Testing lepton universality with semileptonic beauty meson decays

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Abstract

The Standard Model (SM) of particle physics describing the fundamental particles and their interactions has been very successful, but is known to be incomplete. One of the most exciting hints for physics beyond the SM are seen in tests of lepton flavor universality (LFU). In the SM charged leptons (electron, muon, tau) have the same interaction coupling strength and differ only by their masses. The relative ratios of decays to final states differing only by the involved charged lepton can therefore be predicted with good precision. Measuring a deviation from the predicted value would give a clear hint of physics beyond the SM. Here we show such a ratio measurement performed with data recorded by the LHCb experiment utilizing the semileptonic decay of beauty mesons to charmed particles with final states involving a muon or an electron and the corresponding neutrino:

$$R_{e\mu} = \frac{\mathcal{B}(B^0 \to D^{*-} e^+ \nu_e)}{\mathcal{B}(B^0 \to D^{*-} \mu^+ \nu_\mu)} \tag{1}$$

Measuring this ratio with the LHCb experiment poses several challenges. The neutrino remains undetected and consequently the decay can not be fully reconstructed, due to the missing energy and momentum it carries away. Furthermore, the efficiency of reconstructing an electron in the detector must be treated as a special case, because of the Bremsstrahlung it emits, and has to be carefully calibrated using data-driven methods.

We will discuss the current status of this analysis and how these challenges can be addressed.

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