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Observership in Cosmology: the Anthropic Principle

JOHN LESLIE

The Anthropic Principle is that if the universe around us were hostile to Life then we could not be observing it. Today's cosmologists often see this as helping to explain why the observed universe has life-producing characteristics. Are they right? My aim here is to speed in new directions over territory already surveyed in two earlier papers.[1]

In B. Carter's classic formulation of it[2] the Principle has 'weak' and 'strong' forms. The weak is 'that our location in the universe is *necessarily* privileged to the extent of being compatible with our existence as observers'; the strong, that our universe 'must be such as to admit the creation of observers within it at some stage'. Carter sees the strong form as offering 'an *explanation*' when we think 'in terms of a "world ensemble" of universes characterised by all conceivable combinations of initial conditions and fundamental constants', observers existing only in 'an exceptional *cognizable* subset' of the Ensemble.

Care is needed in interpreting all this. (i) When the weak principle speaks of our being appropriately 'located', temporal as well as spatial location is in question. Carter points out that our universe must now be old enough for heavy elements (needed to build our bodies) to have been formed inside stars. (ii) In 'our existence as observers' it is *observership* and not our being *us* which is important. While our universe may well contain many trillion little green men they will be men thanks to their intelligence, not to their having human form: 'anthropic' considerations would give no excuse for a belief in an Ensemble of universes if they dealt with our human observership alone. Still, they can support such a belief only if we can assume such things as that observers must be like us in having bodies, and even bodies which could not exist in such places as the sun's centre or the surfaces of neutron stars—habitats taken seriously by a scientifically ingenious minority and particularly by G. Feinberg and R. Shapiro.[3] (iii) When the strong principle says that our universe 'must be such as to admit the presence of observers' it is not meant that this universe's basic character

1 'Anthropic Principle, World Ensemble, Design', *American Philosophical Quarterly* Vol. 19 No. 2 (April 1982), pp. 141–151; 'Cosmology, Probability and the Need to Explain Life', for the 1982–3 Lecture Series of the Center for Philosophy of Science and the Department of History and Philosophy of Science, University of Pittsburgh, and for a volume expected in 1983, editor N. Rescher. (See my 'God and Scientific Verifiability', *Philosophy* Vol. 53 (January 1978), pp. 71–79 for more on the universe's suitability for Life.)

2 'Large Number Coincidences and the Anthropic Principle in Cosmology', in *Confrontation of Cosmological Theories with Observational Data*, ed. M. S. Longair (Dordrecht and Boston, 1974), pp. 291–298.

3 See their *Life Beyond Earth* (New York, 1980). Though probably far too ingenious they are by no means cranks.

makes observership inevitable. All that is being said is that *its absence* cannot have been inevitable, else we couldn't be observing anything. The cosmic countryside is not one big minefield. It therefore admits, is compatible with, renders possible, the existence of us wide-eyed rabbits. It may still fail to render rabbits necessary. Obviously. But the cosmological literature teems with misunderstandings of this obvious point. Carter himself adds to the confusion when he speaks of 'invocation of an extended (and hence rather questionable) "strong" anthropic principle'. What he should presumably be saying is that *invoking the principle* in one's explanations is questionable because this is to assume (boldly, strongly) that some physically possible universes would never be compatible with observership; to invoke the principle would then be to suppose a queer sort of observational selection effect. In themselves, both forms of the principle are not in the least questionable, for of course the universe in which we observers now exist must be compatible with observership both *here and now* (weak principle) and *at some stage* (strong one). (iv) 'World' and 'universe' are not intended in senses making a contradiction of any claim that there actually exist many Worlds, universes, among which the observational selection effect would operate. A World or universe would here mean not Absolutely Everything, but rather a gigantic causal system *separate or, perhaps, very largely separate* from other such systems. Yet the 'or, perhaps,' can lead to problems in distinguishing the weak principle from the strong. For suppose you believe in a capital-U Universe (Absolutely Everything) which is split into many very largely separate systems; *our being in surroundings suited to Life* could then be treated *either* as a strong principle affair (since we could count our surroundings out to a distance of twenty billion light years as forming a very largely separate system, a small-u universe) *or else* as material for the weak principle (since surroundings even out to twenty billion light years might be counted not as a small-u universe but only as 'the right sort of location'). Consider a capital-U Universe envisaged by G. F. R. Ellis.[1] It is 'completely chaotic' and 'infinite (or very large)'. Some of its regions are in expansion, others in contraction, some turbulent, others smooth, but the regions are so huge that an observer towards the middle of one could not detect the others; for this observer the surrounding region would therefore be a separate universe in some useful sense; so when Ellis says that 'local expansion, homogeneity and isotropy are to be explained by the anthropic principle', no other conditions being favourable to living beings and hence observable, we might say that the strong principle was at work. But equally, we might dislike calling the regions 'universes' despite their hugeness; in that case the weak principle would be said to be operating. And similarly when what is envisaged is oscillations in which Big Bangs are followed by Big Squeezes. J. Wheeler has suggested[2] that physical laws and constants could be different after each Squeeze; only very rarely would they permit Life. It

