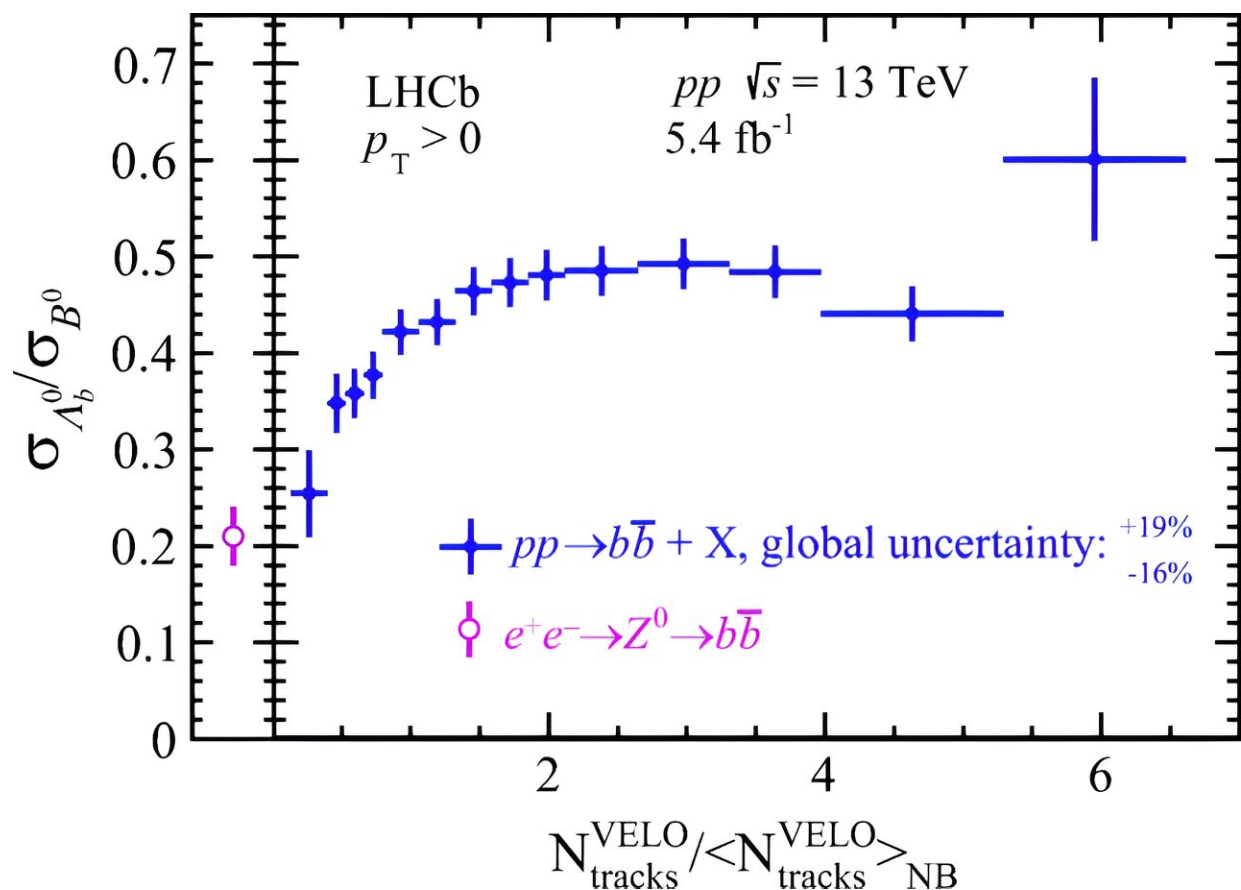


LHCb finds bottom quarks are more likely to exist in baryons than mesons as the environment density increases

March 7 2024, by Bob Yirka



Ratio of Λ_b^0 to B^0 cross-sections as a function of the total track multiplicity measured in the VELO detector (blue). The purple point indicates the value measured in e^+e^- collisions at LEP. Credit: *Physical Review Letters* (2024). DOI: 10.1103/PhysRevLett.132.081901

The team of physicists working on the LHCb Collaboration at CERN has found that bottom quarks are more likely to exist in baryons than mesons as the density of the environment in which they exist increases. In their paper [published](#) in *Physical Review Letters*, the group describes studying the production of b quarks in proton-to-proton collisions.

Quarks are [subatomic particles](#) that carry a fractional charge and are believed to be the building blocks for hadrons. Prior research has suggested that they cannot exist alone—theory suggests that they instead coexist as pairs in mesons or as triplets in baryons. In this new study, the team in Switzerland found that bottom quarks are more likely to exist in baryons than mesons as particle density increases.

Bottom quarks are heavy quarks with a $-1/3e$ charge—they also transition to lower mass quarks at a relatively slow rate and are the second most massive quark included in the Standard Model that underlies [particle physics](#). Perhaps more notably, they are believed to be a decay product of the Higgs boson.

In their work at the Large Hadron Collider, the researchers were studying data from several years' worth of smashing protons together, which included the characteristics of particles that were released. More specifically, they were looking at the rates of production of B^0 mesons and A_b^0 baryons with a single bottom quark and measuring the changes that occurred in their production rates after collisions.

They found that the A_b^0 baryons increased compared to the B^0 mesons over two events: charge particles increasing or transverse momentum decreasing. The trends they found suggested that the degree of density had an impact on the likelihood of the existence of nearby bottom quarks.

More specifically, the denser it was, the more likely it was that bottom

quarks would be among the [baryons](#) rather than the mesons, representing further evidence of coalescence, whereby [quarks](#) combine when smashed together in certain ways. The finding, they note, goes against theories that suggest quark consolidation is independent of environment.

More information: R. Aaij et al, Enhanced Production of Λ_b^0 Baryons in High-Multiplicity pp Collisions at $s=13$ TeV, *Physical Review Letters* (2024). [DOI: 10.1103/PhysRevLett.132.081901](https://doi.org/10.1103/PhysRevLett.132.081901)

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