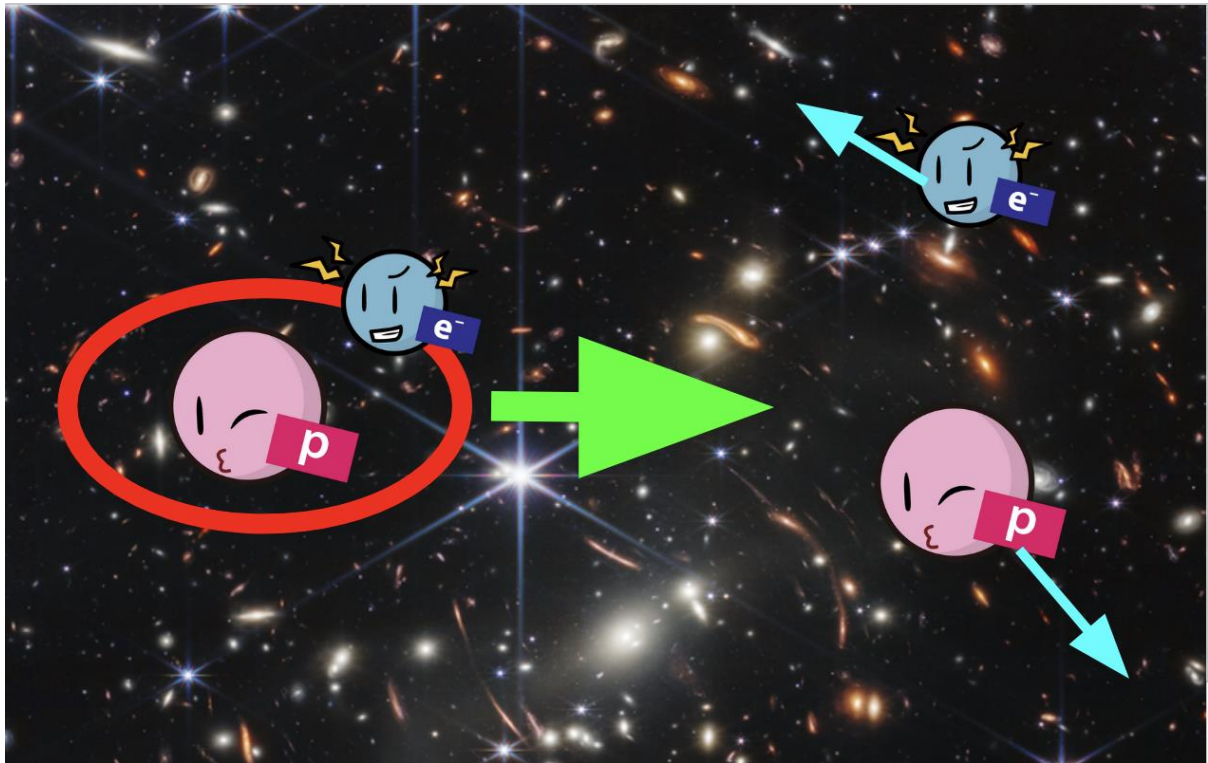


Cosmic Reionization: Exploring the Origins of the Universe

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As we study in junior high school, everything around us is composed of atoms, which are very small particles, and molecules, which are formed by combining atoms. For example, water is composed of many water molecules, and a water molecule is composed of two hydrogen atoms and one oxygen atom. In this way, matter is made of atoms. More than 100 kinds of atoms have been discovered so far.

Among these many kinds of atoms, which is the most important? There are various opinions; some might suggest oxygen, essential for life, or gold, which is both expensive and valuable. However, one compelling answer is hydrogen. A hydrogen atom is the simplest atom, consisting of one positively charged proton and one negatively charged electron. Astonishingly, over 90% of the universe is made up of hydrogen.

Therefore, understanding how hydrogen has evolved is crucial to comprehending the evolution of the universe itself. Let me now explain how hydrogen has changed throughout the universe.

