

Cosmological principle, and my view on philosophy

In this article, I will explain "cosmological principle." Then, I will introduce some of philosopher's earlier criticisms on it, and other's criticisms on science. Thereby I will explain my view on philosophy. Then, I will move on to explain my view on the interpretation problem of quantum mechanics, and conclude this article with some remarks.

"Cosmological principle" states that our Universe is homogeneous and isotropic when viewed on a large enough scale. Homogeneity means that every point has the same properties. In other words, our position in our Universe is no more special than the other positions in our Universe. Isotropy means that every direction has the same properties; our Universe does not favor a particular direction over others. Notice that I used the word "large scale." It's because our Universe is not certainly homogeneous in small scales. There are many stars near our position because we are in a galaxy called "our galaxy." However, where no galaxy is located, there are very few stars. In other words, our position is different from where no galaxy is located. Similarly, our Universe is not isotropic in small scales. At night, we certainly see more stars in the direction of Milky Way (i.e. our galaxy) than the other directions. Nevertheless, as I said before, our Universe is homogeneous and isotropic in a large enough scale, precisely speaking, bigger than 100 Mpc scales (1 Megaparsec is about 3 Million light years). For example, if you take a sphere of radius 100 Mpc than the number of galaxies inside the sphere will be roughly the same no matter where you take the ball in our Universe.

"Cosmological principle" was first stated by Sir Isaac Newton in the 17th century, but only observationally confirmed in the late 20th century. Before the observational confirmation, cosmological principle was a mere speculation. Therefore, some people had criticized it, not knowing that it was a correct principle. For example, the philosopher Karl Popper criticized the cosmological principle on the grounds that it makes "our lack of knowledge a principle of knowing something." He summarized his position as: "the 'cosmological principles' were, I fear, dogmas that should not have been proposed."¹ I was once startled to learn that cosmology is not only a branch of physics but also of philosophy. It is very absurd that philosophers such as Karl Popper, who do not have a firm background in physics and math, say utter non-sense about our Universe. Of course, it is OK

¹ Helge Kragh: "The most philosophically of all the sciences": Karl Popper and physical cosmology

that they criticized cosmological principle, because it was not known whether it was correct or not, but it is indeed pitiful that they were *convinced* on their positions without any *experimental* or *observational* evidence. Moreover, they argue their stance through words, while physicists argue their cases through math. I have a very strong doubt about arguments based on words, because philosophers, who argue through words, often contradict the hard result of physics. This doubt started when I flipped through a philosophy book when I was in high school. In the book, I read statements that seemed to contradict the result of quantum mechanics. This doubt has been strengthened when I flipped through the book "Physics" by the Greek philosopher Aristotle. It was in the style of mathematics books; it tried to proceed its own argument "logically" and "rigorously" leading to theorems, as if to suggest that there was no chance that these theorems were wrong. Nevertheless, we now know that these theorems are all wrong as shown by Galilei and Newton. My doubt on philosophy was further strengthened when I read about Feyerabend's criticism on science in my freshman writing class in college. He criticized the use of perturbation theory in quantum field theory, the physics subject developed in the 20th century. I was enraged, and came up with a good rebuttal. Perturbation theory is used in calculating many mathematical functions in calculators. Does it imply that we cannot trust the results of calculators? Also, he attacked science because there have been a lot of scientific revolutions, which, he argued, undermine the validity of scientific theories.² However, there have been a lot of revolutions in the history of mathematics, as well. Does then this make mathematics untrustworthy? I tried to send him an email, but unfortunately (or fortunately?) he had already passed away.

Nevertheless, I later learned that I once had similar ideas to the ones which philosophers proposed centuries or millenniums ago. I once had ideas similar to Plato's theory of "Ideas." I once thought that if somebody claims that life is an illusion, I might not have a logical way to disprove his idea even though I do not actually believe that life is an illusion. I once thought that there was no logical way to check that the color I sense as yellow may be perceived by some others as blue, even though I did not believe that they did. All these ideas were thought by other philosophers.

