ESSSAT News & Reviews

25:2 (June 2015)

European Society for the Study of Science and Theology

Article-Review 2.
Science becoming more friendly to religion

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Amir D. Aczel: *Why Science Does Not Disprove God*, New York, W. Morrow, 2014, 294 pp, ISBN 978-0-06-223059-1; £16.99 (hdbk); £9.99 (pbk).

Science writer and mathematician Amir Aczel, currently working on research in the history of science at Boston University, has previously made his name both as a statistician (he has published a couple statistics textbooks), and as a mathematics and science popularizer, famous for his *Fermat's Last Theorem* (1996). The purpose of the present monograph can be had from two places: the last paragraph of the book, where Aczel (hereafter A.) tells us that he is not attempting to prove God's existence, but to defend the integrity of science (see also p. 5), as well as the introduction, where he voices his conviction that no argument has been sustainably offered by any one line of investigation of the "new atheism" that would be fatal to the existence of God.

The incident that convinced A. to write this book was his growing irritation over affirmations, made by Richard Dawkins in particular, claiming the authority of science as a warrant for militant atheistic pronouncements, especially as the author and Dawkins met and engaged in debate in a Mexican summer conference (pp. 1-2). In the conclusion, A. tells very briefly the story of Euler's encounter with Diderot in Moscow, whom the former confronted with '$(a + b^n) / z = x$, thus God exists: respond!'. If apocryphal, this story is nevertheless telling, and A. uses it to show how the new atheism has merely revived this confrontational and other-humiliating rhetoric: 'science proves there is no God: respond!'

The book contains several developments that cover a lot of ground, and consists of a prologue with 14 chapters and a conclusion that is kept short and is an efficient summary of the main unifying idea. The writing style is conversational, A. is never obscure, explaining mathematical and scientific ideas with a desire to be understood by the layman. He mentions ideas from many sources, sometimes in their own words, but keeps the narrative free of scholarly footnotes or chapter endnotes. He has gathered references in an end-section where it is possible for him to control his sources. The chapters are devoted to the science and religion interaction, archeology, the revolt of science, 19th century discoveries, Einstein and God, the quantum and God, the 'universe from nothing,' the multiverse, mathematics and probability bearing on the question of God, the limits of human knowledge, the an-

thropic principle, the limits of evolution, symbolic thinking and the invisible, and finally the question of the infinite.

What comes out of the investigation carried in chapter 2 on archeology and the Bible is the rhetorical entanglement of the new atheists, locked in a kind of literalism that is often shared by their opponents, as they constantly attack those who are fundamentalist readers of Scripture.

In his chapter on the triumphs of science in the 19th century (4), A. presents the case of Laplace, who in celestial mechanics overcame the Newtonian need for divine intervention in the cosmos, and recalls the question asked by Napoleon when inquiring about God's place in this system, to which followed the famous answer that there was 'no need of that hypothesis.' A. points out how Dawkins and Hitchens, and just about everyone else, have left out another encounter Napoleon had with an equally important Italian mathematician, Lagrange, who replied, upon learning of this quip, that God is 'a beautiful hypothesis, one which explains many things' (see W. Rouse Ball, *A Short Account of the History of Mathematics*, 4th ed., London, Macmillan, 1908, p. 418).

The chapter on Einstein, God and the Big Bang (5) defends Einstein's belief in a super-human intelligence which, although impersonal, still cannot be turned into a mere heuristic imaginative device.

To introduce the question of God and the quantum (ch. 6), A. explains the gist of the EPR experiment and insists that if spooky predictions have been verified by a famous experiment initially done at Orsay in the 1980s, they rested on probability rules; when today's scientific atheists want to use our knowledge of the quantum world to argue that God does not exist, since these laws would replace him, they forget that a good scientific theory is measured against its predictions. Quantum field theory tells us that the unobserved past as well as the future are indefinite and exist in a spectrum of possibilities, from which many infer that the universe has no single past or history, an assertion that A. takes to be stunning. If we don't understand what goes on in the world of the very small, if we see something like shadows on the wall, akin to Plato's allegory of the cave, it would be in this context rather unbelievable to appeal to quantum theory to say that it tells us that the universe must come from nothing.

