. They never result in matter clumping together in orderly patterns such as we see after the Big Bang forming into ordered galaxies, stars, and planets. The attractive force pulling matter back in had to be exquisitely calibrated to the "explosive" force driving it forward. Physicist Paul Davies informs us that if rate of expansion from the beginning differed more that 10^{-18} seconds we wouldn't be here. In his words: "The explosive vigour of the universe is thus matched with almost unbelievable accuracy to its gravitational power. The big bang was not evidently, any old bang, but an explosion of exquisitely arranged magnitude." (1984, p. 184).

The universe had a beginning and a cause after all, and that realization greatly upset many scientists. Astrophysicist Robert Jastrow points out: "This religious faith of the scientist is violated by the discovery that the world had a beginning under conditions in which the known laws of physics are not valid, and as a product of forces or circumstances we cannot discover. When that happens, the scientist has lost control. If he really examined the implications, he would be traumatized" (1981, p. 19). Many scientists were indeed traumatized and railed against the idea of a beginning. Even the phrase "Big Bang" is a cynical one coined by physicist Fred Hoyle when he was confronted with the idea. Scientists who were committed exclusively to a materialist philosophy likewise rejected the idea because it led to echoes of the "spooky" Genesis story of divine creation *ex nihilo*. Philosopher of science, Georges Politizer, wrote that: "The universe was not a created object. If it were, then it would have to be created instantaneously by God and brought into existence from nothing. To admit Creation, one has to admit, in the first place, the existence of a moment when the universe did not exist, and that something came out of nothingness. This is something to which science cannot accede" (inYahya, 1999, p. 19). Other scientists who railed against the idea of a universe with a finite past include astronomer Arthur Eddington, who said that, "Philosophically, the notion of a beginning is repugnant to me." Eddington's opinion was not animated by anti-religious motives because he was a deeply religious person. His objection was that God's creation must remain mysterious and wonderful, and that "the pursuit of truth (in all aspects of life whether scientific or religious) will always remain just that, a pursuit, not a realization" (Appoloni, 2011, p. 29).

Chemist, Walter Nernst, saw the Big Bang as an affront to science: "To deny the infinite duration of time would be to betray the very foundations of science," and Allan Sandage, the "grand old man of cosmology," concluded that, "It is such a strange conclusion….it cannot really be true" (Jastrow, 1978, p. 122). Sandage later became a Christian, noting that "It was my science that drove me to the conclusion that the world is much more complicated than can be explained by science. It was only through the supernatural that I can understand the mystery of existence" (quoted in Strobel, 2004:84). Physicist Philip Morrison had more of the attitude of following the data where they lead: “I find it hard to accept the Big Bang Theory. I would like to reject it, but I have to accept the facts” (Jastrow, 1978, p. 123).

Because of the increasing number of scientists accepting the theory, the brilliant but eccentric physicist Sir Fred Hoyle remarked that: "The reason why scientists like the ‘big bang’ is because they are overshadowed by the Book of Genesis. It is deep within the psyche of most scientists to believe in the first page of Genesis" (in Curtis, 2012, np). Hoyle went to his grave in 2001 still rejecting the event he baptized as the Big Bang. Nobel Prize winning physicist George Thomson drew the opposite conclusion, stating that based on modern evidence, “Probably every physicist would believe in a creation if the Bible had not unfortunately said something about it many years ago and made it seem old-fashioned” (in Wiegandt & Joas, 2009, p. 189). This is supported by the words of famous scientists themselves. Agnostic astronomer Robert Jastrow said, “Now we see how the astronomical evidence supports the Biblical view of the origin of the world. The details differ, but the essential elements in the astronomical and Biblical accounts of Genesis are the same: the chain of events leading to man commenced suddenly and sharply at a definite moment in time, in a flash of light and energy” (Jastrow, 1981, p. 19). Nobel Prize winning physicist Arno Penzias stated: “The best data we have (concerning the big bang) are exactly what I would have predicted, had I nothing to go on but the five books of Moses, the Psalms, the Bible as a whole” (in Schaefer, 2003, p. 49).

