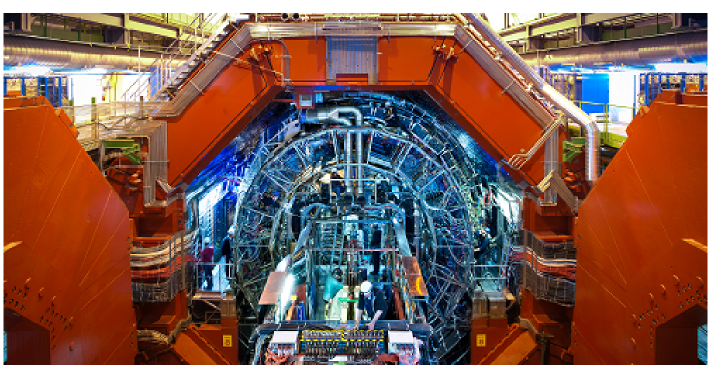
Evidence for an Exotic Antimatter Nucleus

Experiments at the Large Hadron Collider have revealed a previously unseen nucleus known as antihyperhelium-4.

By **Ryan Wilkinson**

Collisions of heavy ions at the Large Hadron Collider (LHC) at CERN, Switzerland, reproduce the extreme conditions that existed in the Universe just after the big bang. These conditions enable the creation of hypernuclei, nuclei containing protons, neutrons, and their heavier, shorter-lived cousins, hyperons, which consist of up, down, and strange quarks. Now, by studying these heavy-ion collisions, the ALICE Collaboration has measured—with a statistical significance of 3 sigma—a hypernucleus called antihyperhelium-4 [**1**]. The team's measurements of that hypernucleus and others could constrain models of particle physics and of neutron stars.

Dozens of different hypernuclei have previously been detected. But their antimatter counterparts are much harder to make, and, until now, only two types have been seen. In 2010, the STAR Collaboration at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, New York, spotted antihypertriton (which has one antiproton, one antineutron, and one antihyperon). Then in 2024, that team detected antihyperhydrogen-4 (one antiproton, two antineutrons, and one antihyperon). The ALICE Collaboration has made the next step-up in atomic number by observing antihyperhelium-4 (two antiprotons, one antineutron, and one antihyperon). The feat was possible because the ions collide at much higher energies at the LHC than at the RHIC.



Credit: A. Saba/CERN

The ALICE Collaboration measured the masses and production yields of hyperhydrogen-4 and hyperhelium-4 and their antimatter counterparts. The masses, which were all about 4 times that of a proton, and the yields were consistent with both predicted and previously measured values. The predicted yields were based on a particle-physics model called the statistical hadronization model, so the results confirm that this model can provide an accurate description of hypernucleus formation in heavy-ion collisions. Refinements to the model could help astronomers understand the impact of hyperons and other exotic particles on the internal structure of neutron stars.

Correction (24 April 2025): *The text was corrected to clarify that the statistical significance of the measurement didn't reach the 5-sigma threshold needed to claim a "discovery."*

Ryan Wilkinson is a Corresponding Editor for ***Physics Magazine*** based in Durham, UK.

REFERENCES

1. S. Acharya *et al.* (ALICE Collaboration), "First measurement of *A* = 4 hypernuclei and antihypernuclei at the LHC," **Phys. Rev. Lett. 134, 162301 (2025).**