New Measurements of a Charmed Baryon

Researchers at the Large Hadron Collider have measured the spin parity of a charm-quark-hosting particle, offering a new test of theoretical models.

By Marric Stephens

On the basis of data collected between 2016 and 2018, researchers at the LHCb experiment at CERN have measured a fundamental property of a short-lived particle known as the Ξ_c baryon [1]. The measurement provides a way of testing predictions made using quantum chromodynamics (QCD), the theory that describes how quarks interact via the strong force.

A Ξ (or “Xi”) baryon comprises two strange quarks and one up or down quark. The Ξ_c baryon is a variation in which one strange quark is replaced by a heavier charm quark. These charmed baryons are produced indirectly from proton collisions at the Large Hadron Collider, but they only last for a fleetingly short time, making their properties hard to measure. The LHCb team targeted one of the Ξ_c baryon’s higher-energy excited states and, by measuring the momenta of its final decay products, reconstructed the full decay chain. This information let them infer the excited state’s spin parity—two properties related to its angular momentum and its behavior under mirror reflection. They also deduced a symmetry breaking (parity violation) in one of the particle interactions.

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Knowing such details about this particular excitation of the Ξ_c baryon allows researchers to refine their understanding of QCD. Calculations within the framework of QCD are difficult, as perturbation theory—a commonly used computation tool—does not work for QCD problems at low-energy scales. Instead, researchers often use approximate methods called effective models. Particles such as the Ξ_c baryon, in which the constituent quarks have very unequal masses, offer a unique proving ground for evaluating the predictions of these models.

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REFERENCES

1. R. Aaij *et al.* (LHCb Collaboration), “First determination of the spin-parity of $\Xi_c(3055)^{+,0}$ baryons,” **Phys. Rev. Lett. 134, 081901 (2025).**