Fine-Tuning

We live in a life-friendly planet, but the conditions for the existence of such a planet, never mind life on it, are so highly improbable that it leaves physicists and philosophers in awe. Each of the four fundamental forces of nature--gravity, electromagnetic, strong nuclear, and weak nuclear--have to be so fine-tuned that even the slightest variation in their values and the universe would not exist. To quote physicists Stephen Hawking and Leonard Mlodinow (2010): “The emergence of the complex structures capable of supporting intelligent observers seems to be very fragile. The laws of nature form a system that is extremely fine-tuned, and very little in physical law can be altered without destroying the possibility of the development of life as we know it. Were it not for a series of startling coincidences in the precise details of physical law, it seems, humans and similar life-forms would never have come into being” (pp. 160-161).

Fine-tuning thus refers to the mind-boggling precision of the physical constants (the laws of nature) at the split-second time of the Big Bang and the subsequent unfolding of their consequences leading to intelligent life on Earth. This precision of individual parameters had been noted for some time, but they were first systematized by physicist Brandon Carter (1974). The razor-edge precision of this fine-tuning has held countless cosmologists in awe, including Freeman Dyson, who wrote: “The more I examine the universe and the details of its architecture, the more evidence I find that the universe in some sense must have known we were coming” (1979:250). Indeed, the fine-tuning of our universe for intelligent life is such a deep mystery of science that it appears to many cosmologists to point to something profound lying within the heart of science. There are literally hundreds of examples of this fine-tuning presented in many fine books written by eminent cosmologists. Thus only a brief bare-bones description of the initial conditions of the universe and the four fundamental forces of nature is presented here.

Phase-Space: The Initial Conditions

It is surely true that most people (even scientists) take the existence of the universe and of intelligent life as a given and rarely ponder the immense improbability of its existence. In statistical mechanics, phase-space is the space of all possible states of a system and their velocities. In this case the system is the entire universe and each point in that space refers to a different way that it might have begun. The second law of thermodynamics is about entropy, or the degree of thermodynamic "disorder." Entropy in a closed system always increases, which means that there had to be an immense degree of order at the Big Bang because any universe capable of supporting life must begin with the lowest possible degree of entropy. Mathematical physicist Sir Roger Penrose (2016) asks us to imagine all the possible ways that the universe might have started in the entirety of phase-space and the probability that the exact point in all its immensity that must be hit to create a life-producing universe. He calculated the probability of the initial entropy conditions of the Big Bang by calculating the total entropy of the universe (thermodynamic equilibrium or maximum entropy). This value is the logarithm of the total phase-space volume of all possible beginnings of the universe, or 10^{123}. Because logarithms and exponents are inverse functions, the total phase-space volume is $10^{10\ (123)}$. Penrose's own words express the wonder (Note: W = original phase-space volume; V = total phase-space volume available.):

> How big was the original phase-space volume W that the Creator had to aim for in order to provide a universe compatible with the second law of thermodynamics and with what we now observe? It does not much matter whether we take the value $W = 10^{10(100)}$ or $W = 10^{10\ (88)}$ given by the galactic black holes or by the background radiation…or a much smaller (and, in fact, more appropriate) figure which would have been the actual figure at the big bang. Either way, the ratio of V to W will be, closely $V/W = 10^{10\ (123)}$. This now tells us how precise the Creator's aim must have been: namely to an accuracy of one part in $10^{10(123)}$. This is an extraordinary figure. One could not possibly even write the number down in full in the ordinary denary notation: it would be 1 followed by 10^{123} successive 0's. Even if we were to write a 0 on each separate proton and on each separate neutron in the entire universe- and we could throw in all the other particles for good measure—we should fall far short of writing down the figure needed. (Penrose, 2016, pp. 445-446).

In other words, our universe is one of $10^{10\ (123)}$ possibilities of phase-space that had the level of order required to produce complex intelligent life. This may be a scientific fact, but it cries out for a metaphysical "why" explanation. Penrose puts it all down the "Creator's aim," which is something sure to irk the ontological naturalist.

