Shaken Atheism: A Look at the Fine-Tuned Universe

by Holmes Rolston III

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Both astrophysicists and microphysicists have lately been discovering that the series of events that produced our universe had to happen in a rather precise way—at least, they had to happen that way if they were to produce life as we know it. Some might find this fact unremarkable. After all, we are here, and it is hardly surprising that the universe is of such kind as to have produced us. It is simply a tautology to say that people who find themselves in a universe live in a universe where human life is possible. Nevertheless, given the innumerable other things that could have happened, we have reason to be impressed by the astonishing fact of our existence. Like the man who survives execution by a 1,000-gun firing squad, we are entitled to suspect that there is some reason we are here, that perhaps there is a Friend behind the blast.

When we consider the first seconds of the big bang that created the universe, writes Bernard Lovell, an astronomer, "it is an astonishing reflection that at this critical early moment in the history of the universe, all of the hydrogen would have turned into helium if the force of attraction between protons—that is, the nuclei of the hydrogen atoms—had been only a few percent stronger. . . . No galaxies, no stars, no life would have emerged. It would have been a universe forever unknowable by living creatures. A remarkable and intimate relationship between man, the fundamental constants of nature and the initial moments of space and time seems to be an inescapable condition of our existence" ("Whence?," *New York Times Magazine*, November 16, 1975).

Astronomer Fred Hoyle reports that his atheism was shaken by his own discovery that in the stars, carbon just manages to form and then just avoids complete conversion into oxygen. If one atomic level had varied half a per cent, life would have been impossible. "Would you not say to yourself . . . 'Some supercalculating intellect must have designed the properties of the carbon atom, otherwise the chance of my finding such an atom through the blind forces of nature would be utterly minuscule' ? Of course you would. . . . The carbon atom is a fix.

. . .A common sense interpretation of the facts suggests that a superintellect has monkeyed with the physics. . . . The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question" ("The Universe: Past and Present Reflections," *Engineering and Science*, November 1981).

"Somebody had to tune [the universe] very precisely," concludes Marek Demianski, a Polish cosmologist (quoted in *Science News*, September 3, 1983, p. 152). Stephen Hawking, the Einstein of our time, agrees: "The odds against a universe like ours coming out of something like the Big Bang are enormous. I think there are clearly religious implications" (John Boslough, *Stephen Hawking's Universe*, p. 121). How the various physical processes are "fine-tuned to such stunning accuracy is surely one of the great mysteries of cosmology," remarks P. C. W. Davies, a physicist. "Had this exceedingly delicate tuning of values been even slightly upset, the subsequent structure of the universe would have been totally different." "Extraordinary physical coincidences and apparently accidental cooperation . . . offer compelling evidence that something is 'going on.' . . . A hidden principle seems to be at work" (*The Accidental Universe*, p. 90, p. 110).

B. I. Carr and M. J. Rees, cosmologists, conclude, "Many interrelations between different scales that at first sight seem surprising are straightforward consequences of simple physical arguments. But several aspects of our Universe—some of which seem to be prerequisites for the evolution of any form of life—depend rather delicately on apparent ‘coincidences' among the physical constants. . . . The Universe must be as big and diffuse as it is to last long enough to give rise to life" ("The Anthropic Principle and the Structure of the Physical World," *Nature*, April 12, 1979).

No universe can provide several billion years of stellar cooking time unless it is several billion light years across. If the size of the universe were reduced from 10^{22} to 10^{11} stars, that smaller but still galaxy-sized universe might seem roomy enough, but it would run through its entire cycle of expansion and recontraction in about one year. And if the matter of the universe were not as homogeneous as it is, then large portions of it would have been so dense that they would already have undergone gravitational collapse. Other portions would have been so thin that they could not have given birth to galaxies and stars. On the other hand, if it were entirely homogeneous, then the chunks of matter that make development possible could not have assembled. (See John A. Wheeler, "The Universe as Home for Man." in Owen Gingerich, editor, *The Nature of Scientific Discovery*.)