A. devotes the next chapter (7) to this question of the creation of a universe from nothing. Once one has some energy available, one can create pairs of particles and anti-particles as shown by Dirac, and hence a universe seemingly out of nothing. If the assumption is that this energy comes from quantum fluctuations, it is not a universe out of nothing, and A. takes to task Lawrence Krauss for his misuse of the idea of empty space. Krauss' nothingness ends up resting on A. Vilenkin's model, which appealed not to

an existing space-time, but to a point with no extension. Such a universe does not come out of complete nothingness, it is the absence of the classical space-time that is referred to as nothingness.

The chapter on the multiverse (8) concludes that the worst feature of this theory is that it is non-parsimonious; like Ptolemy's ancient theory it is a model that has too many free parameters.

The chapter on mathematics, probability and God (9) is remarkable for its balance between technical exposition and accessibility. Acknowledging that many mathematicians, perhaps most, are Platonic in their approach, A. emphasizes that mathematics is not physics, the difference between them being one of 'reality.' In R. Dawkins' *The God Delusion* (see p. 68), one reads that the God hypothesis is very close to being ruled out by the laws of probability, after which Thomas H. Huxley is taken to task for having retreated to agnosticism, feeling incapable of proving or disproving God, Dawkins saying that he should have introduced the idea of probability; Dawkins similarly faults Stephen Unwin for giving God, in his *The Probability of God* (2004), a 50% prior probability against the hypothesis of atheism. A. highlights how Dawkins seems to ignore what H. Jeffreys called a non-informative prior distribution, the only possible honest preliminary distribution one can use when there is no pre-existing information: facing two possibilities, one will have to assign 50% or 1/2 to each. It does not necessarily reflect the investigator's state of mind, but represents an unprejudiced starter. A. reviews in a very broad sense the ideas of Fisher in terms of the design of hypothesis and testing, and points out that Dawkins has not produced a *p*-value for his hypothesis that God, or some form of creation, isn't necessary and does not exist.

In a very interesting development, A. notes how probabilistic analysis runs into problems when one assumes an infinity of possibilities; one of the properties of infinity, which is crucial for elaborations on the multiverse and the anthropic principle, is that with an infinite number of trials, any outcome that has a non-zero probability of happening will eventually happen. Any number less than one when raised to an infinite power will give the answer zero, then subtracting that from one will give one, which is a probability of 100%. (Strangely, A. elsewhere uses a formula of the same kind, $1 - (1 - a)^b$ where b is

$$P\left(\bigcup_{i=1}^{\infty} E_i\right) = \sum_{i=1}^{\infty} P(A_i)$$

with $0 \leqq a < 1$, to establish that the probability of life on other planets ought to be a practical certainty. See *Probability 1*, New York, Hartcourt, 1998, p. 212-213.) In plain language this means that if you try something

infinitely often, no matter how unlikely the occurrence of the event might be, it *has* to happen. Thus, playing the monkey-typing-*Hamlet*-game is not a good approach to real-life situations and real universes. How indeed can extremely improbable things happen with regularity and virtual certainty according to the 'improbability principle,' when at the same time, in the spirit of E. Borel's probability bound (which he set to 1 in 10^{50}), we'd be asked to act as though events of vanishingly small probability never happen? The answer lies in Borel's casting the problem in the framework of a *human* life (see D. Hand, *The Improbability Principle*, New York, Scientific American/Farrar, Straus, and Giroux, 2015, p. 9). The problem with the infinite multiverses favoured by Greene, Krause, Dawkins and others, is that it rests on such a misunderstanding of the idea of infinity. If we go to infinity, we can pretend to prove anything. A. notes with pertinence that whereas infinity, infinitesimals and the like smack of an idealized science, real science has been moving into the realm of information theory more and more. The question of God versus science becomes the question of who created the information set of life.

The chapter on catastrophes, chaos, and the limits of human knowledge (10) presents results in mathematics that tell us that we, in some cases, cannot know certain things.