Gravity

Gravity is the force that gathered the material of the Big Bang and made it coalesce in stars and planets. If gravity had been slightly weaker by the smallest degree at the moment of creation, it would not have been able to pull matter together to form stars and planets. If it had been slightly stronger to the same degree, it would have pulled matter back into a big crunch long before stars and planets were able to form (Gonzalez and Richards, 2004). Once formed, the stars engage in a cosmic balancing act between the force of gravity pushing in and the pressure from the gases produced by burning hydrogen pushing out straining for release (Bussy, 2016). Gravity is thus very powerful at the level of big things like stars and planets, but it is by far the weakest of the four fundamental forces of nature. It is only because the multiple trillions upon trillions of particles in large bodies add up that gravity has the power that it does

The law of gravity states that its strength increases proportional to the masses involved, and decreases with the square of their distance apart. To help us to understand the extraordinary fine-tuning of gravity, physicist Robin Collins asks us to imagine a dial broken down into one-inch increments that stretches right across the universe. This would be more inches than all the grains of sand on Earth. He noted that if we moved the gravity's setting just one inch out of those unimaginable trillions from its current setting, "That small adjustment of the dial would increase gravity by a billion fold." (in Strobel, p. 161).

Cosmologists tell us that gravity is in a cosmic tug of war with dark, or "vacuum energy." Recall that Einstein's cosmological constant allowed for a repulsive energy that was uniform across the universe. Most scientists used to believe that the cosmological constant was zero or even slightly negative, but we now know that the expansion rate of the universe is actually increasing, which can only mean that the cosmological constant is positive and that dark energy is pushing the universe apart. Gonzalez and Richards state that "There is only one 'special time' in the history of the universe when the vacuum and matter energies are the same, and we're living near it. If the vacuum energy had become prominent a few billion years earlier than it did in our universe there would have been no galaxies. If it had overtaken gravity a little earlier still, there would have been no individual stars" (2004:205). The vacuum field is extremely weak as particle fields go, but the early universe still had to have a value large enough to allow the early universe to expand against gravity's pull and, "These particle fields require an extraordinary degree of fine tuning—at least 10^{-53} to get such a small, positive, non-zero, value for the vacuum energy" (Gonzales and Richards, 2004, p. 205).

The Electromagnetic Force

The electromagnetic force is the combination of all electrical and magnetic forces, and is the force that makes chemical bonding possible and thus gives matter its strength, shape, and hardness. If the electromagnetic bonding in the nuclei was even the slightest bit weaker, electrons could not be held in their orbits, and if it was slightly larger the electrons could not bond with the electrons of other atoms. In either case we would not get any molecules. Unlike gravity which only attracts, the electromagnetic force can attract or repulse. The electromagnetic force holds atoms and molecules together by the action of its attraction and repulsion electric charges. The electromagnetic force is so powerful that in comparison the contributions of the other fundamental forces as determiners of atomic and molecular structures is negligible, but without them the electromagnetic force would be useless. Paul Davies informs us that if the ratio of the nuclear strong force (discussed below) to the electromagnetic force had been different by 1 part in 10^{16} the stars could not have formed. He also tells us that if the ratio of the electromagnetic force to the gravitational force were increased by one part in 10^{40} , only small stars can exist, and if it were decreased by the same amount there would be only large stars. "You must have both large and small stars in the universe: the large ones produce elements in their thermonuclear furnaces; and it is only the small ones that burn long enough to sustain a planet with life" (in Lennox, 2009, p. 70).

The Strong Force

The strong nuclear force is by far the most powerful of the four forces, but has the shortest interaction distance. Each atom is made up of a number of positively charged protons, and as we know, positively charged objects brought close together will repel one another by the action of the electromagnetic force. Despite this repulsion, protons must have a way of sticking together or we would have no elements heavier than the hydrogen or helium made in Big Bang nucleosynthesis, and thus no life. It is the strong force that overpowers the proton's natural "shyness" and allows it to mate up with other protons. The strong nuclear force is also the force that powers the stars by crushing hydrogen atoms so tightly that their nuclei overcome their natural repulsion and fuse together, resulting in the massive amounts of energy that keep them alive. This force, along with the weak nuclear force, is called "nuclear" because their activity is confined to the nuclei of atoms (Forget, 2013).

