

A Universe with No Designer

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ABSTRACT: Does the universe shows signs of having been designed by a deity like those of traditional monotheistic religions? Physics is in a better position than religion to give a partly satisfying explanation of the world. Recent developments in cosmology help explain why the measured values of the cosmological constant and other physical constants are favorable for the appearance of intelligent life. The presence of evil and misery disturbs those who believe in a benevolent and omnipotent God. It is not necessary to argue that evil in the world proves that the universe is not designed, but only that there are no signs of benevolence that might have shown the hand of a designer.

KEYWORDS: fine-tuning; anthropic principle; chaotic inflation; theodicy

I have been asked to comment on whether the universe shows signs of having been designed. I don't see how it's possible to talk about this without having at least some vague idea of what a designer would be like. Any possible universe could be explained as the work of some sort of designer. Even a universe that is completely chaotic, without any laws or regularities at all, could be supposed to have been designed by an idiot, as Macbeth suggested.

The question that seems to me to be worth answering, and perhaps not impossible to answer, is whether the universe shows signs of having been designed by a deity more or less like those of traditional monotheistic religions—not necessarily a figure from the ceiling of the Sistine Chapel, but at least some sort of personality, some intelligence, who created the universe and has some special concern with life, in particular with human life. I expect that this is not the idea of a designer held by many here. You may tell me that you are thinking of something much more abstract, some cosmic spirit of order and harmony, as Einstein did. You are certainly free to think that way, but then I don't know why you use words like “designer” or “God,” except perhaps as a form of protective coloration. It would not surprise me to find that John Polkinghorne and I agree about what are the interesting questions; where we do disagree is in the answers.

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It used to be obvious that the world was designed by some sort of intelligence. What else could account for fire and rain and lightning and earthquakes? Above all, the wonderful capabilities of living things seemed to point to a creator who had a special interest in life. Today we understand most of these things in terms of physical forces acting under impersonal laws. We don't yet know the most fundamental laws, and we can't work out all the consequences of the laws we do know. The human mind remains extraordinarily difficult to understand, but so is the weather. We can't predict whether it will rain one month from today, but we do know the rules that govern the rain, even though we can't always calculate their consequences. I see nothing about the human mind any more than about the weather that stands out as beyond the hope of understanding as a consequence of impersonal laws acting over billions of years.

There do not seem to be any exceptions to this natural order, any miracles. I have the impression that these days most theologians are embarrassed by talk of miracles, but the great monotheistic faiths are founded on miracle stories—the burning bush, the empty tomb, an angel dictating the Koran to Mohammed—and some of these faiths teach that miracles continue at the present day. The evidence for all these miracles seems to me to be considerably weaker than the evidence for cold fusion, and I don't believe in cold fusion. Above all, today we understand that even human beings are the result of natural selection acting over millions of years of breedings and eatings.

I'd guess that if we were to see the hand of the designer anywhere, it would be in the fundamental principles, the final laws of nature, the book of rules that govern all natural phenomena. We don't know the final laws yet, but as far as we have been able to see, they are utterly impersonal, and quite without any special role for life. Henri Bergson and Obi-Wan Kanobi were wrong: there is no life force. As Richard Feynman has said, when you look at the universe and understand its laws, "the theory that it is all arranged as a stage for God to watch man's struggle for good and evil seems inadequate."

True, when quantum mechanics was new, some physicists thought that it put humans back into the picture, because the principles of quantum mechanics describe what *observers* would find under various conditions. But, starting with the work of Hugh Everett 40 years ago, there has been a reinterpretation of quantum mechanics as the objective (and deterministic) unfolding of a wave function that describes the observer as well as the system being observed. This work is not completed, so I can't say that we have a satisfactory completely objective formulation of quantum mechanics, but I think we will have.

I have to admit that even physicists going as far as they can go, when they have a final theory, will not have a completely satisfying picture of the world, because we will still be left with the question "Why?" Why *this* theory, rather than some other theory? For example, why is the world described by quantum mechanics? Quantum mechanics is the one part of our present physics that is

likely to survive in any future theory, but there is nothing logically inevitable about quantum mechanics; I can imagine a universe governed by Newtonian mechanics instead. So there seems to be an irreducible mystery that science will not eliminate.

But religious theories of design have the same problem. Either you mean something definite by a God, a designer, or you don't. If you don't, then what are we talking about? If you do mean something definite by "God" or "design," or if for, instance, you believe in a God who is jealous, or loving, or intelligent, or whimsical, then you still must confront the question "Why?" Your faith can leave you with no explanation why the universe is governed by *that* sort of God, rather than some other sort of God.

