The Ratio of Branching fractions

$$\mathcal{B}(\bar{B}^0 \to D^{*+}\tau^-\bar{\nu}_\tau)/\mathcal{B}(\bar{B}^0 \to D^{*+}\mu^-\bar{\nu}_\mu)$$

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Introduction

- Lepton universality is a basic assumption in the standard model, requires equality of couplings between the gauge bosons and the three families of leptons
- Semileptonic decays of *b* hadrons to third generation leptons is sensitive to new physics

Theory and Experiment

- From the HFLAV(heavy flavor averaging group), experient result is

$$R(D^*) = \frac{B(\bar{B} \to D^* \tau^- \bar{\nu}_\tau)}{B(\bar{B} \to D^* \ell^- \bar{\nu}_\ell)} = 0.304 \pm 0.013 \pm 0.007$$

- The current Standard Model prediction is given by

$$R(D^*) = 0.252 \pm 0.003$$

LHCb measurement

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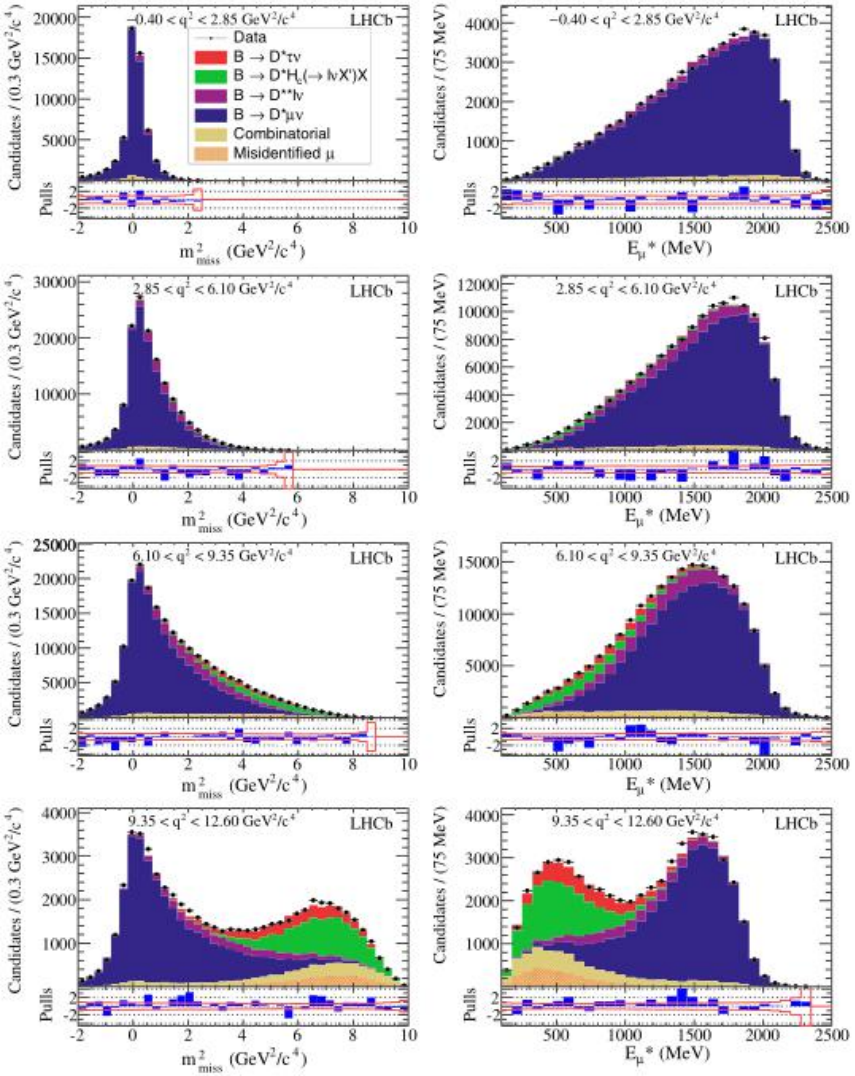
- Recently, LHCb gave the first measurement of R(D*) in hadron collisions.
- It is very easy to reconstruct the decays contain one or more neutrino final states. One could use missing mass/ U_{miss} spectrum, based on the energy-momentum conservation.
- But not easy in hadron collisions.

Key kinematic variables



in the B rest frame: the muon energy, E^*_μ; the missing mass squared, defined as $m^2_{\rm miss} = (p^\mu_B - p^\mu_D - p^\mu_\mu)^2$; and the squared four-momentum transfer to the lepton system, $q^2 = (p^\mu_B - p^\mu_D)^2$, where p^μ_B, p^μ_D and p^μ_μ are the four-momenta of the B meson, the D^{*+} meson and the muon.

highlight

The determination of the rest-frame variables requires knowledge of the B candidate momentum vector in the laboratory frame, which is estimated from the measured parameters of the reconstructed final-state particles. The B momentum direction is determined from the unit vector to the B decay vertex from the associated PV. The component of the B momentum along the beam axis is approximated using the relation $(p_B)_z = (m_B/m_{\text{reco}})(p_{\text{reco}})_z$, where m_B is the known B mass, and m_{reco} and p_{reco} are the mass and momentum of the system of reconstructed particles. The rest-frame variables described above are then calculated using the resulting estimated B four-momentum and the measured four-momenta of the μ^- and D^{*+}. The rest-frame variables are shown in simulation studies to have sufficient resolution ($\approx$15%–20% full width at half maximum) to preserve the discriminating features of the original distributions.

Summary

physics meaning

In conclusion, the ratio of branching fractions $\mathcal{R}(D*) = \mathcal{B}(\bar{B}^0 \to D^{*+}\tau^-\bar{\nu}_\tau)/\mathcal{B}(\bar{B}^0 \to D^{*+}\mu^-\bar{\nu}_\mu)$ is measured to be $0.336 \pm 0.027(\text{stat}) \pm 0.030(\text{syst})$. The measured value is in good agreement with previous measurements at *BABAR* and Belle [3,5] and is 2.1 standard deviations greater than the SM expectation of 0.252 ± 0.003 [8]. This is the first measurement of any decay of a b hadron into a final state with tau leptons at a hadron collider, and the techniques demonstrated in this Letter open the possibility to study a broad range of similar b hadron decay modes with multiple missing particles in hadron collisions in the future.

Summary

data analysis technique

- Also in the hadron collisions, we still could reconstruct the B meson in the decays contain neutrinos, interesting and impressive!