One fascinating fact about protons and neutrons (a neutron has no electrical charge) is that the mass of their nucleus is slightly *less* than the sum of their masses. This strange phenomenon exists because when protons and neutrons come together, a small portion of their mass is converted to energy (remember $E = mc^2$?). This energy is the strong nuclear force that overcomes the electromagnetic repulsion and holds the nucleus together (Forget, 2013). Britain's Astronomer Royal Martin Rees informs us that the mass converted to energy is only .007 of its mass, but if it was .006, a proton would not bond to a neutron to make helium and the universe would consist only of hydrogen. On the other hand, if it was .008, there would be ready and rapid fusion, and no hydrogen would have survived. (in Lemley, 2000, p. 64).

The Weak Force

While gravity, electromagnetism and the strong nuclear force hold things together, the weak nuclear force makes atoms come apart by radioactive decay. During what is called beta decay, a neutron is replaced by a proton, electron, and neutrino by the action of their constituent quarks. The stars could not exist without this process. It is this force that drives the fusion of hydrogen protons and neutrons to form deuterium, which is an isotope of hydrogen that has one proton and one neutron in its nucleus; ordinary hydrogen has one proton and no neutron. This vital action is extremely fine-tuned. The tiniest increase in the strength of the weak force would have driven the hydrogen-to-deuterium process faster, making stars use up their energy faster than their planets could cool, and thus life could not develop. A weaker force may have been too feeble to do much fusing at all, and all we may have in the universe is hydrogen. Because the energy generated from this fusion is the source of the heat we get from the sun, so without this process life could not exist (Plaxo & Gross, 2006).

As weak as it is, the weak force plays a crucial role in producing life. The heavier elements necessary for life are formed in giant stars and spewed into space in supernova explosions. Supernova explosions fuel the cosmic cycle by pollinating the new stars formed from its gasses containing the heavy elements. Such explosions would not occur if the weak force was not exquisitely calibrated. As Davies explains: "If the weak interactions were slightly weaker, the neutrinos [neutrinos are similar to electrons, but they do not carry an electric charge] would not be able to exert enough pressure on the outer envelope of the star to cause the supernova explosion. On the other hand, if it were slightly stronger, the neutrinos would be trapped inside the core, and rendered impotent" (1982, p. 68).

Scientists in the 1970s-80s were puzzled by why there is such an abundance of carbon (the fourth most abundant element) when it is so improbable for stars to make it. Carbon is essential for life because carbon atoms form the backbone of almost all the important biological molecules (the familiar CHNOPS acronym for carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur). To build carbon (element number 6) it is necessary for beryllium (element number 4) to fuse with helium (element number 2). The problem is that radioactive beryllium exists for an average of 10^{-16} seconds, so in this unbelievably short time before beryllium decays, atoms of helium and beryllium must find each other and fuse (Adams & Grohs, 2017). Sir Fred Hoyle (1982, p. 16) wrote the following about this incredible level of precision,

If you wanted to produce carbon and oxygen in roughly equal quantities by stellar

> nucleosynthesis, these are the two levels you would have to fix, and your fixing would have to be just where these levels are actually found to be. Another put-up job? A commonsense interpretation of the facts suggests that a super-intellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question.

The Multiverse Alternative

There are three different interpretations of this fine-tuning, none of which can be subjected to empirical observation, and thus are taken according to one's metaphysical beliefs; that is, one's ontological ideology. The first is that the numbers just happened to take the values they do and other values would have led to a different and perhaps lifeless universe. Given the number of the values and their astronomically improbability, few cosmologists subscribe to this interpretation. The second is that the exquisite precision suggests a supernatural designer who created the universe for a purpose. This is obviously the interpretation favored by theistic physicists. The third is the multiverse interpretation to which I now turn.

