Research Article

Weinberg's Lament: Science and Religion

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Abstract | Weinberg's lament is the rather gloomy conclusion that the existence of the universe, and of intelligence in particular, appears to have no meaning. This essay explores the epistemological basis of this lament.

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It was only a few hundred years ago that the Enlightenment allowed humanity to understand the world in scientific rather than religious terms, and the Industrial Revolution, with its enormous impact on productivity, permitted a large fraction of the population, at least in the developed world, to engage in something other than production, storage, and distribution of food.

One of the most important contributions of the Enlightenment to the future development of modern society was made by Francis Bacon in the 17th century. His ideas changed the very relationship between humanity and nature: he introduced the concept of empiricism and popularized the inductive method of scientific inquiry. This, of course, is the basis of the scientific method, an approach to nature that was unheard of in his time. In Bacon's words: "At the foundation we are not to imagine or suppose, but to *discover* what nature does or may be made to do". Eiseley (1970) and (1973), who has written extensively on Francis Bacon, describes Bacon as "preeminently the spokesman of *anticipatory* man. The long reign of the custom-bound scholastics was at an end. Anticipatory analytical man, enraptured by novelty, was about to walk an increasingly dangerous pathway".

This "dangerous pathway" has led to a strong reaction against the Enlightenment. As put by Berlin (1998) in his essay *The Counter-Enlightenment*, "The proclamation of the autonomy of reason and the methods of the natural sciences, based on observation as the sole reliable method of knowledge, and the consequent rejection of the authority of revelation, sacred writings and their accepted interpreters, tradition, prescription, and every form of non-rational and transcendent source of knowledge, was naturally opposed by the Churches and religious thinkers of many persuasions".

This is the branch of the Enlightenment whose impact on society was ultimately to liberate most people in the western world from the terrible fear generated by rampant superstition, but one should remember that the Enlightenment itself evolved from the anti-scholastic Platonists of the Renaissance, which gave us so much great art and music and other elements of culture.

The Enlightenment also led to Darwinian evolution and a perceived conflict with religion: If the origin of life, and humanity in particular, has a natural explanation, how can one believe in the immortal soul, or that humanity is central to God's creation? As put by

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Omar Khayyám—a doubter of long ago—in two of the quatrains of his *Rubáiyát*:

> "There was a door to which I found no key:
> There was a veil past which I could not see:
> Some little talk awhile of me and thee
> There seem'd—and then no more of thee and me.
>
> Then to the rolling heav'n itself I cried,
> Asking, "What lamp had destiny to guide
> Her little children stumbling in the dark?"
> And—"A blind understanding!" heav'n replied."

Khayyám's "blind understanding" is surely in the realm of faith, which in turn leaves open the possibility of revelation. Revelation (in at least Islam, Christianity and Judaism) with its eternal truths is incompatible with science, which requires reproducibility. But there is a form of revelation—not based on theophany—that *is* compatible with science.

As put by Carroll (2001) in his brilliant history, *Constantine's Sword*, "the truth of our beliefs is revealed in history, within the contours of the mundane, and not through cosmic interruptions in the flow of time. Revelation comes to us gradually, according to the methods of human knowing. And so revelation comes to us ambiguously. Certitude and clarity are achieved only in hindsight, and even then provisionally." Since it is this provisional nature of knowledge that is also the essence of scientific knowledge, religious people who find themselves able to accept Carroll's characterization of revelation should have no difficulty accepting the findings of modern science—those findings reflect the will of God. It is worth noting that Carroll was a Catholic priest before taking up writing as a career.

Carroll's characterization of revelation makes it clear that in his view God does not exist in the sense of western thought; that is, there is not *per se* a "revealer". His characterization is perhaps closest to that of Spinoza; as put by Russell (1960), "Individual souls and separate pieces of matter are, for Spinoza, adjectival; they are not *things*, but merely aspects of the divine Being. There can be no such personal immortality as Christians believe in, but only that impersonal sort that consists in becoming more and more one with God. Finite things are defined by their boundaries, physical or logical, that is to say, by what they are *not*: 'all determination is negation.' There can be only one being who is wholly positive, and He must be absolutely infinite. Hence Spinoza is led to a complete and undiluted pantheism". Here, pantheism should be interpreted as the doctrine of identifying God with the various forces and workings of nature.

The "blind understanding" of Khayyám is not enough for most people to bridge the gap between revelation and scientific discovery, and not even for some scientists. Many suffer from what I have called Weinberg's lament. In his book *The First Three Minutes*, physicist Weinberg (1983) complained that: "The more the universe seems comprehensible, the more it also seems pointless." But he found some solace in the fact that "The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy."

Weinberg's elegant prose contains a deep regret that our enormous advance in understanding the physical nature and evolution of the universe has not allowed us to find meaning or purpose in human terms for the existence of the universe. This is the essence of Weinberg's lament.

