

Anthropic Principle

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Disclaimer

- I am not going to give a serious scientific talk
 - This talk is scientifically vacuous
- I am neither an expert on the anthropic principle nor a supporter of it
 - If you have any objections, don't ask me
- I chose this topic simply because this is a special seminar to celebrate Sanghyeon's retirement

The most incomprehensible thing about the universe
is that it is comprehensible.

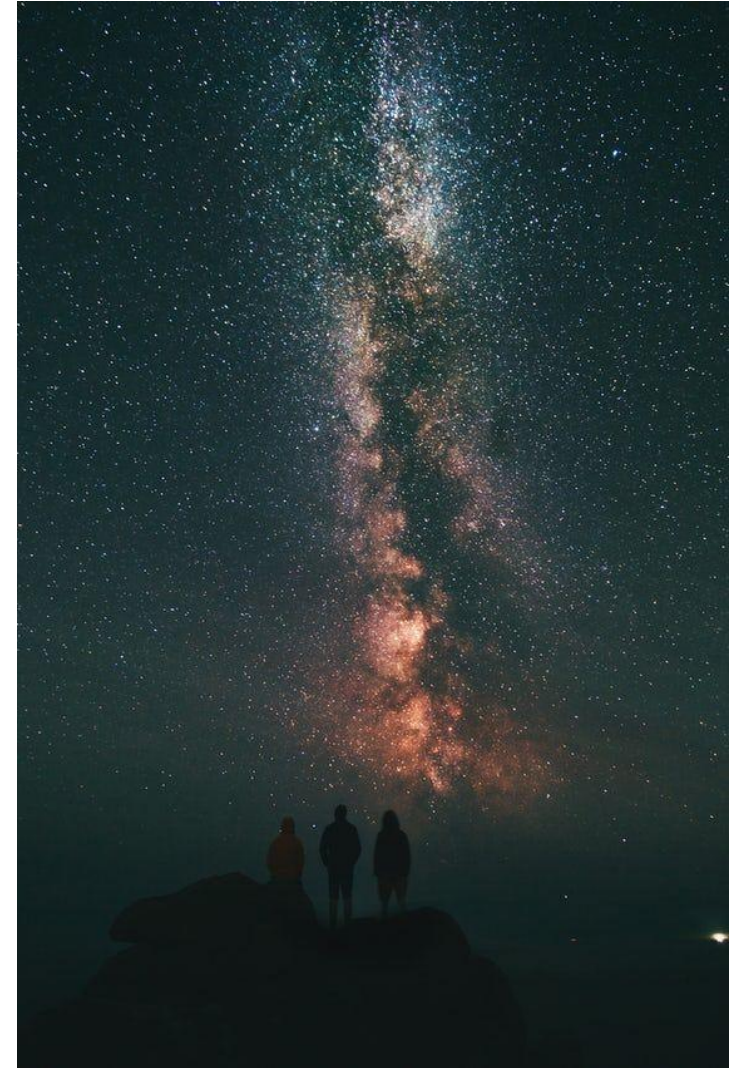
— *Albert Einstein (1936)*

"Physics and Reality". Journal of the Franklin Institute. 221 (3)

Reduce Number of Unanswered Questions

- One aspect of science is to reduce the number of unanswered questions.
- This is especially true for particle physics.
 - The ultimate goal is to find the so-called “theory of everything”.
- Suppose we find it. Then we are left with a question:
 Why does it have such a form?
 - One possible answer: mathematical consistency
 - It should be accepted as a kind of fundamental axiom of our universe
 - It cannot be answered within science
- Actually, there is another question which, I think, is more fundamental.

Why is our world governed by laws rather than chaos?



Why can our world be explained by scientific laws?

Wigner's puzzle

COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS, VOL. XIII, 001-14 (1960)

The Unreasonable Effectiveness of Mathematics in the Natural Sciences

Richard Courant Lecture in Mathematical Sciences delivered at New York University,
May 11, 1959

EUGENE P. WIGNER

Princeton University

“The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve. We should be grateful for it and hope that it will remain valid in future research...”



Eugene Wigner

Physics = Art of Approximation

“[T]he mathematical formulation of the physicist's often crude experience leads in an uncanny number of cases to an amazingly accurate description of a large class of phenomena.”



"Spherical cow"

Reorganize the questions

Question 1: Why does the universe exist?

- I can't imagine any reasonable answer. Just accept the existence like a fundamental axiom in mathematics.

Question 2: Why is our universe governed by physical laws?

- Two possible responses
 1. I can't imagine any reasonable answer. It is not a scientific question.
 2. All possible multiverse + some kind of the anthropic principle

From the viewpoint of reducing the number of unanswered questions, introducing multiverse and anthropic principle may be more economical and minimal than leaving the question 2 unanswered.

In what sense is the anthropic principle relevant?

