Makoto Kobayashi, Toshihide Maskawa

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■Purpose of Exhibition

Makoto Kobayashi and Toshihide Maskawa are the recipients of the Nobel Prize in Physics in 2008, awarded for “for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature.” They both attended elementary schools and junior and senior high schools in their birthplace of Nagoya, and both went on to attend Nagoya University. In this exhibit, we tell the story of how these two men became researchers, and we introduce the details of their award-winning research. This exhibit comprises a display in what we call the High Unit as well as two island displays. The High Unit display introduces the winners and their prize-winning achievements, while the islands present experiential exhibits related to the award.

■Additional Knowledge

Sakata Laboratory
Kobayashi and Maskawa met in the Sakata Laboratory in the Faculty of Science of Nagoya University. This laboratory established a policy of maintaining a democratic laboratory that allowed faculty members and students to stand as equals in terms of research and classroom management. In the realm of scientific research, both professors and students were accorded equal status, and a free atmosphere was maintained in which all could engage in discussions without maintaining a hierarchy. During their time at the laboratory, these two researchers engaged in many discussions.
Award-winning Research
Kobayashi and Maskawa conducted research and published their paper in 1973. They were awarded the Nobel Prize in Physics in 2008. A total of 35 years passed between these events; one might wonder why so much time was required to recognize their accomplishment. One of the main reasons for the passage of so much time is that their findings had to be precisely verified to determine if they were right.
Their research was intended to elucidate the phenomenon of “broken symmetry” discovered in 1964. We won’t go into detail about that phenomenon here, but it was a challenging problem that the physics of that time could not quite grasp. Their research focused on why symmetry could be broken, and they eventually came up with an innovative hypothesis. Under their hypothesis, if quarks that remain undiscovered actually existed, it would result in broken symmetry. And by 1995, 22 years after the announcement, all the quarks they had predicted had been discovered. But that alone did not prove their hypothesis correct. Besides, if their experiments could not confirm broken symmetry as the two of them had indicated in theory, it could not be proved correct. In 1981, it was announced that broken symmetry could occur in particles called B-mesons, in keeping with the hypothesis. To confirm this, a Japanese laboratory and an American laboratory competed to carry out these experiments. In 2001, a Japanese laboratory obtained reliable evidence, and soon the American laboratory obtained the same experimental results, finally proving that their theory was correct. As a result, they were awarded the Nobel Prize in Physics. Immediately after receiving the award, Maskawa said that being told by fellow researchers that their theory was correct made him happier than hearing he had won the Nobel Prize. This appears to be the kind of natural response that a true researcher would express.

Phenomena that can be expressed through mathematical formulas
Their research shows that the phenomenon of broken symmetry cannot be fully explained by the existence of four types of quarks, but it can be explained by the existence of six types. In order to understand that four types would not lead to success, and that six types would do so, one needs to grasp the power of mathematics.
Even for problems that don’t reach the level of a Nobel Prize-winning challenge, such as the question of what angle to throw a ball to achieve the greatest distance, the power of mathematics is required to solve it. For those who are adept at mathematics, it is possible to explain many physical phenomena.
The purpose of this exhibit is to help people understand that physical phenomena and mathematics have a very close and important relationship.
The Earth and the Moon have different gravity. Even if a ball is thrown at the same speed, it will fly farther on the Moon. Since the Moon’s gravity is one-sixth that of Earth, could the ball be thrown at one-sixth the speed to fly the same distance as on Earth? We invite you to try out your math skills in this exhibit.

What is matter made of?
The research undertaken by Kobayashi and Maskawa also explored what matter is made of. You may have heard how the ancient Greeks believed all matter was made of four elements: earth, water, air and fire. In modern times, the elementary particles are considered to be the basic building blocks of matter.
In this exhibit, each time you press the button, the video is enlarged to double its size to show what a material is

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made of. As the image expands rapidly, you can see cells, DNA, molecules, and the nucleus of an atom. And once the video shows protons, it ends. The final images suggest that the proton is an elementary particle that serves as the basic particle, but unfortunately it is not. We would like to show what a proton contains, but it is not possible to extract the contents of a proton. We know a proton contains three elementary particles named quarks, but we cannot isolate the quarks to view them, so that’s where the video ends.
Our bodies are made of substances comprising interconnected atoms, and atoms are made of protons, neutrons, and electrons. Neutrons also comprise three elementary particles known as quarks. Electrons themselves are elementary particles, of which there are 17 types.

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Note: The above were published in the Japanese language. Titles are translated for convenience.