His use of the word "pointless" is deliberate. This word is generally taken to be synonymous with having no purpose or meaning, but it shouldn't be. The now undisputed fact that the universe came into existence some fourteen billion years ago rules out earlier theories of an eternal universe, and today many people call this event the "creation". Had Weinberg written ". . . it also seems purposeless", rather than ". . . it also seems pointless", it would leave open the interpretation that there could be a creator, usually identified with God, whose purpose remains hidden. To think the universe has a purpose could then be interpreted as an act of faith. On the other hand, most people including scientists could accept the idea that there is some *meaning* behind the existence of the universe. Even that belief is a form of faith, but one that leaves open the possibility that science could in time discover that meaning.

Is this possible? Could the methods of science discover a meaning for the existence of the universe? To address these questions one must understand the limits of science both in terms of observation and theory. The latter is invariably associated with the use of mathematics to express the theories meant to explain observations. Only rarely is the relationship between mathematics and theory—and the limits of this con-

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nection—explored. The next two sections constitute an introduction to these issues. The final section, "Weinberg's Lament", returns to the question of whether science could discover the meaning of existence.

Observation and Theory

Human beings have a variety of senses including the obvious ones of sight, hearing, touch, smell, and taste. Many other animals have different suites of senses, some in common with humans and some not—like the ability to sense and use electric or magnetic fields for practical purposes such as finding prey and navigation, or having extended, or at least different, visual or hearing ranges than human beings. Animal interpretation of the world around them can be very different from each other and from human perception.

One of the great achievements of modern science has been to transcend the biological limits of observation by the use of sophisticated instruments. The data acquired from observation are then "explained" by unifying them into a logical theoretical framework, usually mathematical in nature. Is a mathematical framework necessary, and is it adequate? This question brings to mind Wigner's (1967) essay "The Unreasonable Effectiveness of Mathematics in the Natural Sciences", which can be found in his book *Symmetries and Reflections*. As put by him, "The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve. We should be grateful for it and hope that it will remain valid in future research and that it will extend, for better or for worse, to our pleasure, even though perhaps also to our bafflement, to wide branches of learning".

Implicit here is what it means to understand something. Yet this is rarely if ever clearly defined. To understand something new, one must relate the new information to what is already known; *e.g.*, the idea of force comes directly from our senses and it is a relatively easy step to relate such experience to two objects that interact through a force. In mathematics, one relates knowledge gained from arithmetic to the abstraction of algebra. Ultimately, however, mathematics has its limitations and its reflection in reality is not really understood, although it has been studied since ancient times.

In classical electromagnetism electric and magnetic fields are defined in terms of observations of the forces they produce. These fields are then related to each other by Maxwell's equations, which also predict electromagnetic radiation. Maxwell's equations are a quintessential example of a physical theory. Theory unites and unifies observations by constructing a mathematical model that can often be communicated in an intuitive way through the use of geometrical and other types of figures. Poincaré (1905) expressed the implicit limitation of this method in his book *La Valeur de la Science* as follows: "Science is, in other words, a system of relations. It is only in relations that we should attempt to find objectivity; it would be futile to search for it in the things themselves instead of in their relations to one another. The assertion that science can have no objective value because it provides us only with knowledge of the relations would be wrong, for it is just these relations which are to be regarded as objective".

It is the radiation predicted by Maxwell's equations, in the form of black body radiation, which led to the discovery of the limitations of classical electromagnetism. In order to explain the observed spectral distribution of intensity for heat radiation, Planck introduced the idea that radiated electromagnetic energy must come in multiples of a minimum energy given by a constant times the frequency. This idea coupled with Einstein's special relativity led to quantum mechanics and much of modern physics.

Nevertheless, there have been questions about the meaning of quantum mechanics and quantum field theory since their inception. Generally, these are ignored by most physicists who simply use the formalism as a tool for making calculations for physical systems. Much of the contention over many years in the twentieth century can be summed up by the question, "Is radiation composed of elementary particles or is it a wave?" Of course, as pointed out by Niels Bohr many years ago in his elephant parable, it is neither. It is interesting and somewhat amusing to note that Bohr was Knighted in 1947 by Fredrick IX conferring on him the Order of the Elephant—the highest Order of Denmark.

Mathematics and Physics

The role of mathematics in physics reached a new height in the use of group theory in the Standard Model of particle physics. Groups are abstract entities that are defined very broadly. They consist of a set of

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elements along with an operation that can combine any two elements into a third. The operation must in addition meet certain requirements.

Group theoretical methods did not receive a warm reception when introduced into the physics community. As put by Slater (1975) in his autobiography, "Wigner, Hund, Heitler, and Weil entered the picture with their 'Groupenpest'. The authors of the 'Groupenpest 'wrote papers which were incomprehensible to those like me who had not studied group theory. The practical consequences appeared to be negligible, but everyone felt that to be in the mainstream one had to learn about it. It was a frustrating experience, worthy of the name of a pest." The "pest" was never vanquished. Today group theory is fundamental to the Standard Model of particle physics and plays an important role in many other areas of physics as well.

