Two new excited states of the Lambda-b beauty particle observed by LHCb

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In beautiful agreement with the Standard Model, two new excited states of the Λ_b beauty particle have just been observed by the LHCb Collaboration. Similarly to protons and neutrons, Λ_b is composed of three quarks. In the Λ_b's case, these are up, down and… beauty.

Although discovering new particles is increasingly looking like a routine exercise for the LHC experiments, it is far from being an obvious performance, particularly when the mass of the particles is high. Created in the high-energy proton-proton collisions produced by the LHC, these new excited states of the Λ_b particle have been found to have a mass of, respectively, 5912 MeV/c^2 and 5920 MeV/c^2. In other words, they are over five times heavier than the proton or the neutron.

Physicists only declare a discovery when data significantly show the relevant signal. In order to do that, they often have to analyse large samples of data. To obtain its beautiful result, the LHCb Collaboration has analysed the information coming from about 60 million million ($6x10^{13}$) proton-proton collisions collected during the 2011 data-taking period. In particular, since the excited states only survive for a very short time before decaying, physicists carefully studied the decay products and tracked the whole process back to the decay vertex. The analysis took scientists several months to complete but today they are able to present the discovery with very high statistical significance, namely 4.9 σ for the first excited state and 10.1 for the second one.

Although never observed before, the excited states of the Λ_b particle were expected to exist according to the Standard Model, the theory that tells us how quarks combine to build particles and matter. The LHCb result is therefore a new confirmation of the success of the theory itself.

EXCITED STATES OF MATTER

Matter can be formed in different energy states. The most stable one – that is, the one that survives the longest before decaying – is the so-called "ground state", in which particles have the lowest possible energy. States with higher energy are called "excited states". They are still allowed by Nature but they are unstable. The higher the formation energy (i.e. the mass) the more unstable they are.

Provided by CERN

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