Logically, there can be two types of universes

- Chaotic universe. No rule. No law. No logic at all.
 - ➔ No life. No human being ➔ We cannot exist in these universes
 - ➔ Ruled out by the anthropic principle
- Universes governed by some laws
 - Possibility of intelligent life

Existence of Human Being

- The most reliable and definite experimental fact in our universe.
 - We should take all data into account without prejudice.
 - Intentionally ignoring this fact violates the fundamental spirit of science.
- In this sense, the anthropic principle is not a matter of preference.
 - Just assuming the existence of some fundamental law is ungrounded like Plato's idea.
 - Need to separate selection effect from inevitable consequences of physical laws
- Accepting the idea of multiverse is necessary in this context.
 - Provides an answer to the Wigner's puzzle.
 - Once we accept (maybe reluctantly) the existence of multiverse, then we can further discuss possible types of multiverse

“Evolution” of Multiverse

- Many-world interpretation in QM
 - Allow different initial conditions. Same fundamental constants.
- Inflation
 - Some fundamental constants can be different
- String landscape
 - Most of the fundamental constants including spacetime dimensions can change

Still, all these multiverses assume some definite mathematical laws of nature. I would add another kind of multiverse which is very chaotic and cannot be described by any law.

Origin of the Anthropic Principle

- Officially coined by Brandon Carter in 1973 at a symposium in Kraków celebrating the 500th anniversary of Copernicus's birth
 - "Reaction against exaggerated subservience to the Copernican principle"
 - "Although our situation is not necessarily central, it is inevitably privileged to some extent"
- Our very existence as observers constitutes a powerful piece of data that introduces a profound selection effect into our scientific observations

Stance of Leading Physicists

According to Gemini 2.5 Pro Deep Research,

- Weinberg: the pragmatic proponent
- Susskind: the leading advocate
- Hawking: the sophisticated frameworker
- Witten: the reluctant adopter
- Gross: the staunch critic

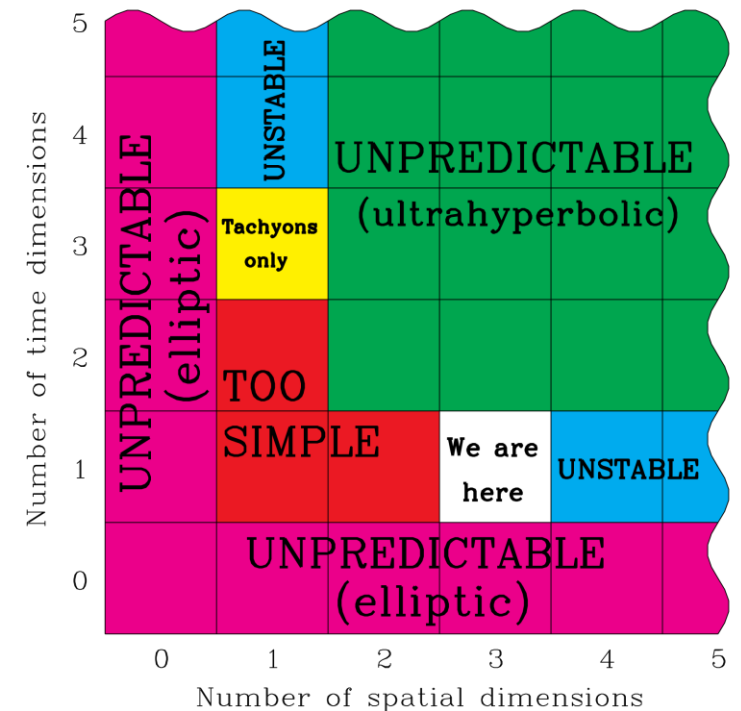
WAP and SAP

- Weak Anthropic Principle (WAP)
 - The properties we observe in the universe must be compatible with the existence of observers.
 - Epistemological principle constraining our inferences
 - Does not explain the universe's properties

- Strong Anthropic Principle (SAP)
 - The universe must have properties that allow life to develop within it at some point.
 - Teleological or metaphysical claim
 - Ontological principle that the universe is compelled or designed to produce observers

Some examples of AP

- Weinberg's argument of the upper bound of the cosmological constant
- Boltzmann's solution to the claim that the 2nd law of thermodynamics violates Poincare recurrence theorem
 - The universe must have started from the initial state with very low entropy
- Spacetime dimension = 4
 - Temporal: 1
 - Spatial: 3
 - Other dimensions are ruled out
- Explanation of nucleosynthesis of ^{12}C by Hoyle
 - May not be true
- Dicke's solution to Large number coincidence raised by Dirac



What is all the fuss about?

Why has this got to do with Sanghyeon's retirement?

Sanghyeon and IBS

- Everyone knew that Sanghyeon was exceptionally talented in many areas even when he was a student.
 - Not only among his peers but also among the professors
 - Not only in physics but also in arts, dance, cooking, writing and so on.
- After seeing how Sanghyeon handled a task, Prof. D. Min was so satisfied that he once proclaimed:
 - * Prof. D. Min is the person who first conceived and materialized the idea of IBS around 15-20 years ago.

"Mr. Chang is the real worker!" ("장군이 일꾼이야!")

Sanghyeon and Anthropic Principle

- I once wondered how CTPU managed to operate so smoothly.
 - A kind of fine-tuning problem suitable for the anthropic principle
 - The primary reason, of course, is Director K. Choi.
 - But is that enough?
- I recall another IBS in particle physics, but it no longer exists.
 - The primary reason, of course, was what you all know.
 - But what happened if there had been another Sanghyeon there?
- Existence of CTPU can be explained by the presence of Sanghyeon
 - # of "multiverse" = 2 in this case

Prediction

- If this argument is correct, CTPU is doomed now.
- But the anthropic principle does not predict when it will happen.
 - In any case, all human beings are doomed.

Thank you for your patience