The Standard Model is based on the work of Wigner who classified the irreducible representations of the relevant group in terms of the parameters of spin and the non-negative rest mass of the particle. Sternberg (1994) in his book *Group Theory and Physics*, summarizes one of the key points of Wigner's work as stating that an elementary particle '*is*' a representation of this group! Thus, a real elementary particle is *identified* with a representation of an abstract group!

If it were possible to identify all of reality with a mathematical structure, then reality itself would have to be subject to the limitations of that structure. If this were the case, one of the most fundamental limitations would come from the Gödel incompleteness theorems (van Heusden 2016), which in essence say that any logical system that includes a certain amount of elementary arithmetic contains statements that can neither be proved or disproved in that system; and that the consistency of the system itself cannot be proven within that system. Are these theorems reflected in physical reality? It turns out that there is indeed a class of dynamical systems that appear to offer some examples of where this is true (Agnes and Rasetti 1987; Moore 1990).

Weinberg's Lament

That the universe seems pointless to those who do not hold to the traditional faiths may be the inevitable consequence of the reductionist approach implicit in the scientific method used by scientists. Attempts have been made to transcend the limitations imposed by reductionism, the concept that the nature of complex phenomena can always be reduced to, or explained by, simpler more fundamental ideas. Perhaps the most promising is what is known today as emergent behavior. Such an approach offers hope to many thoughtful people that there may be a way to transcend Weinberg's lament—the rather gloomy conclusion that the existence of the universe, and of intelligence in particular, appears to have no meaning.

Science has been able to reveal the evolution of the universe back to the first moment of its coming into existence, but cannot offer any explanation for what Fred Hoyle derogatorily called the "big bang," other than it might have been a random and meaningless quantum fluctuation. What this "fluctuation" was supposed to have taken place in, since neither space nor time, as we understand it, had yet come into existence, is left unanswered. The problem is that the universe's coming into existence is a *sui generis* event, which places it outside the domain of the scientific method.

I said earlier that the Enlightenment had an impact on society that was ultimately to liberate most people in the western world from the terrible fear generated by rampant superstition. This is true in the sense that it led to modern science, which transformed the western world in a mere a few hundred years; nothing comparable has occurred in human history. But the Enlightenment has also been extended to other branches of knowledge and misinterpreted to mean that there are eternal, timeless truths that implicitly govern moral, economic, political and the social spheres of human activity. All such theories are contradictory to the fundamental precepts of science.

The concept of timeless truths has a long intellectual history. Plato strongly emphasized timeless truths and Aristotle in the *Nicomachean Ethics* maintained that one of the highest virtues was the contemplation of such timeless truths. Pre-Enlightenment religious thought was also based on eternal truths, as were more modern social theories. Hegel believed that objective concepts and principles that govern human society exist, and that history evolves as a dialectical process. Marx identified these principles as material relations between classes, which were governed by general laws.

These moral and political constructs based on scientific theories of economics, sociology and psychology have failed abysmally in the 20th century causing far too much suffering and many humanitarian crises. Hopefully we won't repeat them in the 21st century.

History has shown that the concept of empiricism and the inductive method of scientific inquiry have only limited applications in other areas of human endeavor. There is no morality implicit in science, and the methods of science have led to much quantification but few advances in the understanding of the economic, political and social aspects of human existence.

That science cannot provide a moral framework does not mean that scientists do not have an ethical responsibility to clearly inform the general public about the implications for society of their discoveries. This was true in the 20th century, for example, with regard to the discovery of nuclear fission and fusion and is especially true in the 21st century with the ongoing revolution in biology and the growing ability to modify existing organisms and create new ones.

Weinberg's lament, and the expectation that science can find some meaning for the creation of the universe, is essentially a category error. Science can no more explain its existence—in the sense of first causes—than theology can explain electromagnetism or gravitation. But if the sole reliable method of gaining knowledge is through the autonomy of reason and the methods of the natural sciences, where does that leave us?.

It leaves us with our ignorance about the meaning behind the existence of the universe. Faith and tradition can offer solace, but the validity of any "truths" offered by faith cannot be proven by science or reason alone. Weinberg (1999) has given his view on science and religion in one of his articles in the *New York Review of Books*: "I am all in favor of a dialogue between science and religion, but not a constructive dialogue. One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment."

More than half a century ago, Smith (1955) wrote a beautiful book called *Man and His Gods*. In the *Epilogue*, Smith captures what must happen if the modern world is to avoid what might well be characterized as a social form of Armageddon:

"As a fallen angel, man would be ludicrous. As an intelligent animal, he has reason to be proud because he is the first who can ask himself, "Whither, Why, and Whence?' and confident because he can know himself as a creature of earth who has risen by his own efforts from a low estate. If he would rise higher he must be true to earth, he must accept that he is its creature, unplanned, unprotected and unfavored, co-natural with all other living creatures and with the air and water and sunlight and black soil from which their dynamic pattern has been fabricated by impersonal and indifferent forces. In every wish, thought and action he is seeking to escape the same protoplasmic disquietude that impels the meanest flesh crawling beneath his feet. He must find his values and his ends entirely within this frame of reference".

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