The chapter on God and the anthropic principle (11) aims at establishing that, whereas we can say 'if the parameter values were not what they are, we would not be here to ask the question,' one cannot use such a statement to falsify the competing hypothesis 'the parameters were created the way they are in order to make a universe.' A. recalls how Stephen Hawking has wondered about the parameters of the universe all his life and pointed out that, if the electric charge of the electron had been slightly different from what it is, stars would either not burn at all or would not have exploded in supernovas to spew out in space elements we need for life. Hawking was led to the anthropic principle in his attempts to explain how a universe supporting life, which *a priori* has an incredibly small probability of emerging, ever came about, and the new atheists have embraced this theory because it's a substitute for God.

The chapter on evolution and its limits (12) argues that evolution is a theory that is not without flaws, leaving unexplained a host of behaviours and phenomena, in particular why certain species would exist at all when they seem to have gone way beyond the minimal that could be sufficient for selection. A. offers a comparison of quantum mechanics and evolution, and if he acknowledges that evolution explains the richness of life we see in the world today, he underscores that it doesn't do it through controllable prediction nor the use of formulae or mathematical organization of data.

The chapter on art, symbolic thinking and the invisible boundary (13) argues that if we ask when consciousness arose, meaning reflexive consciousness, we will not find an ally in science in answering this question; the notion of emergence as developed in philosophy does not have much scientific support. A. insists on the fact that consciousness has never been produced in a laboratory or by any experiment.

The chapter on engaging the infinite (14) is, along with chapter 9, very stimulating, being closer to A.'s primary research. After rapidly reviewing Russell's paradox, A. focuses on Cantor, and his capacity to discover levels of infinity, to carry out arithmetical operations on infinite quantities in order to understand how he could be said to 'see' infinity. From the ideas of smaller and larger degrees of infinity, and of an infinitely dense real number continuum, A. moves on to declare the absurdity of the idea of an infinite multiverse. The existence of the multiverse should enable one to find the one particular universe within the infinite collection that would by chance satisfy the requirement of matter as we know it for life to come about; for this what is needed is a continuum of parameter values from which to choose our universe, but where *are* all these infinitely densely packed other universes which are needed for the choosing to work? The case of Cantor is interesting because it provides an example where strict physical logical analysis given as explanatory and reductive cannot but fail. Gödel also showed that some truths about infinity can never be known to us, that there are properties of numbers that will forever remain outside our reach. The implication of his incompleteness theorems applied to science is that we will never be able to know everything about our universe because we are part of it; it stands to reason that the question of God's existence may be one of those Gödel-like mathematical truths that will forever stay outside our sphere of knowledge.

A.'s book raises the level relative to most popular science writing, and gets to a good critical assessment of many issues, showing a mastery of the subjects treated that is quite welcome in this ongoing discussion. He remains non-committal, as he himself acknowledges, so we get in the end one more book arguing that God and science are neither incompatible nor antithetical. There is a still largely uncharted part of this dialogue that could gain from asking whether propositions containing 'God' have empirical content, whereas here this is only really defended historically and exegetically relative to Einstein. This will not be answered without the use of a confirmation or likelihood approach, and if, e.g., the name of Unwin comes up (that of Swinburne doesn't anywhere), nothing is achieved other than to administer a lesson in the use of the probability calculus. If A. counters Dawkins by asking what is the *p*-value for atheism or non-theism, he does not even start providing his own. This gives the book an artificial flavour, consistent with its disengagement from any faith tradition (p. 5).

A. writes from the perspective of a humbler science, which would not spew out certainties and ask ‘respond!’. If it is certainly welcome, one still has to ask whether some critics will not be quick to dismiss this as another argument from the gaps in our knowledge of God. Interestingly, this question has been entertained by A., who writes convincingly that the picture, in some sciences like quantum field theory, or astrophysics, needs some inverting: it is not that we have a solid framework all the way down, and then there would subsist a small hole at the edge of our knowledge; it is rather that most of our knowledge is made up of giant holes (see p. 210). Some would recognize here a point already made by J. Polkinghorne in a different setting, namely quantum ontology versus, here, evolutionary explanations. It would have been interesting to see the author elaborate further on this and treat it from a more robust and satisfying epistemological standpoint.