1 'The Homogeneity of the Universe', *General Relativity and Gravitation* Vol. 11 No. 4 (1979), pp. 281–289.

2 In many places, e.g., 'From Relativity to Mutability', pp. 202–247 of J. Mehra, ed., *The Physicist's Conception of Nature* (Dordrecht and Boston, 1973).

would be natural to declare that the strong principle applied here yet there is a case for saying instead that the weak one is at work, observers being located at appropriate points in the history of a single oscillating World.

After tidying up these linguistic matters we can tackle the big questions. Could we truly have good grounds for believing in a World Ensemble, a set of small-u universes, in which conditions varied greatly from universe to universe? And if so, how ought this to affect explanations in science and perhaps elsewhere?

It quickly becomes plain that physics and astronomy as such—divorced from all biology—supply virtually no grounds for believing in such an Ensemble's existence, though they may suggest ways in which it might conceivably have come about. The chief reason for belief in very many varied universes is that, given sufficiently many of them, random changes could be rung until at long last conditions somewhere became suitable for Life. Which is to say that the ultimate reason for believing in them is that the observed conditions seem not just suitable, but *very remarkably* suitable.

It is for instance claimed that if the cosmic expansion rate at an early stage in the Big Bang had been different by as little as one part in a million million then this would have led to lifelessness (since the cosmos would then fall to bits too fast or recollapse too soon); that tiny increases in turbulence would have multiplied the primeval heat billions of times, disastrously, yet that great turbulence is what one would expect when regions causally disconnected at the start of the Bang first appeared on one another's horizons; that increasing or decreasing the strength of the strong nuclear force by one per cent would have prevented carbon forming in any quantity, while a two per cent increase would have stopped quarks forming protons, essential constituents of atoms; that chemistry and biology depend on the mass of the neutron's being greater than that of the proton by just about one part in a thousand; and so on.[1] Though some such claims may be open to some doubt their cumulative force is great. In contrast, theories of how a World Ensemble could come to exist have been sketched only very sketchily and face powerful objections. It is not even known, for example, whether the observed cosmos is sufficiently dense to be fated to collapse in a Big Squeeze, nor is it understood how it could ever rebound from collapse as is required by Wheeler's Oscillating Universe theory. And yet there is a widespread feeling that *some* theory which gives us an Ensemble must be right, no matter how wild all such theories may look; for how otherwise are we to explain the actual existence anywhere of living beings who can observe and form theories?

An indication of the strength of this feeling is the growing popularity of Everett-Wheeler-Graham Many Worlds Quantum Theory,[2] currently much favoured as a means of getting one's Ensemble.[3] Initially this was

