

## The Anthropic Principle

Things are the way they are in our universe because if they weren't, we wouldn't be here to notice.

Brian Greene.

The anthropic principle attempts to provide an answer to the question: "Why is the universe the way it is or, why is there life?" The basic idea behind the anthropic principle is that there is much more to the universe than we can see. (1) There is a kind of a super universe with many bubble universes, each with its own inflation in this sea of bubble universes. In other words it is a multiverse idea with our universe one of an infinite number of universes. It was first introduced by the British physicist, Brandon Carter to explain coincidences in the universe regarding large numbers. (2) Since then it has been used by astronomers in several ways and is seen as increasingly important in cosmology.

The anthropic principle comes in various forms of which the most important are the strong anthropic principle and the weak form. The least controversial form is the weak anthropic principle which states that the conditions for life are a requirement whenever we look at the universe. In a more understandable form it says that the universe is the way it is, because if it were different we would not be here to observe it. In their book: *The Anthropic cosmological principle* John Barrow and Frank Tipler define it as: "The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exists sites where carbon-based life can evolve and by the requirements that the universe be old enough for it to have already done so." (3) It is interesting that the carbon-based form of life is a requirement, not just any form of life.

The strong anthropic principle makes a much bolder statement that the only type of universe permitted to exist are those which contain life at least during a part of its existence. This form is the least acceptable and is open to criticism. It is unscientific because it is not falsifiable. Scientists tend to avoid the strong form of the anthropic principle. It is clear that the anthropic principle will

create strong opinions. Andrew Liddle and John Loveday (see above) stated that the astrophysics group at the Fermi National Accelerator Laboratory had a rule that if any visiting speaker mentioned 'the A word' the seminar would end immediately. Undoubtedly the anthropic principle in its strong form is unscientific and must be rejected. In its weak form it is a "little more than an essential observational effect that needs to be taken into account in interpreting certain kinds of observations. (See (1)).

It appears there are parts of the universe not accessible to us since light from such parts of the universe did not have time to reach us. If this is what proponents of the multiverse idea as a theory, as mentioned above, have in mind, it is acceptable. However, due to the accelerated expansion of the universe such parts of the universe will never be accessible to us. In this sense the anthropic principle, even in its weak form, is unverifiable.

In cosmology the anthropic principle has proved to be powerful when used in conjunction with theories of cosmological inflation in particular those of a self-reproducing type. In such models, physical laws may vary at the very large scale universe. Liddle and Loveday indicated that the scales applicable here are much larger than our observable universe. In such regions parameters like the cosmological constant or the lifespan of a proton might differ from those in our region of the universe. Although it is clear that laws might differ from those in our region of the universe. It is imperative that the laws in our universe must support life. The self-reproducing inflation described here can be coupled to an important idea in the superstring theory known as the string landscape. Without going into too much detail it suggests that the string theory has a unique set of governing equations. However, the set of stable states of the system is very large and range from  $10^{100}$  to  $10^{1000}$  with each possible state responding to different physical laws. It is interesting to note in terms of this view known as self-reproducing inflationary cosmology, this cosmology is capable of moving regions of the universe between these states. Within the entire universe all possible states appear at different locations. To conclude it means that the anthropic arguments can be used to select among these.

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(1) Gribbin J. 2006. The Universe. A Biography. Penguin Books, U.K.

- (2) Liddle A and Loveday J. 2009. Oxford Companion to Cosmology. Oxford University Press.
- (3) Barrow J.D. and Tipler F. 1985. The Anthropic Cosmological Principle. Oxford University Press. Quoted by Liddle A. And Loveday J.