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The Anthropic Principle.

The term *Anthropic Principle* (AP) was introduced by the physicist Brandon Carter, who stated that "what we can expect to observe must be restricted by the conditions necessary for our presence as observers" (Carter 1974, p. 292). The central idea of AP could be put as follows:

> AP: We can observe only those states of affairs that are compatible with the existence of observers.

The term has subsequently been applied to all manner of claims, variously obscure and bizarre. This entry restricts its attention to the central and philosophically interesting idea. Carter distinguished what he called the weak version of the principle, according to which "our location in the universe is necessarily privileged to the extent of being compatible with our existence as observers" (Carter 1974, p. 293) and the strong version that states that "the universe (and hence the fundamental parameters on which it depends) must be such as to admit the creation of observers within it at some stage" (p. 295). The distinction was meant merely to apply the simple insight of AP on the one hand to local conditions at places and times within the universe, and on the other to features of the universe as a whole. The unfortunate wording of Carter's strong principle has led many to misunderstand it as attributing necessity to the universe's fundamental parameters. Whatever appeal this idea has seems to derive from a simple scope confusion. AP tells that necessarily, if humans observe a universe, then it has the parameters that allow for the development of observers. It does not follow that if humans observe a universe then the conditions required for observers obtain necessarily.

1. Applications Within the Universe

AP is obviously true, and may appear too obvious to be of any interest. It is said to play a crucial role in explanation and theorizing about the universe. But how could a seemingly trivial, necessary truth enter into scientific explanations and inferences at all?

One can begin to answer this question by recalling that failure to consider the limits on what can be observed often leads to errors in scientific reasoning. This is well illustrated by one of John Leslie's cases of selection bias in *Universes* (1989). If a person finds all of the fish he or she has caught to be more than five inches long, this person may be tempted to inductively infer that all fish in the lake are longer than five inches. But the strength of this inference is undermined by noting that the net used cannot hold smaller fish. One can understand this epistemic situation in terms of competing explanations. The hypothesis that all fish in the lake are more than five inches long may, in principle, explain the failure to observe any shorter fish: one has not seen short fish because there are none around to see (perhaps chemical waste has rendered the adult fish population infertile). But such an explanation becomes redundant when it is noted that the method of observation prevents one from seeing smaller fish, whether there are any in the lake or not. If this person had been fishing with a regular reel and bait, it would be remarkable that he or she would have failed to catch small fish, and the hypothesis that all the fish in the lake are longer should be taken more seriously. The inference to all fish being more than five inches long is undermined by eliminating its use as an explanatory hypothesis.

It pays to be clear on what is explained here and what is not. The observational limitation—using a net with large holes—does nothing to explain, for any particular fish, why that fish is longer than five inches. What is explained is the failure to observe anything but long fish.

In a similar way, AP can serve as a check on overly zealous use of what is known as the Copernican Principle in cosmology. Copernicus famously taught that the Earth is not central to the solar system, let alone the universe. Taking this lesson to heart, cosmologists have been wary of theories that attribute special characteristics to the Earth's spatio-temporal position. The Copernican Principle instructs, roughly, to proceed on the assumption that the conditions that obtain within one's observable neighborhood are more or less the same throughout space-time. As a guard against gratuitous biases about the human place in the universe, the Copernican Principle is appropriate. But it would be equally arbitrary to rule out the possibility that in the vastness of space-time, there are isolated pockets with strikingly unique features. And it is not out of the question that humans may happen to occupy one of these special regions. Indeed, if these rare conditions are necessary for the development of intelligent life, this is just where humans should expect to find themselves. It would be a mistake akin to that in the fishing story to extrapolate too eagerly from observations of local conditions to the wider universe if these locally observed features are a necessary condition of one's being here to observe anything. For in this case one can adequately explain the failure to observe any other features, even if most of the universe is different. (One of the earliest influential appeals to AP by the physicist R. H. Dicke, in "Dirac's Cosmology and Mach's Principle" [1961], uses this kind of strategy.)

One must be careful to distinguish this lesson from some more grandiose claims made on behalf of AP. Some incautious statements by physicists have been taken to suggest that human's existence and ability to observe the universe helps to explain why those observed features took hold. Clearly this explanation goes in the wrong direction. From human existence together with certain laws of nature, it may be possible to deduce that certain conditions obtain; this is not, however, sufficient for explanation. It is the required conditions that (partly) explain why humans are here, and not the other way round. Human observational limits no more explain why any observed conditions obtain than the use of a fishing net with large holes explains the length of any fish. In each case it is only one's failure to make contrary observations that is explained.

2. Applications to the Universe's Fundamental Parameters

According to contemporary cosmology, if the values of various fundamental parameters of the universe—such as force strengths and particle masses—differed ever so slightly from their actual values, life could not possibly have developed anywhere in the universe. And it appears that these parameters could easily have been different. It is as if the universe were the product of a machine with dozens of dials that determined its features. The vast majority of dial combinations result in a universe that collapses within seconds, or that contains nothing but hydrogen, or nothing but black holes. Only the most delicate adjustment of the dials will produce a stable universe, capable of supporting life at some time and place. Without the aid of deliberate adjustment, the odds of the big bang producing a life-permitting universe appear extremely low.

