How universal is (lepton) universality?

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Just as a picture can be worth a thousand words, so the rarest processes at the Large Hadron Collider (LHC) can sometimes have the most to tell us. By isolating and counting decays of B+ mesons to a kaon and two leptons, the LHCb experiment has tested a key assumption of the Standard Model – lepton universality, the idea that electrons, muons and tau leptons should behave in the same way, and be produced equally often in weak decays. In a presentation given at this week's Large Hadron Collider Physics conference, LHCb results reveal the first hints of a difference.

According to the Standard Model, a B+ meson should decay to a kaon, electron and positron as often as it decays to a kaon, muon and antimuon. If a measurement of both rates shows a difference between them, it could be the first sign of something new. Rare B meson decays provide a particularly good laboratory for testing universality, as the decays proceed in a way that allows new, otherwise unseen, particles to influence the rate seen experimentally. Additional Higgs bosons, or a new, heavy version of the Z boson, could alter the relative rate of electron and muon production and be detected in this way.

LHCb has now analysed their entire dataset of proton-proton collisions from the LHC and finds that B+ mesons decay to muons about 25% less often than they decay to electrons. As these decays only occur a couple of times in every 10 million B+ decays the measurement is still dominated by statistical error, even if it is the world's most precise determination. The observed difference has a significance of 2.6 standard deviations, corresponding to a chance of one in a hundred that it is due to a statistical fluctuation. More data from the forthcoming high energy LHC run is needed to confirm if this tantalising result is indeed the first sign of something new in the universe.