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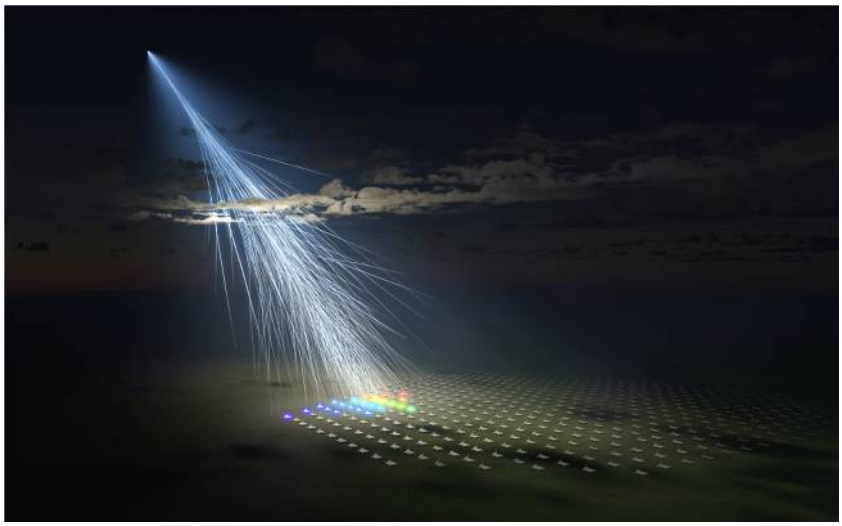
Chasing the Wonders of Nature



Conceptual illustration of the Amaterasu particle;
the highest energy event in the Telescope Array experiment
ICRR https://www.icrr.u-tokyo.ac.jp/news/14465/

Ever since I was a kid, I have been fascinated by nature. When I was little, my main interest was bugs and animals. I would often catch insects with my friends, and my parents frequently took me to zoos and farms. I loved interacting with nature by feeding the animals and going horseback riding. On top of that, my parents often took me to science museums. While most kids my age were begging to go to amusement parks to ride roller coasters, I always wanted to spend my weekends at the science museum. My mom probably thought I was a bit unusual for that, but she still kindly took me to as many different museums as she could. Back then, I didn't understand any of the complicated math or physics behind the exhibits. However, walking through those halls taught me something very important: the natural world is completely full of wonders, and exploring science is incredibly fun. In many ways, those science museum trips became the true starting point for my entire journey.

Once I started elementary school, my interest shifted to stargazing. I learned that stars are classified by their brightness, called magnitude, and that they form patterns like the Summer Triangle. Wanting to see what I had learned in books with my own eyes, I asked my parents to show me the night sky across different seasons. Seeing those constellations in real life was beautiful beyond words. As I read more and learned just

how incredibly hot, massive, and far away those stars were, I was able to appreciate their beauty on a much deeper level. Through these experiences, I grew to love the natural world. Nature itself became my greatest inspiration to study science, especially physics and astronomy.

As I moved through junior high, high school, and university, I dove deeper into these subjects. I learned that nature follows strict rules, and by using the power of math, we can actually predict how the universe works. I realized that nature's beauty is not just in how it looks, but in its "universality"—the fact that the same rules apply everywhere. By then, my interest in science had grown into a deep passion.

While studying physics, I learned about the most extreme phenomena in the universe. I discovered things like neutron stars, where just one cubic centimeter weighs a billion tons; black holes that are billions of times heavier than our Sun; and galaxy clusters stretching across 10 million light-years. These mind-boggling facts reminded me of how tiny human imagination really is and made me want to chase after this kind of wonder. I am deeply satisfied with my decision to pursue my passion for science, and I am fully committed to continuing on this path. The study of science is undeniably challenging and often demands immense perseverance. However, this struggle is ultimately rewarded with a profound connection to the mysteries of nature. These natural wonders are infinitely more fascinating and astonishing than any human invention. In today's world, which is increasingly flooded with artificial creations generated by AI, it is my sincere hope that more young people will engage with the true marvels of science.

Also, reading papers about world-first discoveries changed how I thought. I realized these breakthroughs weren't just made by "important people" far away. In fact, some Nobel Prize-level discoveries, like pulsars and exoplanets, were made by graduate students. Knowing this gave me tremendous courage to dive into the world of research myself.

Currently, I am researching the origin of ultra-high-energy cosmic rays (UHECRs). Cosmic rays are tiny, invisible particles raining down from space. Some of them carry a trillion times more energy than the particles produced in nuclear power plants. We still do not know exactly where these extreme particles come from, but they must be related to the most violent events in the universe, such as supermassive black holes,

galaxy collisions, or exploding stars.

I am working as a member of the Telescope Array experiment. Our array of detectors collects particles falling from the sky to detect "air showers" created by UHECRs. When a UHECR hits our atmosphere, it collides with an air molecule. That crash is so powerful that it creates a shower of new particles, scattering them just like a break shot in a game of billiards. These new particles are moving so fast that they crash into even more molecules, eventually turning a single UHECR into billions of particles.

The Telescope Array consists of detectors spread out every 1.2 kilometers over a massive 700-square-kilometer area. Amazingly, we can see detectors that are more than 10 kilometers apart react at the exact same time! This is the very footprint of a UHECR. I support the experiment from both the hardware side, by maintaining the detectors, and the software side, by analyzing data. It is a huge thrill when a detector I put together actually works. On top of that, it lets me experience the truth of science firsthand.

In my analysis, I use computer simulations to figure out physical values. Taking the physics I learned in class and actually using it with my own hands is a rare and special opportunity. It brings me great happiness and makes me feel like I am opening up the very frontiers of science.

When the origin of UHECRs is finally revealed, unlocking the mystery of these high energies that cannot be created on Earth will help us understand how the universe was formed. It might even provide hints for next-generation energy industries. I am convinced that researching UHECRs is the perfect subject to fulfill my sense of wonder.

I used Gemini to improve the language and grammar.