

Three's Company for Bottom Quarks

Bottom quarks are increasingly more likely to exist in three-quark states rather than two-quark ones as the density of their environment increases.

By **Ryan Wilkinson**

A quark—a fundamental constituent of matter—cannot exist in isolation. Instead, theory predicts that quarks typically couple together in mesons or through baryons. Now the LHCb Collaboration at CERN in Switzerland shows that baryon formation is more common in dense environments than in sparse ones if a specific quark called a bottom quark is present [1]. This finding has implications for our understanding of how elementary particles consolidate to form visible matter.

The LHCb Collaboration studied the particles created in high-energy proton–proton collisions at CERN's Large Hadron Collider. Specifically, the collaboration's members examined the production rates of Λ_b^0 baryons and B^0 mesons—composite objects that each contain one bottom quark. The team monitored relative changes between these two production rates for proton–proton collisions that created charged particles in different numbers and with different transverse momenta.

The collaboration found that the production rate of Λ_b^0 baryons increased relative to that of B^0 mesons as the number of charged particles increased or as the transverse momentum of the particles decreased. These trends imply that, as the particle environment becomes denser, bottom quarks are increasingly more likely to be incorporated into baryons, as opposed to mesons. The team says that this result disfavors conventional particle-physics models in which the consolidation of quarks is independent of the particle environment. Instead, it fits with alternative particle-physics models in which baryon formation depends on the environment's density.

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REFERENCES

1. R. Aaij *et al.* (LHCb Collaboration), “Enhanced production of Λ_b^0 baryons in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV,” *Phys. Rev. Lett.* **132**, 081901 (2024).



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