In the light of these data, that the universe meets the conditions for life has struck many scientists and philosophers as a striking fact that requires explanation (whether or not this attitude is appropriate may be questioned, but it is only on this initial assumption that uses of AP arise). Some have taken these facts as the basis of a new version of the argument from design. The remarkable coincidence of physical parameters required for life may be explained by the actions of a rational agent. Others have suggested that the solution may lie in a more fundamental theory, with laws constraining the range of values that crucial parameters can take. The application of AP is supposed to undermine the need for such hypotheses. The simplest anthropic-style response takes the form of a popular glib reply: "If the physical parameters hadn't been just so, then we wouldn't be here puzzling about the matter!" The inadequacy of this response is well illustrated by the following analogy from Leslie. Standing before a firing squad, a dozen guns are fired your way, but not a single bullet hits you. Clearly you have grounds to be astonished and wonder why you have been so lucky. Did they all deliberately miss? Did someone fill their guns with blanks? It is possible that their missing you is just a fluke, but this seems incredible. It becomes no more credible when one considers that if the gunmen had not all missed, you would not be here to puzzle about it. Given that people do observe a universe, it is no surprise that they see one that meets the conditions for observers to exist. But they may well still wonder how they, or anyone, is here to see anything at all.

3. Multiple Universes

More serious uses of AP couple it with the suggestion that this universe is just one of an enormous variety of actually existing universes. (Here "universe" does not refer to the totality of what there is, but rather to a large, more or less isolated aggregate of matter in space-time.) Of course this strategy is viable only to the extent that there is any reason to suppose that there are a great number of universes. This is highly controversial. One of the proposed universe generating models is the Inflationary Theory in cosmology. The Multiple-Universe hypothesis is distinct from the Many-worlds interpretation of quantum mechanics, but some have appealed to the latter as a way in which the required variety of universes might be generated (see Leslie 1989).

How could the existence of other universes help solve a puzzle about this universe? For any improbable outcome of an event, if you repeat the type of event enough times you can expect to get an outcome of that type eventually. To take the popular example, if a monkey types for long enough, or a large enough army of monkeys is put to work, it is all but certain that somewhere, at some time, a monkey will type a sonnet. Similarly, whereas it may be extremely unlikely that any particular universe meets the conditions for life, if there are a large enough number of them, it is to be expected that at least one of them will by chance be life-permitting. The vast majority of universes will be rather bland, containing no stars or planets, let alone life. There should be no room to wonder why humans have been lucky enough to see only one of the nice universes. They may note by AP that they could not possibly have found themselves in any other kind of universe, as those universes fail to meet the conditions for human existence.

The same explanatory strategy has been employed in areas of science as diverse as statistical mechanics and evolutionary biology. Ludwig Boltzman (1895) suggested a similar idea to account for the extremely low level of entropy (i.e., roughly, the high degree of order) in the observable neighborhood. Boltzman's speculation was that the universe is extremely large in space and time, with disorder on the large scale, but large, finite regions of order within. One can picture this view as like an infinite number of coins tossed on an infinite expanse. The big picture will almost certainly be a random, disordered mess. But with maximum probability there will also be enormous finite stretches of nothing but heads, and vast regions of beautiful and orderly patterns. Boltzman noted that it is only in regions of low entropy that living organisms such as humans can be found. So on this hypothesis, people should not be surprised to find that theirs is a low-entropy environment. Similar principles are applied in Darwinian explanations of the evolution of organisms. The tree of life consists of an enormous variety of branches produced by random mutations. Most of these are hidden from human view. It is only those that have the remarkable ability to sustain themselves and reproduce that people are able to observe.

As before, care needs to be taken in stating what has been explained and what has not. The plenitude of universes does not explain why this particular universe humans inhabit is life-permitting. The answer to the question "Why is this universe suitable for life?" is not "Because there are many other universes." The existence of many universes does not raise the probability that any particular one such as this can support living creatures. At most, what is to be expected is some universe will do this.

What the hypothesis of many universes may do however, is remove the urgency of explanation regarding the particular universe in which humans find themselves. That this universe is life-permitting seems remarkable only insofar as it seemed remarkable that there was life at all. But if there are many universes, then it is not surprising that there is a place somewhere in some universe that life can develop. The more specific question of why it is this universe and not another one appears less urgent, like the question of why Jones won the lottery, or why the golf ball landed on this blade of grass. An adequate answer may be along the lines of "That's just how it turned out."

See also Cosmology; Many Worlds Interpretation; Statistical Mechanics.

Bibliography

Barrow, John, and Frank Tipler. *The Anthropic Cosmological Principle*. Oxford: Clarendon Press, 1986

Boltzman, Luwig. "On Certain Questions of the Theory of Gases." *Nature* 51 (1895): 413–415.

Carter, Brandon. "Large Number Coincidences and the Anthropic Principle in Cosmology." In *Confrontation of Cosmological Theories with Observational Data*, edited by M. Longair, 291–298. Dordrecht, Netherlands: D. Reidel, 1974–. Reprinted in *Modern Cosmology and Philosophy*, 2nd edition, edited by John Leslie, 131–129. New York: Prometheus, 1998–.

Dicke, R. H. "Dirac's Cosmology and Mach's Principle." *Nature* 192 (1961): 440–441. Reprinted in *Modern Cosmology and Philosophy*, 2nd edition, edited by John Leslie, 127–130. New York: Prometheus, 1998.

Earman, John. "The SAP Also Rises: A Critical Examination of the Anthropic Principle." *American Philosophical Quarterly* 24 (4) (1987): 307–317.

Leslie, John, ed. *Modern Cosmology and Philosophy*, 2nd edition. New York: Prometheus, 1998.
Leslie, John. *Universes*. London: Routledge, 1989.

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