1 For more such claims and supporting references, see the first two papers mentioned on p. 573, n.1.

2 See B. S. DeWitt and R. N. Graham, eds., *The Many Worlds Interpretation of Quantum Mechanics* (Princeton, 1973).

3 Favoured, for instance, by Carter, by P. C. W. Davies' *The Accidental Universe* (Cambridge, 1982), and by B. J. Carr and M. J. Rees in 'The Anthropic

developed on philosophical grounds, the observations predicted by it being no different from those to be expected on a more traditional approach. What troubled Everett was the essentially probabilistic nature of quantum mechanics. In classical physics, it is true, there were probabilistic expressions describing, say, the location of an atom which had bounced off another and whose present whereabouts were unknown. However, this held no mystery. Only a positivism of the most primitive type would have maintained that the atom's location *was indefinite*—that the atom was itself somehow smeared out over the expanding volume of its uncertain whereabouts, until an observation collapsed that volume to a point! Yet in quantum mechanics the collapse of the wave function could seem to involve precisely such smeared-out-ness. In a famous experiment waves of probability governing electron locations appear to pass through each of two slits in a screen and then interact, cancelling one another here and reinforcing there, just like actual waves; the patterns of wave interference can be built up over a period even when only one electron is in flight at any instant. Now, how on earth could an observer's uncertainty about whether a particular electron would pass through slit B instead of slit A make it *certain* that the electron would not go to particular points (those where wave cancellations occur) which it could go to if slit A alone were open? Everett's solution to the paradox is that every electron—and everything else— is constantly splitting so as to follow *all* the paths which have any possibility at all; thus in two-slit experiments actual electron-waves are interacting, waves composed of vastly many electrons into which an original electron has split up. Only one electron would in the end be detected by any one observer as landing on the photographic plate beyond the two slits of his screen, but this would be because both the experimental apparatus and the observer who was present when the electron began its flight would be undergoing equivalently many splits. This would induce no sense of schizophrenia since the products of any split would quickly lose almost all causal contact with one another; they would be for practical purposes in separate universes. So here at last could be a way of making some sense of the quantum physicist's typical but very odd claim that Reality is relative to the observer. For in Everett's picture just what you are going to observe a moment from now is of course relative to just which of the various you's—the ones into which you-now will have split—is in question.

In your universe at this present instant it is Undeniable Truth that there is only one you. But, says Everett, that is because the universe in question is a single twig of one of the very latest branches of a large-U Universe. The twig will in turn split into countless more, each a separate small-u universe, and in every one of them an observer bearing your name will again be able to contemplate the same Undeniable Truth. Though the Everett picture is extremely odd it is at least consistent! Please distinguish it from the self-contradictory idealistic (or extreme positivistic) picture in which observ-

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Principle and the Structure of the Physical World', *Nature* Vol. 278 (12 April, 1979), pp. 605–612.

ations collapse a wave function *which must remain uncollapsed until observations occur* despite how the evolution of any observers whatsoever *itself depends on the wave function's collapsing in particular ways* among all the ways made possible by wave function development during the entire multi-billion-year previous history of the cosmos. For Everett, the wave function of the Universe never collapses; there is only splitting, the becoming real of all the varied possibilities which the wave function describes; and splitting need not depend on observations. Measurementlike interactions can produce it long before observers arrive on the scene.

If it is said that a splitting cosmos is fantastic then the currently popular answers are, first, that when two-slit experiments appear to reveal waves it may be simplest in the long run to say that there actually are waves—real waves and not such ontological oddities as waves of probability—even if that means introducing the numerical complexity of multiple universes; and second, that the many universes *should be welcomed since they could help to explain the actual existence of observers*. This is because splits early in the Big Bang could have yielded universes (main branches of the exploding Universe) which differed greatly: in their expansion rates, in their turbulence, in the relative strengths of their gravity, electromagnetism and strong and weak nuclear forces, in their particle masses, and so forth. On Everett's account even the tremendously improbable combination of characteristics which Life apparently requires would be bound to be realized somewhere, because to Everett 'tremendous improbability' simply means realization in only a tiny subset of the branches.

However, most philosophers will not welcome multiple universes, whether of Everett's kind or of any other. For remember, the chief grounds for belief in them do not come from physics; the results of two-slit experiments, for example, could always be shrugged off with a 'Nature just is essentially probabilistic.' Instead these grounds come from biology. They concern Life's delicacy, the apparent need for fine tuning of Nature's laws and constants and initial conditions if observers are ever to evolve. But this looks suspiciously like the stuff of the much condemned Argument from Design.

