**Looking back to the beginning of the universe, shaping the future**

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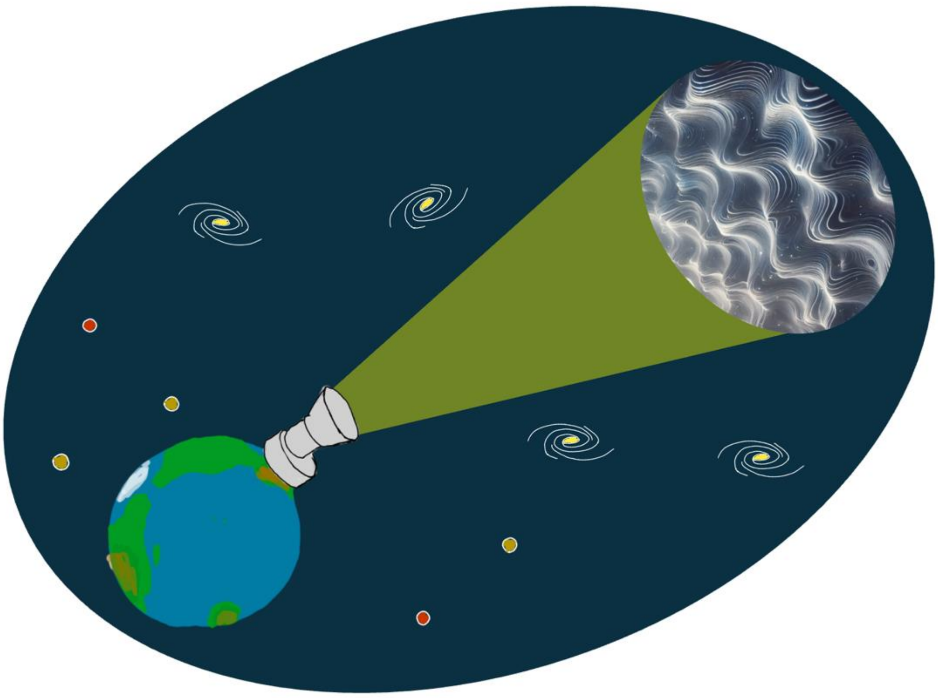
Have you ever wondered how the universe began as a child? I guess you have. The universality of this curiosity is shown in the fact that humanity has created variety of myths throughout its history in all eras and places. However, nowadays, the pursuit of answers to such questions goes beyond myth and enters the realm of physics. That is, we can tackle this mystery by observations with cutting-edge technology and reasoning. I am working on the scientific endeavor of studying the beginning of the universe by observing the cosmic microwave background radiation, the electromagnetic waves that come from the farthest reaches of the universe. Through studying the origins of the universe, I particularly want to find answers to the two questions, "What is the origin of the structures currently found in the universe?" and "Can we unify the two theories, quantum theory and general relativity?"

Let me explain the background of these open questions. First, regarding the origin of the structure of the universe. Think of the things around you: a desk, yourself, a school. Expanding the scale, you can think of your town, the land of your country, and the Earth. The solar system, the Milky Way, the cluster of galaxies... At this scale, we know that there are areas in the universe with a lot of matter and areas without. You and I are in an area with a lot of matter. Such large-scale structures in the universe were formed as slight fluctuations in density in the early universe grew due to gravity. This process is well explained by the established Big Bang cosmology. But how did those slight density fluctuations in the early universe arise? This is still unknown.

Next, let's discuss the second open question: "Can we unify the two theories, quantum theory and general relativity?" The fundamental theories of physics that humanity has reached so far are quantum field theory, which describes microscopic phenomena, and general relativity, which explains gravitational phenomena on a macroscopic scale. Great efforts have been made to create a quantum theory of gravity by unifying these two theories. However, the lack of experimental and observational data makes theoretical construction challenging.

By precisely measuring the direction of light wave oscillation of the cosmic microwave background and seeking characteristic pattern in it, we might get answers to these two questions. In other words, we can test the following theoretical hypothesis: "Gravity is quantized, and during the unique period of rapid inflation in the early universe, quantum fluctuations in gravity and energy occurred. Among these, the energy fluctuations became the origin of cosmic structure.”



I pursue this research not only to answer humanity's big questions about the origins of the universe but also because I'm driven by a curious spirit to discover the unknown. Researching the early universe is a way to uncover mysteries that directly relate to our existence. I'm especially fascinated by how the cosmic structure, which includes us, was born from quantum fluctuations. When I was in high school, I had the opportunity to attend a talk by a researcher in this field, which evoked my interest and set me on this path.

I am also very attracted to the fact that cutting-edge technology is used in cosmic research. Observing the faint cosmic microwave background requires the development of various instruments, such as superconducting detectors and readout systems, dilution refrigerators, and optical apparatuses. It also requires computational technology to handle massive data, and theoretical model building across various fields. Working with these tools and collaborating with researchers from different disciplines to make new discoveries is a joyful experience for me as a scientist.

What impact might the findings of this research have on how we think and act?

If it is proven that all structures in the universe originated from quantum fluctuations in the earliest universe, the impact will be wide-ranging. From a physics perspective, the unification of quantum theory and general relativity will become more realistic. Since it would be the first evidence that gravity can truly be described using quantum theory, this will provide a stronger confidence that our approach is correct and help us to build a better theoretical framework. Moreover, observing the quantum fluctuations of the early universe means observing highest-energy phenomena we ever have. It will help us refine and select unified physics theories at high energies, ultimately leading us closer to the truth. This research also has significant implications for understanding other cosmic mysteries like dark matter and dark energy.

Next, significant impacts can also be considered from a philosophical perspective. If all structures derive from quantum fluctuations, our understanding of existence itself may change. If the recognition that humans, other living things, and even stars ultimately come from the same source, it may lead to a more integrated view of life's position and humanity's role in the universe. This may bring changes in religious beliefs, ethics, and social values, leading to a reassessment of human relationships with each other and nature.

Moreover, the technological applications cannot be overlooked. Superconducting detectors developed for cosmic microwave background observations could be used for other purpose like medical imaging and geological exploration. As understanding of quantum theory progresses and the properties of gravity are deeply clarified, new technologies may develop based on that. For instance, measuring instruments using quantum gravity can be expected. These will not only expand theoretical exploration but also provide practical benefits in many fields, including everyday life.

In this way, advances in early universe research will have wide-ranging academic, philosophical, and technological impacts, holding the potential to change our future.

Acknowledgment

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