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Search for new physics in the final state of τ, b, ν

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The Standard model (SM) is one of the most successful physics theory, however it presents disagreements between some predictions and the observations. One of them has been studied in the last decade and it's related to the lepton universality. The R_{D^*} Anomaly appear to be enhanced respect to the standard model by roughly 30% with a global significance of $\approx 4\sigma$. This has been studied by BaBar, Belle and LHC-b experiments. As the measure it's close to the traditional 5σ deviations, it could be a sign of new physics. Nevertheless an approaching to the problem considering the b quark and the τ in the final state has never been measured. The aim of this project is discarding values from the mass parameter space for extensions to the SM as the W' model.

The standard model is the ruling theory for the composition and interaction of the known universe so far. It's composed by different type of particles, the quarks and leptons, each one with 3 generations, then we have the gauge bosons, responsible for the electric, weak and strong interactions, and finally the Higgs boson, responsible of giving mass to the rest of the massive particles from the SM. However, it's far from being a definitive theory, with problems as the Strong CP problem, and the neutrino masses, it is still in tests in experiments as the Tevatron and the LHC. One of this problem is associated with particles from the third generation of quarks and leptons, punctually with the b quarks, and the τ leptons. \\

The R_{D^*} is the ratio between the branching fraction of B decaying semileptonicaly to a τ with respect to the decay to other charged leptons, i.e:

\begin{equation}
R_{D^*} = \frac{\Gamma(B \rightarrow D^{(\ast)}\tau \nu)}{\Gamma(B\rightarrow D^{(\ast)}l\nu)}
\end{equation}
With $l = e$ or μ\cite{greljo2019mono}.\\\\

This measure appears to be enhanced respect to the standard model by roughly 30% with a global significance of $\approx 4\sigma$ in experiments as BaBar, LHCb, and Belle \cite{PhysRevLett.120.171802,PhysRevD.92.072014,PhysRevLett.109.101802}.\\\\

This is a problem because the standard model predicts for such process a characteristic known as the lepton Universality. Which states that in a process sufficiently energetic with a leptonic the 33.3% of the times the process will end with a τ in the final state, 33.3% of the the times we will find a μ in the final state and the other times will be a e. In that sense many models related to Beyond Standard Model physics as W', Z' model predict stronger interactions to the third generation of leptons and quarks compared to the other generations.\\

Many Studies had search new physics signs in process as $b \rightarrow \tau, \nu$, but in this sense the crossing symmetry can be used to study the phenomena by considering the three particles in the final state and the distribution of variables as the Transverse mass between the b, ν and τ, ν, and the total mass between the 3 particles.

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