The cosmological principle, and my view on philosophy

In this article, I will explain the "cosmological principle." Then, I will introduce some of the 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, then 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, the cosmological principle was 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 nonsense 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 the 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.

Let me give you an example that shows that arguments based on words, rather than math are hard to be trusted. In 2015, a Saudi Arabian cleric claimed that the Earth does not rotate. He argued that, if the Earth rotated, an airplane would be able to reach from the United Arab Emirates to China, simply by staying still on air, as China would come toward the airplane through Earth's rotation. To such a silly argument, what would you reply? In order not to get bogged down in detail, you would like to reply that you cannot feel that the Earth rotates according to Galilean principle and Newton's law. Then, to this reply, let's say that another Earth rotation denier could mention that he had heard that some Earth rotation believers claimed that the rotation of Earth manifests in the motion of objects on the Earth and claim that there was no consensus among Earth rotation believers, therefore their arguments could not be trusted. He could further go on to demand the Earth rotation believers to answer by "yes or no" to the question whether the rotation of the Earth could affect the motion of objects on Earth. However, both statements by the Earth rotation believers are basically correct; you can never feel the rotation of the Earth, if by feeling you mean that China is coming toward you when you stay still on air. Nevertheless, if you shoot a missile, the missile receives a force called "Coriolis force" due to the rotation of the Earth, and it can never hit the target unless the Coriolis effect is taken into account in the calculation of the trajectory. All these arguments can be clarified in simple mathematical formulas, yet in words, they are confusing.

Let me give you another example that shows the ambiguity of everyday words, i.e., non-mathematical words. According to Einstein's theory of relativity, the length of a moving object is shortened. This is called "Lorentz contraction." Somebody asked whether a moving object is *actually* shortened, or whether it only *seems* to be shortened. To somebody who is not familiar with the theory of relativity, it may seem a well-posed, and well-defined question without any ambiguity in

the words chosen. No. It depends on what the questioner meant by "actually" shortened and "seems" to be shortened. Let me explain. The moving object is not moving from its point of view; it moves with zero speed. According to the theory of relativity, something that is not moving is not Lorentz contracted. Thus, when the moving object sees itself, it will not be shortened. From this perspective, depending on what the questioner exactly meant by "actually," it may be legitimate to answer that the moving object is not actually shortened. On the other hand, to calculate how moving object seems to eyes of an observer, it is not sufficient to consider Lorentz contraction; one has to consider the duration of time the light takes to reach the eyes of an observer. In other words, considering the duration of time the light takes only, without considering the Lorentz contraction separately, will never give the right answer for how moving object seems to eyes of an observer. Lorentz contraction is not just an observer's effect due to the duration of time that light takes to reach the observer. In this sense, it may be legitimate to answer that the moving object is actually shortened.

My doubt on philosophy was further strengthened when I read about Feyerabend's criticism of 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 did 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.

[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?."

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" 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] Anyhow, 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 as "truth is realized through men," 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 faith in this religion, through studying physics. Even though it may be hard to make you believe Einstein's religion if you have not already studied significant amount of physics, you may be somewhat persuaded if you read my earlier essay "The mathematical beauty of physics: simplicity, consistency, and unity." There, I explained the inverse square property of Coulomb's law. Would you believe that the inverse square property of Coulomb force is not independent of man, especially considering that it obeys the inverse square property to very high accuracy and can be re-expressed in different forms beautifully? Let me also quote Murray Gell-Mann, a Nobel laureate in physics. In a Ted Talk, he said "Now, who today would claim that (i.e., unification) as a mere conceit of the human mind? That the force that causes the apple to fall to the ground is the same force that causes the planets and the moon to move around, and so on? Everybody knows that. It's a property of gravitation. It's not something in the human mind. The human mind can, of course, appreciate it and enjoy it, use it, but it's not -- it doesn't stem from the human mind. It stems from the character of gravity."

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

[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.

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 loophole in the argument. Also, I believe that EPR paradox, proposed by Einstein, Podolsky, Rosen is a genuine paradox, even though most contemporary physicists do not believe so.[6]

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!"[7] 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 a 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 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

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

[6] Read "EPR paradox" to learn more about this.

[7] 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. N. David Mermin, "What's wrong with this pillow?" Physics Today, April 1989

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 into believing that their reasonings through words were much more powerful and convincing than the ones through math or calculation. Thus, I believe that the epistemology of philosophers who have never studied the basics of quantum mechanics, special relativity, and general relativity can't be trusted.

The following quote by physicist Sabine Hossenfelder sums up my view on philosophy well. "Like good psychologists, good philosophers of science succeed in making themselves superfluous. And like good psychologists, they shouldn't be offended if a patient furiously denies needing help."[8]

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. (Answer[9])

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."

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[8] p220, "Lost in math" by Sabine Hossenfelder

[9] 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 edge contradicts the cosmological principle.