Physicists have made some other, quite striking thought experiments. If the universe were not expanding, then it would be too hot to support life. If the expansion rate of the universe had been a little faster or slower, then the universe would already have recollapsed or else the galaxies and stars could not have formed. The extent and age of the universe are not obviously an outlandish extravagance. Indeed, ours may be the most economical universe in which life and mind can exist—so far as we can cast that question into a testable form.

Change slightly the strengths of any of the four forces that hold the world together (the strong nuclear force, the weak nuclear force, electromagnetism, gravitation—forces ranging over 40 orders of magnitude), or change various particle masses and charges, and the stars would burn too quickly or too slowly, or atoms and molecules, including water, carbon and oxygen, would not form or would not remain stable.

It is not that we cannot imagine another world in which intelligence or life might exist. It is rather that, in this world, any of a hundred small shifts this way or that would render everything blank. Astrophysicists John D. Barrow and Joseph Silk calculate that "small changes in the electric charge of the electron would block any kind of chemistry" ("The Structure of the Early Universe," *Scientific American*, April 1980: see also John D. Barrow and Frank J. Tipler, *The Anthropic Cosmological Principle*). A fractional difference, and there would have been nothing. It would be so easy to miss, and there are no hits in the revised universes we can imagine: and yet this universe is a delicate, intricate hit.

One can still explain the universe by randomness—this universe is one of a run of universes and big bangs, and ours happened to have the right characteristics for life. Or one can invoke the many-worlds theory: the universe is constantly splitting into many worlds, some of which will be right for life. But to invent myriads of other worlds in order to explain how this one came to be seems to show an addiction to randomness in one's explanatory scheme. It seems more economical (and remember that science often recommends simplicity in explanations) to posit that there were some constraints on the only universe we know that made it right for life.

The human world stands about midway between the infinitesimal and the immense. The size of our planet is near the geometric mean of the size of the known universe and the size of the atom. The mass of a human being is the geometric mean of the mass of the earth and the mass of a proton. A person contains about 10^{28}

atoms, more atoms than there are stars in the universe. Such considerations yield perhaps only a relative location. Still, questions of place and proportion arise.

Nebulae and stars exist at low structural ranges. A galaxy is mostly nothing, as is an atom. Fine-tuned though the system is, at both ends of the spectrum of size nature lacks the complexity found at the mesa levels in Earth's ecosystem. Humans do not live at the range of the infinitely small, nor at that of the infinitely large, but they may well live within the range of the infinitely complex, a range generated and supported by the simpler but stunning microphysics and astrophysics. In our 150 pounds of protoplasm, in our three pounds of brain, there may be more operational organization than there is in the whole of the Andromeda Galaxy. The number of associations possible among our 10 billion neurons, and hence the number of thoughts humans can think, may exceed the number of atoms in the universe. Humans, too, are stars in the show.

The point is not that the whole universe is necessary to produce Earth and *Homo sapiens*. To so conclude would demonstrate myopic pride. The issue is richness of potential, not anthropocentrism. There is no need to insist that everything in the universe has some relevance to our being here. God may have overdone the creation in pure exuberance, but why should the parts irrelevant to us trouble us? We might even be a bit sorry if the entire sublime universe turned out to be needed simply for our arrival, or even for the scattering of life and mind here and there within the universe. But certainly we cannot leave ourselves out of the account, either.

Since Copernicus, physics has made us wary of claiming a privileged location for Earth. Since Darwin, humans have seemed the result of selection operating over blind variation. Since Newton, the world has seemed only matter in motion. Since Einstein, our location in space and time has seemed a function of our reference frame as observers. Humans have been dwarfed from above, celestially; deflated from below, atomically; and shown to be nothing but electronic particles. In a universe 20 billion years old and 20 billion light years across, humans, the result of 5 billion years of evolution, have felt lost in the stars and in the agelong struggle for life.

But physics has been busy painting a new picture. Christians caught up in the debate over creation in biology may not have noticed how congenial physics and theology have become. The physical world is—shades of Bishop Paley!—looking like a fine-tuned watch again, and this time many quantitative calculations support the argument. The forms that matter and energy take seem strangely suited to their destiny.