In this respect, it seems to me that physics is in a better position to give us a partly satisfying explanation of the world than religion can ever be, because although physicists won't be able to explain why the laws of nature are what they are and not something completely different, at least we may be able to explain why they are not *slightly* different. For instance, no one has been able to think of a logically consistent alternative to quantum mechanics that is only slightly different. Once you start trying to make small changes in quantum mechanics, you get into theories with negative probabilities or other logical absurdities. When you combine quantum mechanics with relativity, its logical fragility increases. You find that unless you arrange the theory in just the right way you get nonsense, like effects preceding causes, or infinite probabilities. Religious theories, on the other hand, seem to be infinitely flexible, with nothing to prevent the invention of deities of any conceivable sort.

Now, it doesn't settle the matter for me to say that we cannot see the hand of a designer in what we know about the fundamental principles of science. It might be that, although these principles do not refer explicitly to life, much less human life, they are nevertheless craftily designed to bring it about.

Some physicists have argued that certain constants of nature have values that seem to have been mysteriously fine-tuned to just the values that allow for the possibility of life, in a way that could only be explained by the intervention of a designer with some special concern for life. I am not impressed with these supposed instances of fine-tuning. For instance, one of the most frequently quoted examples of fine-tuning has to do with the energy of a certain excited state of the carbon nucleus. The build-up in stars of elements necessary for life, like carbon and oxygen, depends on the carbon nucleus' having an excited state at an energy within a narrow range, where in fact just such a state is found. The reason that it has to have this energy is to provide a way for carbon nuclei be formed in stars in collisions of helium nuclei with unstable beryllium nuclei, which is a necessary step in the build-up of all elements heavier than helium. But recent calculations show that, as has been long expected, without any fine-tuning of the constants of nature one would in any case expect the carbon nucleus to have a state like an unstable molecule, consisting of a helium nucleus and a beryllium nucleus, which would

naturally have an energy close to the values necessary for the synthesis of carbon and heavier elements.¹

There *is* one constant whose value does seem remarkably well adjusted in our favor. It is the energy density of empty space, also known as the cosmological constant. It could have any value, but from first principles one would guess that this constant should be very large—much too large to allow matter to clump together in the early universe, which is the first step in forming galaxies and stars and planets and people. It's too early to tell whether this is a real problem, or whether there is some fundamental principle that explains why the cosmological constant must be this small.

But even if there is no such principle, recent developments in cosmology offer the possibility of an explanation why the measured values of the cosmological constant and other physical constants are favorable for the appearance of intelligent life. Sidney Coleman has shown how quantum mechanical effects can lead to a picture of the wave function of the universe in which the wave function is the sum of many different terms, each term corresponding to a big (or little) bang in which what we call the constants of nature take all possible values. Also, as you have heard here from Alan Guth, in the "chaotic inflation" theories of Andre Linde and others our Big Bang is supposed to be just one episode in a much larger universe in which big bangs go off all the time, each with different values of the fundamental constants.

In any such picture, in which the universe contains many parts with different values for what we call the constants of nature, there would be no difficulty in understanding why these constants take values favorable to intelligent life. There would be a vast number of big bangs in which the constants of nature take values unfavorable for life, and much fewer where life is possible. You don't have to invoke a benevolent designer to explain why we are in one of the parts of the universe where life is possible. In all the other parts of the universe there is no one to raise the question.

To conclude that the constants of nature have been fine-tuned by a benevolent designer is like saying "Isn't it wonderful that God put us here on earth, where there's water and air and the surface gravity and temperature are so comfortable, rather than some horrid place, like Mercury or Pluto." Where else in the solar system but on earth could we have evolved?

Reasoning like this is called "anthropic." Sometimes it just amounts to an assertion that the laws of nature are what they are so that we can exist, without further explanation. This seems to me to be little more than mystical mumbo-jumbo. On the other hand, if there really is a large number of worlds in which some constant takes different values, then the anthropic explanation of why in our world it takes values favorable for life is just common sense, like explaining why we live on the earth rather than Mercury or Pluto. The actual value of the cosmological constant, recently measured by observations of the motion of distant supernovas, is about what you would expect from this sort of argument; it is just about small enough to prevent it from interfering with

the formation of galaxies and so on. But we don't yet know enough about physics to tell whether there are different parts of the universe in which what are usually called the constants of physics really do take different values. This is not a hopeless question; we will be able to answer it when we know more about the quantum theory of gravitation than we do now.

