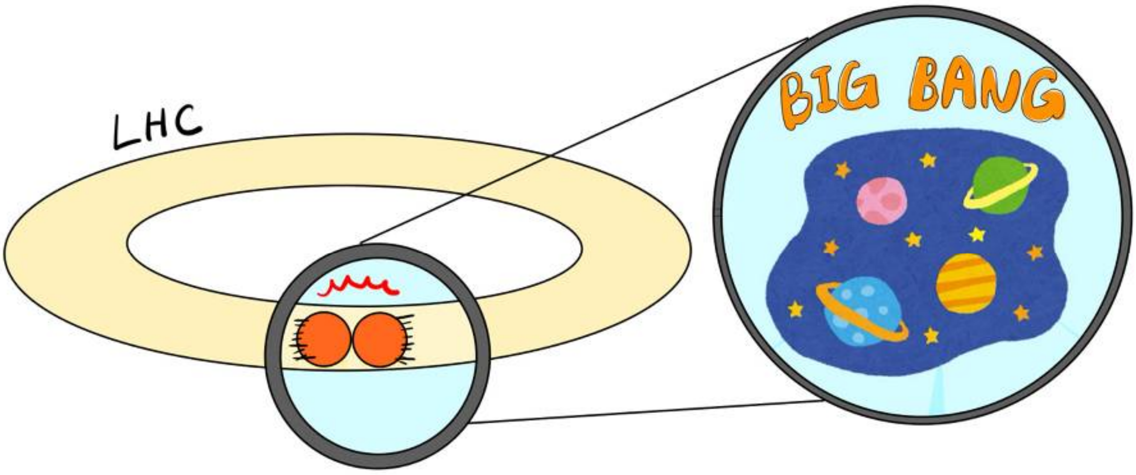
Unlocking the Secrets of the Universe with Tiny Particles

Risako Tagami



Have you ever looked up at the night sky and wondered, “How did the universe begin? What will happen to it in the future?” These are some of the biggest questions people have asked for a long time. One way for scientists to explore them is by studying the tiniest building blocks of nature, elementary particles.

About 100 years ago, scientists discovered the universe is expanding. This suggests it began in a very small, dense state. Although we cannot go back in time to see the early universe, we can recreate a similar situation here on Earth by using a huge machine called a particle accelerator.

I work with the largest accelerator in the world, the Large Hadron Collider (LHC), located in Europe. At the LHC, we speed up tiny particles called protons to nearly the speed of light and smash them together. These high-energy collisions can recreate the extreme conditions that existed just after the Big Bang, allowing us to explore the behavior of matter under such intense energy and density.

Protons are among the fundamental constituents of matter. Everything we can touch or see in the universe, like stars, planets and even your body, is made of just about 5% of all the matter in the universe. This visible matter includes particles like protons, neutrons and electrons. Protons and neutrons themselves are made of even smaller particles called quarks. Quarks and electrons are examples of elementary particles, which we believe cannot be broken into anything smaller. By observing how these particles behave during collisions, we uncover the basic physical laws that have shaped the universe from its earliest moments to today.

But what about the remaining 95% of the universe? Around half of it is something called dark matter, which we cannot see or touch, but we know it exists because of its effects. The LHC also might help us discover what dark matter really is by possibly creating dark matter particles directly.

Therefore, by smashing tiny particles together and studying what comes out, we're trying to understand the history of the entire universe. That's the goal of my research and it's a journey filled with wonder and discovery.

What I find most exciting about my research is the chance to discover something completely new about the universe. At the LHC, we smash protons together at the highest energy ever created by humans. No one has ever explored this energy range before, so we have a real chance to be the first scientists to find answers to long-standing cosmic mysteries. These collisions could open a window into an unseen world of particles and forces, something that makes this work endlessly thrilling. What makes this research even more interesting is that I get to think deeply and analyze the data myself. I spend time carefully looking at patterns and testing ideas, just like solving a mystery. When I find a small clue or make progress toward understanding how the universe works, it gives me a huge sense of accomplishment, feeling like I'm taking one step closer to answering the biggest questions in science.

Another reason I enjoy this research is that we can control what we're studying. Some people might say we should just observe the universe using telescopes. That's helpful, but if we want to study the early universe, we have to rely on signals that have traveled for billions of years. These signals are weak and hard to interpret. We often don't even know if they contain the exact information we need. In contrast, at the LHC, we create energetic collisions ourselves, right in front of our detectors. I work with the ATLAS experiment, one of the huge detectors at the LHC. It's designed to measure what happens in each collision. Because we control the process and use precise instruments, we can study things in a clearer and more detailed way. That's what makes my research both exciting and meaningful to me.

If I could go back in time and give advice to my 12-year-old self, there would be two things I would say.

The first is: make the most of your math classes. When I was in middle and high school, I found math the subject I found the hardest to understand in terms of purpose. I didn't hate it, and I studied it as I was told, but I didn't really see why it mattered. Looking back, I realize that was a missed opportunity. Now, I see math as the language we use to read and understand the universe. Imagine the universe as a mystery novel. In a typical mystery novel, there's usually a structure made of patterns and logic that helps the readers figure out who the culprit is. Both the story and the clues are written in natural language, so we can follow the reasoning and reach the answers. In the same way, the universe has its own mysteries, and the framework that guides us toward the answers is physics. But unlike a novel, the universe isn't written in natural language. It's written in the language of math. That's why learning math is so important: it gives us tools to understand the rules of physics and therefore uncover the secrets hidden in the universe. If I had realized that math is not just a school subject but a powerful tool for understanding the world, I think I would have enjoyed studying it much more.

The second is: practice thinking logically. As a scientist, I often have to use logic to understand results and make sense of data. I also need to present my thoughts clearly and logically when explaining my research or talking about my strengths and weaknesses. In Japanese educational system, we don't always get enough opportunities to practice this kind of thinking unless we try on our own. I wish I had made a habit of thinking logically about everyday situations and choosing my actions carefully. That would have been great training and helped me make better decisions with fewer regrets.

Note: I have used ChatGPT for paraphrasing while writing this essay.

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