Because the incredible fine-tuning of this universe has led some physicists to posit a fine-tuner, others have turned to the notion that our universe is but one of perhaps trillions of other universes: a "multiverse." I do not claim that physicists who are attracted to research on the multiverse concept are animated by atheism, but the concept is most attractive to atheists who have invented one metaphysical entity to get rid of another. As cosmologist Bernard Carr said: "If you don't want God, you'd better have a multiverse" (in Folger, 2008). The exquisite calibration—for which both atheistic and theistic scientists rule out chance—means that the universe has a fine-tuner or we have a multiverse of trillions of universes in which every possible variation of constants and forces exists somewhere.

Physicist Alan Lightman notes that the design notion of the universe does not appeal to atheistic scientists wedded to ontological naturalism and that: "The multiverse offers and explanation of the fine-tuning conundrum that does not require the presence of a Designer" (2011, p. 38). Lightman concedes that the multiverse hypothesis is conjecture that cannot be proved, but it must be accepted on faith:

> Not only *must* we accept that the basic properties of our universe are accidental and incalculable. In addition, we *must* believe in the existence of many other universes. But we have no conceivable way of observing these other universes and cannot prove their existence. Thus, to explain what we see in the world and in our mental deductions, we *must* believe in what we cannot prove (2011, p. 40).

Lightman echoes Richard Lewontin's view quoted earlier to the effect that scientists are forced by their *a priori* commitment to an absolute naturalistic worldview. The notion behind the multiverse hypothesis is that if we posit enough universes at least one should contain all the impossible "coincidences" that have led to complex and intelligent life. All these universes are said to arise when rapid inflation milliseconds after the Big Bang created different universes in bubbles of space with identical laws of physics. We will never be able to see these other universes since they are beyond our Hubble volume (that volume of the universe that we can observe, which extends from Earth to the maximum distance light traveled since the universe became transparent about 380,000 years after the Big Bang).

Another model of the multiverse assumes that different regions of space exhibit different laws of physics in different localities, and thus there are infinite possibilities of development for these universes. This model assumes a mega-universe producing an infinite number of universes arising within a larger system, like bubbles popping into existence. Because our universe bubbled into existence from a pre-existing mega-universe, this eternally inflating mega-universe takes us back to a past eternal universe. However, Mithani and Vilenkin (2012, p. 6) have shown that even if these alternate universes exist they must have had a beginning. Past eternal universes must contain trajectories that stretch infinitely into the past, which they say is not possible. They write that: “Here we have addressed three scenarios which seemed to offer a way to avoid a beginning, and have found that none of them can actually be eternal in the past.” The essence of their argument is that nothing can escape eventual massive entropy, and a past eternity would have taken everything to massive disorder by now.

Physicist Max Tegmark proposes that parallel universes are mathematical structures made up of all mathematical structures which we can conceive of governed by different equations from those that govern our universe. Under this model any conceivable universe is subsumed within it. As Tegmark explains, this model "can be viewed as a form of radical Platonism, asserting that the mathematical structures in Plato’s realm of ideas…exist ‘out there’ in a physical sense, casting the so-called modal realism theory…in mathematical terms akin to what Barrow refers to as ‘π in the sky’” (2009, p.12). This is Plato’s ideal reality in which mathematical structures are real and the language we use to describe our subjective perceptions of reality is an approximation of the perfect mathematical “forms” of reality. If every one of Tegmark’s mathematical structures is outside of our space and time, then no measurement or observation could ever falsify their existence.

M-Theory: Hawking and Mlodinow’s *Grand Design*

The implications resulting from Tegmark’s theory is precisely what we would expect: that is, the multiverse hypothesis has been pursued since it was first proposed with resort to Platonic rationalism rather than Aristotelian empiricism. The multiverse idea is subsumed under something called M-theory; a theory that unites several versions of string theory. M-theory asserts that the fundamental constituents of reality are not the point particles of standard physics such as quarks, but rather filaments of energy called "strings." These strings are said to vibrate with different oscillations that give rise to all particles and forces in the universe. They do not vibrate only in the familiar 3 dimensions of space and one of time, but rather 11; 10 spatial dimensions plus time, which are “folded" in on one another. The extra dimensions are curled up in “internal space” in trillions of possible ways, each assumed to be able to describe phenomena with its own restricted range. The number of possible solutions to the equations of M-theory may be as many as $10^{1,000}$, with, "Each solution represents a unique way to describe the universe. This meant that almost any experimental result would be consistent with [any one version of] string theory; the theory could never be proved right or wrong" (Folger, 2008, np).