It would be evidence for a benevolent designer if life were better than could be expected on other grounds, including anthropic grounds. A certain capacity for joy would naturally evolve through natural selection, as an incentive to animals who need to eat and breed in order to pass on their genes. It may not be likely that evolution would produce animals who are fortunate enough to have the leisure and the ability to do science and think abstractly, but our sample of what is produced by evolution is very biased, by the fact that it is only in these fortunate cases that there is anyone thinking about cosmic design. Astronomers call this a selection effect. (Astronomers like Sandra Faber have to worry continually about selection effects of one sort or another.) The universe is very large, and it should be no surprise that, among the enormous number of planets that support only unintelligent life and the still vaster number that cannot support life at all, there is some tiny fraction on which there are living beings who are capable of thinking about the universe, as we are doing here. The real question is whether life is better than would be expected from what we know about natural selection, taking into account the bias introduced by the fact that we are thinking about the problem.

This is a question that everyone will have to answer for him- or herself. Being a physicist is no help with questions like this, so I have to speak from my own experience. My life has been remarkably happy, probably in the upper 99.99 percentile of human happiness, but even I have seen a mother die painfully of cancer, a father's personality destroyed by Alzheimer's disease, and scores of second- and third-cousins murdered in the Holocaust. Signs of a benevolent designer are pretty well hidden.

The prevalence of evil and misery has always bothered those who believe in a benevolent and omnipotent God. Sometimes God is excused by pointing to the need for free will. Milton gives God this argument in *Paradise Lost*:

I formed them free, and free they must remain
Till they enthral themselves: I else must change
Their nature, and revoke the high decree
Unchangeable, eternal, which ordained
Their freedom; they themselves ordained their fall.

It seems a bit unfair to my relatives to be murdered in order to provide an opportunity for free will for Germans, but even putting that aside, how does free will account for cancer? Is it an opportunity of free will for tumors?

It is not necessary for me to argue here that the evil in the world proves that the universe is not designed, but only that there are no signs of benevolence

that might have shown the hand of a designer. But, in fact, the perception that God cannot be benevolent is very old. Plays by Aeschylus and Euripides make a quite explicit statement that the gods are selfish and cruel, though they expect better behavior from humans. God in the Old Testament demands of us that we be willing to sacrifice our children's lives at His orders, and the God of traditional Christianity and Islam damns us for eternity if we do not worship Him in the right manner. Is this a nice way to behave? I know, I know, we are not supposed to judge God according to human standards, but you see the problem here: if we are not yet convinced of His existence, and are looking for signs of his benevolence, then what other standards *can* we use?

In an e-mail message from the American Association for the Advancement of Science, I learned that the aim of this conference is to have a constructive dialogue between science and religion. I am all in favor of a dialogue between science and religion, but not a constructive dialogue. Religion has done some good in the world, but on balance its effects on our lives have been awful. This is much too big a question to be argued here, so I'll just have to state my own opinion: with or without religion, good people would tend to behave well and bad people would do evil things, but the peculiar contribution of religion throughout history has been to allow good people do evil things. One of the great achievements of science has been, not to make it impossible for intelligent people to be religious—the example of John Polkinghorne shows that this is not impossible—but at least to make it possible for them not to be religious. We should not retreat from this accomplishment.

NOTE

1. This excited state of the carbon nucleus is 7.65 million electron volts (MeV) above the energy of the carbon nucleus in its normal state, the state of lowest energy. Calculations [Livio, M., D. Hollowell, A. Weiss, and J. W. Truran, *Nature*, Volume 340 (1989), p. 281] show that it would be necessary to increase the energy of the excited state by considerably more than 0.06 MeV in order significantly to reduce the amount of carbon and heavier elements produced in stars. Since 0.06 MeV is less than 1 percent of 7.65 MeV, this may look like some sort of fine-tuning is at work. But, as Livio *et al.* point out, if we think of this excited state of the carbon nucleus as an unstable state of a beryllium nucleus and a helium nucleus, then we should compare 0.06 MeV with the energy of the excited state relative to the total energy of a beryllium nucleus and a helium nucleus, which is only 0.281 MeV, rather than with the energy of the normal state. Since 0.06 MeV is 21 percent of 0.281 MeV, this is not a very impressive example of fine-tuning. Recent calculations [Hong, S.H., and S. J. Lee, nucl-th/9903001, to be published] show that in fact there would be expected to be an unstable state of a beryllium nucleus and a helium nucleus at about this energy, with no fine-tuning needed. For a contrary view, see H. Oberhammer, P. Richler, and A. Csoto, preprint nucl-th/9810057.