Collider: The most advanced power of humans to explore how the world forms

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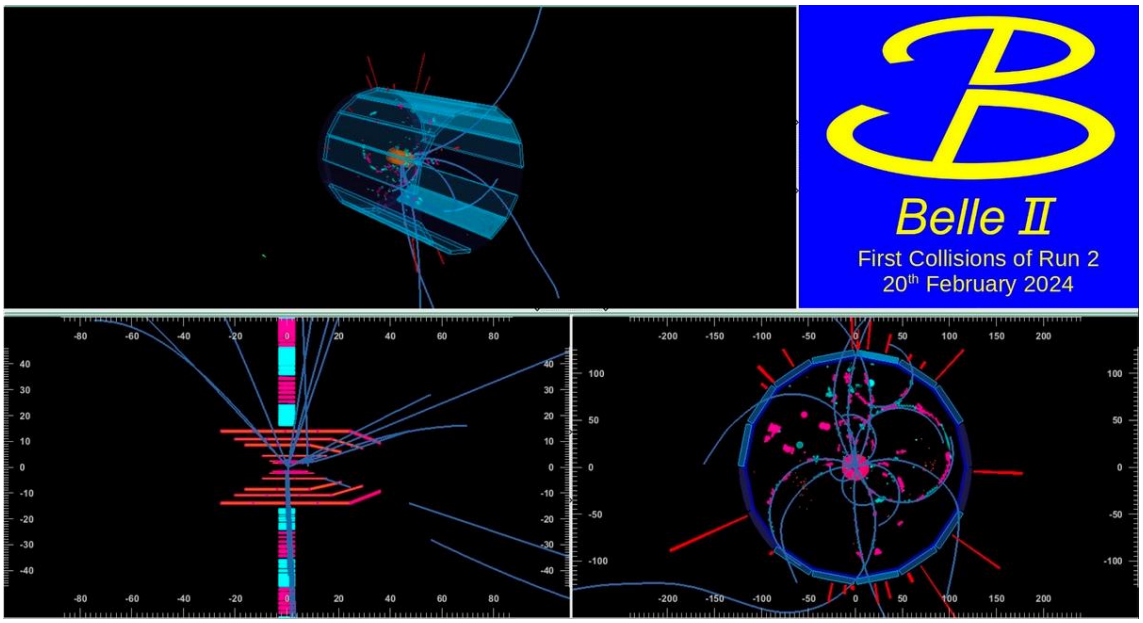

(fig: https://www2.kek.jp/ipns/ja/news/5413/)

I have always been interested in science and our understanding of the natural world since I was a child, thanks to many fantastic scientific public books and science fiction artworks. Imagining how the world forms and how it evolves was a fantastic experience for me. When I was in junior high school, I encountered a sci-fi novel called The ***Three-Body Problem***, in which aliens block the scientific development of human beings by hindering the operation of collider experiments. An anime ***Steins;Gate*** also develops its story on the stage of a collider, the Large Hadron Collider (LHC) at "SERN." Scientists in "SERN" use the LHC to produce small black holes and carry out evil experiments, trying to control the whole world. These sci-fi artworks sparked my curiosity about colliders. I started to wonder: What are colliders? Why are they so important in the scientific field that the aliens have to hinder the collider experiments to block human science? Why are they so powerful that evil scientists use colliders to dominate the world? With an interest in the natural world and curiosity about colliders, I became a physics student, devoting myself to the study of collider experiments.

Colliders are not pure fantasy; they are tools we actually use to explore the world, and

even “SERN” is real, though it is called CERN and is not evil. CERN is an institution in Europe that studies nucleons and particles. The reason why aliens in the story try to stop collider experiments is that colliders can create the most fundamental, or smallest, elements of the world. Studying these basic elements helps us understand how the world forms and how the universe evolves. Knowing the most basic rules of physics can change our way of living and the power of technology we can achieve, which is feared by aliens in ***The Three-Body Problem***. The power of colliders comes from their scientific goal: to study how the world forms.

By saying “how the world forms,” we mean understanding the smallest parts of everything around us. If you ask what the world is made of, some people might say molecules, atoms, or nucleons. These answers are not wrong, but they are not the “real” answer. The most fundamental units known to human beings are called elementary particles. We have different names for each kind of particle: quarks, leptons, and bosons. These particles form everything in our universe, including nucleons, atoms, molecules, and even interactions, which are the forces gluing each particle together to form larger units. Even these forces are formed by particles.

To study elementary particles, we needed to find these particles. Initially, we extracted particles from materials that exist naturally, which we call radiation, or we waited for particles to come to Earth from outer space, known as cosmic rays. Radiation sources and cosmic rays helped us make many revolutionary scientific findings, such as the first known positron (the anti-particle of the well-known electron) and the oscillation of neutrinos (special particles that rarely interact with others and can transform into different types). However, the particles coming from radiation and cosmic ray are in small number. To measure the properties of elementary particles precisely, we need to record an extremely large number of particles. The more particles we can record, the more accurately we can understand their behavior and improve our theories about elementary particles.

With technological advancements, we built particle accelerators and colliders. By colliding a particle with its anti-particle, they annihilate and generate new particles according to their total energy, allowing us to observe their behavior. Accelerators speed up charged particles using electric fields to high energies. The larger the accelerator, the higher the energy particles can reach. Ring-shaped accelerators, called synchrotrons, can have diameters from 1-2 kilometers to 10 or more kilometers.

Systems with two accelerators for particles and anti-particles that collide are called colliders. Colliders can create particle events at a frequency of more than 2 billion interactions per second. With such large statistics, we can measure probabilities precisely, providing crucial information to verify quantum theories and understand our universe better.

Understanding the most basic parts of our world is key to advancing our society. Discovering electricity led to electrical machines, understanding electrons led to electronic devices, and discovering various atoms led to many chemical products. The findings in elementary particles today will surely bring revolutionary changes in how we work and live in the future.

Science is an exciting journey that starts with curiosity. If you love exploring the unknown and imagining new possibilities, consider diving into the world of particle physics. Whether inspired by science fiction or the real impact of research, there's a place for you in this thrilling field. The future of science holds endless possibilities, and you could be part of the next big discovery that changes our understanding of the universe.

I used GPT4-o to check my English grammar and rephrase some complicated sentences.