Hawking and Mlodinow are leading M-theorists who note that the universe is indeed exquisitely fine-tuned, but they want to attribute it to blind luck because if multiple trillions of universes exist, there must be a winner in the ultimate Powerball game. Hawking and Mlodinow (2010, p.117) inform us that: "People are still trying to decipher the nature of M-theory, but that may not be possible.” However, they continue as though it is not only possible, but has been done and dusted. They posit the existence of a many different universes based on the "laws" of M-theory, of which they previously said may be undecipherable. They write: “The laws of M-theory therefore allow for different universes with different apparent laws, depending on how the internal space is curled. M-theory has solutions that allow for many different internal spaces, perhaps as many as 10^{500}, which means that it allows for 10^{500} different universes, each with its own laws" (p. 118).

The number of universes predicted by M-theory is therefore incredibly large (the best estimate of the number of atoms in the known universe is 10^{80}). However, 10^{500} is not enough to effectively address the fine-tuning for life phenomenon. Penrose's calculation of the probability of getting the universe started in the required low entropy state is $10^{-10\ (123)}$. This number is way beyond the probability boundaries of 10^{500} universes. Thus, even such a number of hypothesized throws of the die cannot effectively account for the fine-tuning "problem."

M-theorists write as though they ascribe intelligence, personality, and agency to mathematical equations, since they appear to believe that their equations can bring universes into existence. Hawking and Mlodinow (2010) follow Tegmark's notion that the universe owes its existence to nothing but mathematical laws: "Because there is a law like gravity, the universe can and will create itself from nothing... Spontaneous creation is the reason there is something rather than nothing, why the universe exists, why we exist" (p. 180). The law that Hawking and Mlodinow say created trillions of universes from "nothing" is gravity, which is something, not nothing; or is it? When asked to where gravity came from, Hawking answered: "M-theory" (in Lennox, 2011, p. 39). So for Hawking the force of gravity was created by mathematical symbols on paper! Tim Radford, science editor of Britain's *Guardian* newspaper, captures the God-like nature with which M-theory has been endowed by Hawking and Mlodinow (Radford, 2010, np):

> M-theory invokes something different [from other theories of science]: a prime mover, a begetter, a creative force that is everywhere and nowhere. This force cannot be identified by instruments or examined by comprehensible mathematical prediction, and yet it contains all possibilities. It incorporates omnipresence, omniscience and omnipotence, and it's a big mystery. Remind you of Anybody?"

M-theory is causing serious ideological rifts in physics over how science should be pursued. Roger Penrose, who worked alongside Hawkins for many years, described it as "a collection of ideas, hopes, aspirations. The book [*The Grand Design*] is a bit misleading. It gives you this impression of a theory that is going to explain everything; it's nothing of the sort. It's not even a theory" (in Lennox, 2011, p. 55). Mathematical physicist Peter Woit wrote a book-length stinging criticism of M-theory, likening it to postmodernism: "There is a striking analogy between the way superstring theory research is pursued in physics departments and the way postmodern 'theory' has been pursued in humanities departments. In both cases, there are practitioners that revel in the difficulty and obscurity of their research, often being overly impressed with themselves because of this" (2006, p. 207.

Mathematical physicists Ellis and Silk argue that theories such as M-theory harm physics by turning it into metaphysics with their proponents arguing for relaxing the criteria by which a theory is judged useful or not. The mathematical elegance of M-theory notwithstanding, it generates untestable hypotheses about multiverses in place of empirical science.

> Faced with difficulties in applying fundamental theories to the observed Universe, some researchers called for a change in how theoretical physics is done. They began to argue—explicitly—that if a theory is sufficiently elegant and explanatory, it need not be tested experimentally, breaking with centuries of philosophical tradition of defining scientific knowledge as empirical. We disagree. As the philosopher of science Karl Popper argued: a theory must be falsifiable to be scientific (2014, p, 321).