Moreover, there is perhaps need to think philosophically. Through learning quantum mechanics and general relativity, I began to have a deep appreciation of how the Universe works harmoniously. I also began to have my own epistemology, even though I did not know the word "epistemology"

² It is not a simple matter to say a preceding theory is wrong because that was superseded by another. To understand this point, read "Did Einstein really prove that Newton was wrong?."

then, nor possess the linguistic ability to express my own epistemology. However, through a book titled "Einstein's unification" I came across Einstein's diagram on his epistemological ideas.³ Anyway, I found myself deeply consenting to the diagram. I would never ever have agreed with the diagram if I had never studied quantum mechanics or general relativity. Also, from Einstein's biography "Einstein, an intimate study of a great man" I came across Einstein and Tagore's conversation. Tagore asserted that truth is not independent of man, but Einstein thought that truth is independent of man. Upon the rebuttal of Tagore, Einstein said "I cannot prove my conception is right, but that is my religion." I think that Einstein came to have a faith in this religion, through studying physics.

Now, my view on the interpretation problem of quantum mechanics. In the 20th century, the advent of quantum mechanics brought about many discussions on the philosophy of quantum mechanics, notably the "interpretation" problem of quantum mechanics. Never before had physics influenced philosophy more profoundly, as quantum mechanics is so bizarre. It says things like a single, indivisible, particle actually goes through two or more different paths at the same time.⁴ Moreover, quantum mechanics can predict with what probability such and such phenomena will occur, but that's it. It seems to suggest that our future is not determined because all that is determined is that such and such phenomena will occur with such and such probabilities. There are many interpretations of quantum mechanics, and the mainstream is "Copenhagen interpretation."⁵ I personally do not believe in any probabilistic interpretation of quantum mechanics such as Copenhagen interpretation because I believe that the future is deterministic; God gave each of us our own destiny. The only way out of probabilistic interpretation would be "hidden variable" theory, a yet unknown, hypothetical theory, which asserts that quantum mechanics as now is an incomplete theory, and there is a complete, deterministic, theory behind quantum mechanics. Most physicists agree that Bell theorem disproves the hidden variable theory, but like Nobel laureate 't Hooft, I think that there is a loop hole in the argument.

³ Actually, I saw this diagram from another book when I was in elementary school, but I didn't understand it then.

⁴ Read "A short introduction to quantum mechanics I addendum: revisiting double slit experiment" to learn more about this.

⁵ Read "A short introduction to quantum mechanics I: observables and eigenvalues" to learn more about this.

Besides believing that determinism is correct, I have no interest in the philosophical interpretation problem of quantum mechanics. Among physicists, there is a saying which I agree well with: "Shut up and calculate!"⁶ Indeed this may be what I should perhaps do, as not just the interpretation problem, but philosophy in general is too difficult for me. I had hard time reading the autobiography of Heisenberg, the father of quantum mechanics, and the autobiographical notes of Einstein, which were both full of philosophical discussions. It would be a waste of time if I too much think on philosophy instead of physics, as I am not good at philosophy; it is unlikely that I will make a big progress. But, if I calculate, I may succeed better.

Two things are sure. First, not all philosophy is nevertheless non-sense or useless. Even though Nobel laureate Steven Weinberg wrote "I know of no one who has participated actively in the advance of physics in the postwar period whose research has been significantly helped by the work of philosophers," during the prewar period, Einstein came up with the theory of relativity, which he would not have been able to discover, had he not studied any philosophy, according to Einstein himself. Moreover, even though I am not a fan of philosophy, Einstein's epistemological diagram I just mentioned fascinates me, and there is no other way to explain it without using philosophical language.

Second. How many "prominent" philosophers claimed that the theory of relativity was wrong? They had deluded themselves to believe that their reasonings through words were much more powerful and convincing than the ones through math or calculation. Thus, I have a strong doubt on the epistemology of philosophers who have never studied the basics of quantum mechanics, special relativity, and general relativity. I am sure that I know about our Universe more than any such philosophers, even the ones who specialize in "cosmology."

Problem 1. Argue that there can be no "edge" of our Universe, if the cosmological principle is correct. By "edge" I mean the surface of the universe which divides the space into what is inside our Universe and what is outside our Universe. (Answer⁷)

⁶ This saying is often attributed to either Paul Dirac or Richard Feynman, but David Mermin says that he was the one who first said this.

⁷ If there were an edge of our Universe, it would mean that the edge would be very special places. Since the cosmological principle states that every place is equivalent, the presence of the

If there is no edge of our Universe, would this mean that our Universe is infinite? You will be able to answer this question after reading our article "Manifold."

edge contradicts the cosmological principle.