Eccentric Star Shape Footprint Unravel the Mysteries of Our Ordinary World

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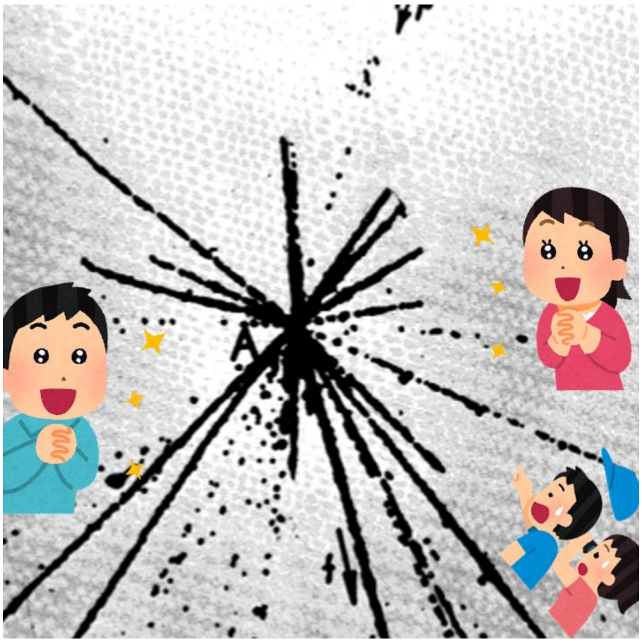
What is the smallest component of the matter? You may have learned that it is an atom, but in the last 100 years, physicists have found that atoms are composed of nuclei and electrons moving around nuclei, and nuclei are also formed by protons and neutrons. In more recent days, protons and neutrons are also found to be compounds of smaller elementary particles, called "Quark"s by physicists. In this sense, we can regard a quark as the smallest unit of matter. In more accurate expression, the proton is the formation of two "Up" quarks and one "Down" quark, which is in contrast to the neutron formed by two down quarks and one up quark.

According to how quarks and nuclei form larger compounds, various particles can exist and the same particles can exhibit different properties. Back in the 1950s, surveying such particles was one of the researchers' interests. Some physicists established experiments that recorded the particle tracks in special materials. They also planned to carry such experiments with a balloon at a high altitude, expecting cosmic rays there could produce particles that were rare in the ground. In one of the experiments, researchers observed an unusual star shape track[1]. Star shape was found to be the footprints of multiple particles emitted from nuclei and cosmic rays interaction, but confused the researchers. No one could explain its weird shape with the knowledge up until that point but they concluded that the new particle named "Lambda" could involve the interaction. Now modern scientists know what it was. Lambda is similar to protons and neutrons but the difference is that it contains in itself an unusual quark, called a "Strange" quark.



Some of you wonder why it is named strange. The historical and accurate explanation is a little bit complicated, but briefly, one can explain that strange quarks don't appear in ordinary situations and disappear immediately. This is mainly because strange quark is much heavier than up and down quarks. Lambda is the formation of up, down and strange quarks and is much heavier than its friends proton and neutron. Generally in particle physics, heavy particles can only be produced with high energy injected. So as described at the beginning, high energy particles such as cosmic rays at a high altitude could make researchers find the Lambda particle. Moreover, Lambda and strange quark can be regarded as unusual in the sense of lifetime. Lambda can't survive for more than 20 ns (1 ns = 10ˆ-9 seconds), and similar strange-contained particles have shorter lives. To sum up, Lambda rarely appears and it disappears immediately, so ordinary observation can't detect it.

Strange quarks compounds including Lambda have fascinated many physicists since its discovery. Some of them collected high-energy cosmic rays occasionally producing Lambda particles and also produced them artificially. Others have achieved to explain mathematically what the strange quark is.

The former physicists are generally called experimentalists. Their goal is to make the strange quark compounds table more broadly and more precisely, like the well-established periodic table. They have revealed empirically the strange quark’s physical properties such as mass and lifetime. They also discovered several types of strange compounds, including a family of Lambda particles and nuclei containing Lambda particles. In the study of strange or Lambda compounds, they determined experimentally the strength of interaction. Moreover, their effort covered producing high-performance apparatus to determine the physical values with as small as possible uncertainty.

The latter physicists are theoreticians. They revealed why physical quantities take their values. They also have found the universality of many relevant physical states or values. They could predict unknown particles with their knowledge. Their efforts resulted in the theory called “the Standard Model” covering almost all particle physics. It has achieved great success and is now believed to be the ultimate and fundamental theory of all nature.

What I point out is that experimentalists and theoreticians seem to contrast but are compensated for each other. Experimentalists’ data helps theoreticians build a theory and theoreticians’ prediction helps experimentalists design their plans. They have been good colleagues with the same interest as strange and Lambda.

What is interesting is that Lambda or strange quark may probably not be relevant to our lives. As described above, they are hard to exist in the ordinary world. It is suspicious whether such rare and short-lived particles directly influence us.

Despite abnormality, physicists have been driven by their curiosity, not knowing their results will change the world. Their curiosity-driven attitude potentially turned out to unravel the unexpected aspects of the world. If they didn’t have tried to reveal the unknown particle at its discovery, nowadays abundant physical triumphs wouldn’t exist. Many of the physical trium phs are reevaluated after their discoveries, so continuing the study of apparently unimportant results is quite emphasized.

Lambda is one example of reevaluated results. As described simply, all ordinary matter is composed of up and down quarks, so strange quarks or Lambda seemed completely extraordinary. However, recent studies have implied Lambda can be a probe of protons, neutrons and their compounds, atoms.

Let me explain simply. In particle physics, protons or neutrons tend to expel the same kind of particles from the nucleus. Because of this, if we want to survey atom structures by injecting ordinary matter, it cannot enter the center of atoms. However, Lambda can. Protons or neutrons almost neglect Lambda. Lambda is believed to be an excellent probe of atoms. It is paradoxical but interesting that an unordinary particle can be useful for ordinary matter survey by its abnormality.

Since its discovery as a star shape footprint, Lambda has been a topic of interest in particle physics and nuclear physics. It is extraordinary and seems far from our ordinary world. Nevertheless, it can tell us about our world from outside. Once we review the histories, this magnificent idea is the outcome of researchers' curiosities. To focus on strangeness even though it seems useless, is one of the most important attitudes of science.

(References)

[1] Figure adapted from "Delayed disintegration of a heavy nuclear fragment: I", M. Danysz and J. Pniewski, The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 44, 348 (1953). © Copyright [1953], reprinted by permission of Informa UK Limited, trading as Taylor & Taylor & Francis Group, http://www.tandfonline.com

(The use of assistive tools)

Dictionary to get suitable expressions I want to convey

Autocorrect in Google Docs for spelling correction and simple grammatical e
rror correction

Grammarly (free plan) for grammar check