They also write that because M-theory is metaphysical, "theoretical physics risks becoming a no-man's-land between mathematics, physics and philosophy that does not truly meet the requirements of any" (2014, p. 321). The bottom line on M-theory is that its predictions have no chance to ever be observed experimentally, not even in principle.

Conclusion

This article has looked at the ideological battles in physics. We tend to see physics as value-free**,** and physicists as emotionless nerds consumed only with science. But just because physicists are arguably the brightest folks on the planet, it does not mean that they are immune to the emotional tug of an ideological worldview. The conflict is between two ideologies addressed here is about the biggest questions of human existence, so it would seem inevitable that all thinking people acquire an ideology to help them to make sense of those questions. The first ideology is the theistic perspective affirming that a complete view of reality must engage the mental and spiritual realms as well as the physical and material realms of existence. The second is an atheistic perspective of the ontological naturalist which affirms that all reality is reducible to the physical and material, and the mental and spiritual life is an illusion. Hawking and Mlodinow (2010, p. 32) find that their perspective affirms this: "It is hard to see how free will can operate if our behavior is determined by physical law, so it seems that we are no more than biological machines and that free will is just an illusion."

There is a fiction that the great majority of physicists are atheists, which is perhaps true of ontological naturalists, but certainly not true of the majority of physicists. Baruch Shalev (2003) wrote mini-biographies of all 719 Nobel Prize winners from 1901 to 2000 and found that only 10.5% fell into atheist, agnostic, or “freethinker” category, with winners in literature (37.2%) making up by far the biggest category of non-believers. Physicists had only 4.7% in the atheist, agnostic, or “freethinker” category, which helps us to understand prize-wining mathematical physicist Robert Griffiths’ statement: “If we need an atheist for a debate, we go to the philosophy department. The physics department isn’t much use” (in Kainz, 2010, p.21).

M-theory and the multiverse have been posited as the ontological naturalists answer to the Big Bang and cosmic fine-tuning. M-theorists, including Hawking and Mlodinow, recognize that the probabilities involved in the initial conditions and fine-tuning exhaust the probability resources if we are constrained to posit only one universe, so they posit trillions, which they say solves the “conundrum” of fine-tuning. The theory is touted as a theory of everything, but if it allows anything to be possible it is better described as theory of anything. It has created one metaphysical entity—a multiverse that bootstraps itself into existence—in order to get rid of another. Even if other universes do exist with laws permitting spontaneous generation, it still does not explain the origin of those laws or life in *this* universe. Moreover, if multiple universes exist, their existence merely pushes back the question of origins back another level, and still does not answer either the fine-tuning phenomenon (the “multiverse-making machine” would itself have to be fine-tuned) or the ultimate questions of our existence in this universe.

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Ideology in Physics: Ontological Naturalism and Theism Confront the Big Bang, Cosmic Fine-Tuning, and the Multiverse of M-Theory

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Abstract

The most profound questions that philosophers and scientists have asked across the centuries have been metaphysical and existential, such as “What is the meaning and purpose of life, why are we here, and why is there something rather than nothing?” There can be no definitive answers to these questions, so those who pose and propose answers to them necessarily engage ideology. Some physicists have become philosophers in that they are attempting to answer these profound questions with highly speculative theories as, for instance, Hawking and Mlodonow’s book The *Grand Design* (2010) which they tout as providing new answers to age-old questions by positing a multiverse that created itself. Other physicists impugn these efforts as putting physics in a no-man’s land and wanting to relax the empirical and falsifiable criteria for judging the usefulness of a theory. These theories are offered in response to the remarkable precision of the initial conditions of the Big Bang, and the exquisite fine-tuning of nature’s laws for intelligent life. Theistic or deistic physicists see these things as the mark of a designer; atheist or agnostic physicists call this a as an affront to science and offer the multiverse hypothesis as an alternative. The ideological battles are thus between ontological naturalists (there is no reality beyond the physical) who lean toward atheism, and methodological naturalists (there is a mental and spiritual reality as well as a material one) who lean toward theism or deism.