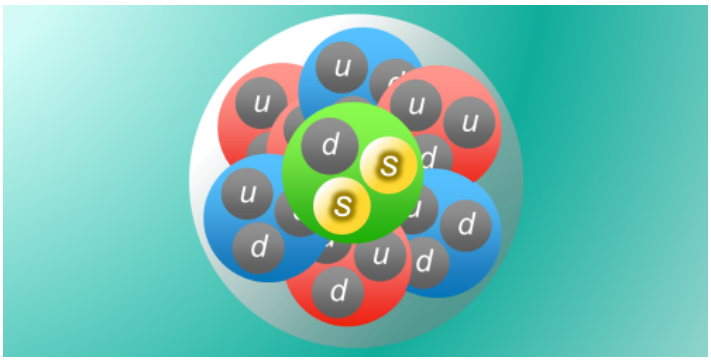
Doubly Strange Nucleus Observed

Particle physicists have detected a short-lived nucleus containing two strange quarks, whose properties could provide new insights into the behavior of other nuclear particles.

By **Michael Schirber**

Baryons are three-quark particles, such as protons, neutrons, and the lesser-known hyperons. The latter's claim to fame is that they contain at least one strange quark. Researchers study hyperons to understand how baryons interact. One experiment, known as the J-PARC E07 experiment, has now uncovered a very rare interaction in which a hyperon with two strange quarks binds to a normal nucleus [**1**]. By measuring precisely how this "hypernucleus" decayed, the team behind the experiment was able to determine the particles' binding energy.

The collaboration directed a beam of K mesons from J-PARC (the Japan Proton Accelerator Research Complex) into a diamond target. Collisions in the target produced hyperons—specifically Ξ hyperons that are made up of two strange quarks and one down quark. These hyperons then traversed a stack of photographic sheets that recorded the particle tracks. Using an automated track-identification system, the team extracted an event where a Ξ hyperon bonded with a nitrogen nucleus, briefly forming a doubly strange hypernucleus.



Credit: S. Hayakawa/Japan Atomic Energy Agency

Only a handful of doubly strange hypernuclei have been seen before—in fact the events are so rare that they are often given their own names. The J-PARC E07 team has christened their event IBUKI, which is the name of a mountain on the Japanese main island. By identifying the decay products in this event, the team determined that Ξ hyperons bind to nitrogen nuclei with an energy of 1.27 MeV, which agrees with theoretical predictions. As more data are processed, the researchers expect to find roughly ten more Ξ-hyperon events, which could provide insights for nuclear physics as well as for theories of neutron star models.

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REFERENCES

1. S. Hayakawa *et al.*, "Observation of Coulomb-assisted nuclear bound state of $\Xi^- - {}^{14}$N system," **Phys. Rev. Lett. 126, 062501 (2021).**