First, it is believed that the universe began with the Big Bang. According to Big Bang cosmology, the universe started in a state of high temperature and high density and has continued to expand ever since, leading to the formation of the universe as we know it today. At the onset of the universe, various particles were vigorously moving around. Protons and electrons, the building blocks of hydrogen atoms, were not yet bonded together but were instead moving independently. This energetic state of matter is known as plasma.

However, approximately 380,000 years after the Big Bang, protons and electrons finally combined to form hydrogen atoms. This significant event has been confirmed by satellite observations and is universally acknowledged as a fact.

However, in the current universe, almost all the hydrogen atoms have once again dissociated into a plasma state. This process, known as cosmic reionization, is believed to have occurred a few hundred million years after the Big Bang. The first stars and galaxies, which formed during this same period, are thought to have emitted ultraviolet light that caused the hydrogen atoms to break apart. The specifics of when, at what pace, and by what mechanisms cosmic reionization occurred remain largely unknown, making it one of the open questions in astrophysics. Solving these questions is my current goal.

My journey into the field of astrophysics began when I attended a lecture on cosmology and particle physics as a junior high school student. There, I learned that neutrinos, a type of elementary particle, affect the distribution of galaxies. I was captivated by the revelation that physics could bridge the vast expanse of the universe and the microscopic world of elementary particles within a single theoretical framework. This realization sparked a profound curiosity in me, and I became determined to explore this fascinating field further through my own research.

In my current research on cosmic reionization, I explore the vast history of the universe through the microscopic lens of hydrogen atoms reacting with ultraviolet light. This process is intimately linked to the emergence of the first stars and galaxies, tying directly into the

fundamental questions of how the universe began and where we come from. I find profound joy in delving into such intriguing topics and contributing to our understanding of these cosmic phenomena.

Additionally, the promising nature of astrophysics research further motivated me to pursue this field. There are still many fundamental mysteries in the universe, such as cosmic reionization, that remain unsolved, making it a profoundly rewarding area of study.

Moreover, the field of astrophysics is not only full of mysteries but also equipped with powerful tools to unravel them. For instance, the James Webb Space Telescope, launched in 2022, has the capability to capture detailed images of distant galaxies, revolutionizing our understanding of the cosmos. Future projects such as the Thirty Meter Telescope (TMT), which boasts a 30-meter mirror, promise even more discoveries. This ensures ample opportunities for today's junior high students to participate in groundbreaking scientific advancements.

Understanding the early universe significantly impacts scientists in various other fields. For example, research on cosmic reionization enhances the understanding of plasma physics, and the study of chemical reactions in the early universe is connected to the understanding of the origin of life. Since astrophysics integrates various sciences, its study results revolutionize the perspectives of scientists in many fields.

Research in this field will not only revolutionize the lives of scientists but also impact everyone's daily life. A primary aspect involves the data that astrophysics handles and how it is analyzed. Modern telescopes gather vast amounts of data daily, and this total is continuously increasing. To sift through this extensive data for interesting celestial objects and phenomena, scientists employ various methods, including machine learning. Furthermore, once relevant data is collected, they must analyze it using sophisticated statistical techniques such as Bayesian inference.

This challenge is not unique to astrophysics; it pervades modern society as well. With digitalization advancing across various sectors, companies are now able to collect massive amounts of data. However, how to effectively utilize this data remains largely uncharted. Consequently, the analytical techniques developed in astrophysics are expected to be increasingly adopted in broader societal applications, serving as a model for big data utilization.

Furthermore, astrophysics is expected to serve as a gateway for many to delve deeper into the realms of physics and statistics. As an applied field, astrophysics integrates a broad spectrum of physical sciences, such as Einstein's general relativity, to conduct its research. As the outcomes of these studies become more widely known, it is anticipated that they will spark a broader interest in not just astrophysics but in physics as a whole.

Humanity has gazed at the night sky and studied the movements of the stars since ancient times. Theories such as Newton's classical mechanics and Einstein's theory of relativity have evolved alongside observations of celestial phenomena. Moving forward, astrophysics will continue to pave the way for future advancements in physics, enhancing understanding among both researchers and the general public alike.

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