The message of this paper is that it is high time we philosophers started taking such stuff seriously. Whether the cosmological evidence points to Many Worlds or to God, it does do some exciting pointing. (It might just conceivably point to this: that fine tuning is needed only for producing carbon-and-water-based observers living on planets and taking billions of years to evolve. Other observers, it might be urged, evolve in a thirtieth of a second on neutron stars or exist as laser life in the rarefied gas of interstellar space, or are pieces of frozen hydrogen whose atoms twirl and circle in biologically ordered ways, etcetera. But even that would not be boring.)

One reason for taking the matter seriously is that not only how one does one's Cosmology or one's Philosophy of Religion (*or* one's Exobiology—one's thinking about whether extraterrestrial life should be sought in frozen hydrogen or whatever) but even how one does one's Physics ought from now on to be affected by what one thinks of Design arguments. Is it true that these are hopelessly confused over the nature of probability when they present a life-containing universe as something which would be vastly improbable if lacking a special explanation such as God or multiple universes might supply? If so, then alas the same utter confusion now governs the speculations of many of the world's leading scientists. It pushes them towards the view that the observed physical laws and constants, particle masses, curvature of space, entropy imbalances and so on *are not* explicable in all their details by any still to be discovered Grand Unified Field Theory, since they are instead subject to endless variation from one to another of enormously many universes.

In the two papers mentioned at the start, I argue that the probabilistic arguments of the scientists are not confused. Instead it is we philosophers who have dreamed up muddled counter-arguments. We have reasoned, e.g., that if the universe were hostile to Life then we shouldn't be here to discuss the affair and that *therefore* the fact that we are observing an unhostile universe could not possibly call for special explanation. Or again, that *there can obviously be only one universe* and that therefore, because probability and improbability apply only where repetitions are possible, the laws and conditions characterising that universe and leading to the presence of observers cannot be improbable.

Let us not forget that the Many Worlds hypothesis may face serious competition from the God hypothesis. In a book surveying theism from Plato onwards J. L. Mackie finds little attraction in the theory that a divine Person was Designer and Creator of the cosmos, yet he recognizes that this theory has 'a formidable rival' in the position developed in my *Value and Existence*, viz. that God (not necessarily the God of Christianity or of any other religion) is best described as a creative ethical requirement that the universe exist or (which is just to phrase things differently) that God is the world's Power of Being, i.e., its creative ethical requiredness.[1] Now, while admitting that talk of a creative ethical requirement is not logical nonsense and has a simplicity which is lacked by any talk of God-as-a-Person, Mackie finally concludes that any metaphysics based on it must be too speculative. Though its falsehood could not be known *a priori* it must be implausible because of there being no actual evidence in its favour. But, I protest, this involves a very questionable manoeuvre with the concept of *actual evidence.* Surely there is actual evidence for a theory when (a) it is not logical nonsense and (b) it is simple and (c) it explains something crying out to be explained and not explained simply by other theories. The evidence may not be overwhelming or direct. It may not be of the Here-is-one-hand-and-there's-another kind which G. E. Moore finds so satisfying. It can be actual evidence none the less. Well, let us leave aside for the moment any struggles with whether the bare existence of any world at all cries out to be

1 Mackie, *The Miracle of Theism* (Oxford, 1982): *Value and Existence* (Oxford, 1979) provides the main subject-matter of a chapter. See also my 'The theory that the world exists because it should', *American Philosophical Quarterly* Vol. 7 No. 4 (October 1970), pp. 286–298, 'Efforts to explain all existence', *Mind* Vol. 87 No. 346 (April 1978), pp. 181–194, and 'The World's Necessary Existence', *International Journal for Philosophy of Religion* Vol. 11 No. 4 (1980), pp. 207–224.

explained, or again, all fuss over whether an explanation is needed for the sheer fact that the world obeys causal laws. Let us concentrate on whether *observership* needs explanation. Modern cosmology appears to confirm that it does. And though the Many Worlds hypothesis (for example in its best entrenched variation, Many Worlds Quantum Theory) provides a possible explanation here, it is hardly one noteworthy for its simplicity, is it? So long as God is not viewed as a divine Person whose existence is utterly inexplicable, the God hypothesis could well be the more reasonable. And in that case to say there was no actual evidence for it would be like saying that because black holes cannot be observed directly there could be no signs of their existence.[1]

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