LHCb observes a new decay mode of the charmed beauty meson

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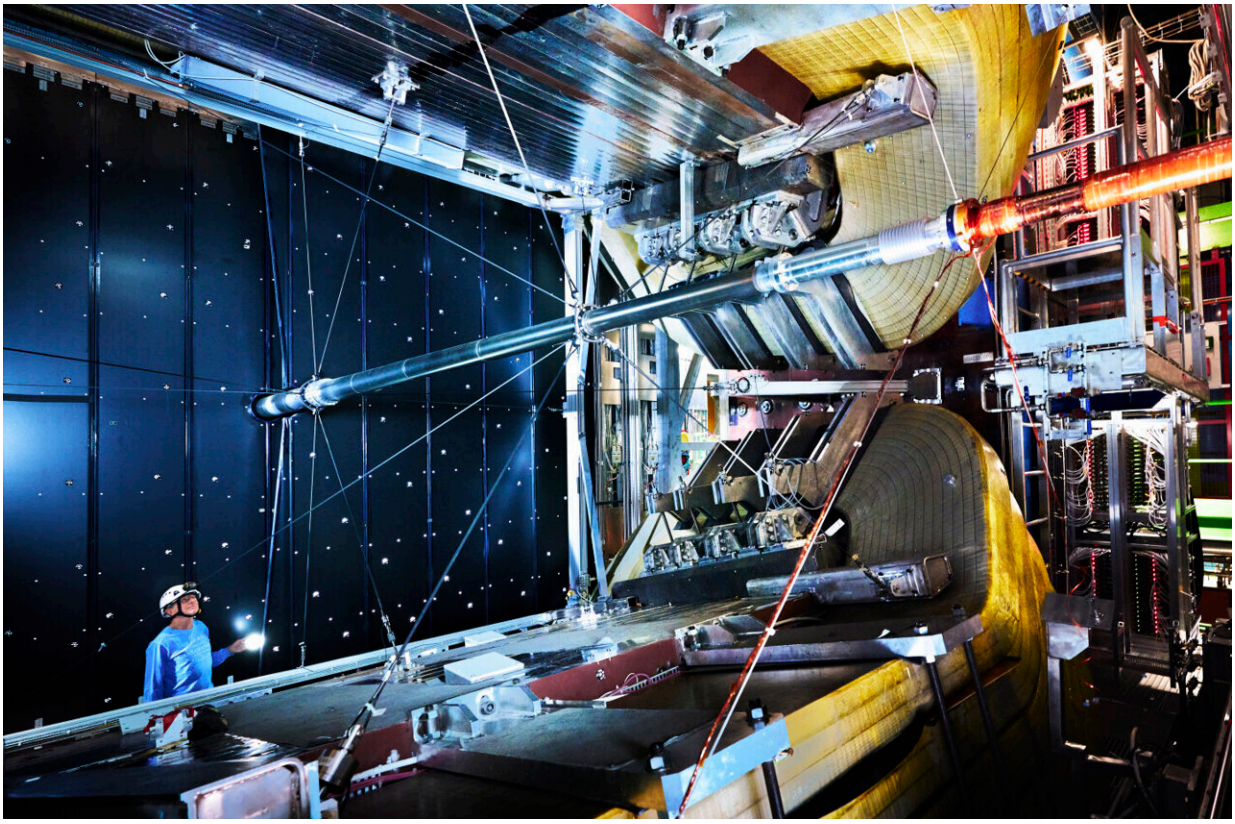

The LHCb detector. Credit: Maximilien Brice, CERN

The LHCb collaboration recently reported on the *arXiv* preprint server the first observation of the decay of the B_c^+ meson (composed of two heavy quarks, b and c) into a J/ψ charm-anticharm quark bound state

and a pair of pions, $\pi^+\pi^0$. The decay process shows a contribution from an intermediate particle, a ρ^+ meson that forms for a brief moment and then decays into the $\pi^+\pi^0$ pair.

The B_c^+ is the heaviest meson that can only decay through the weak interactions, via the decay of one heavy constituent quark. B_c^+ decays into an odd number of light hadrons and a J/ψ (or other charm-anticharm quark bound states, called "charmonia") have been studied intensively and have been found to be in remarkable agreement with the theoretical expectations.

The decay of B_c^+ into a J/ψ and a $\pi^+\pi^0$ pair is the simplest decay into charmonium and an even number of light hadrons. It has never been observed before, mainly because the precise reconstruction of the low-energy π^0 meson through its decay into a pair of photons is very challenging in an LHC proton-proton collision environment.

A precise measurement of the $B_c^+ \rightarrow J/\psi\pi^+\pi^0$ decay will allow better understanding of its possible contribution as a background source for the study of other decays of B_c mesons as well as rare decays of B^0 mesons. From the theoretical point of view, decays of B_c into J/ψ and an even number of pions are closely related to the decays of the τ lepton into an even number of pions, and to the e^+e^- annihilation into an even number of pions.

Precise measurements of e^+e^- annihilation into two pions in the ρ mass region (as in the B_c decay discussed here) are crucial for the interpretation of results from the Fermilab g-2 experiment measuring the anomalous magnetic dipole moment of the muon, since low-energy e^+e^- annihilation into hadrons is an important source of the uncertainty of the g-2 measurements.

The ratio of the probability of the new decay to that of the decay of B_c^+

into $J/\psi\pi^+$ has been calculated by various theorists over the last 30 years. Now these predictions can finally be compared with an experimental measurement: most predictions agree with the new result obtained by LHCb ($2.80\pm0.15\pm0.11\pm0.16$).

The large number of b-quarks produced in LHC collisions and the excellent detector allows LHCb to study the production, decays and other properties of the B_c^+ meson in detail. Since the meson's discovery by the CDF experiment at the Tevatron collider, 18 new B_c^+ decays have been observed (with more than five standard deviations), all of them by LHCb.

More information: Observation of the B_c^+ to $J/\psi\pi^+\pi^0$ decay, *arXiv* (2024). DOI: 10.48550/arxiv.2402.05523

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