

Search for New Physics in the final State B, τ, ν

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1 Problem

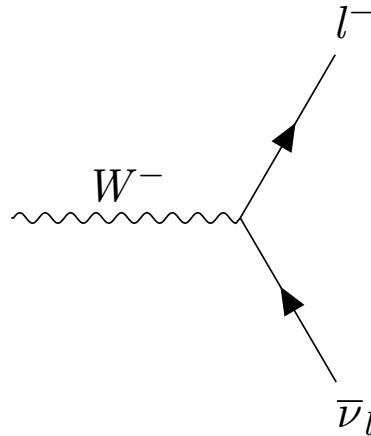
- The Lepton Universality
- The $R_{D^{(*)}}$ Anomaly
- The Crossing Symmetry

2 The Project

- Phases
- Exploratory Analysis

The Lepton Universality

If we have a process where $m_\tau \ll E$ then we can ignore the τ 's mass, the 3 charged leptons will start to look very similar.

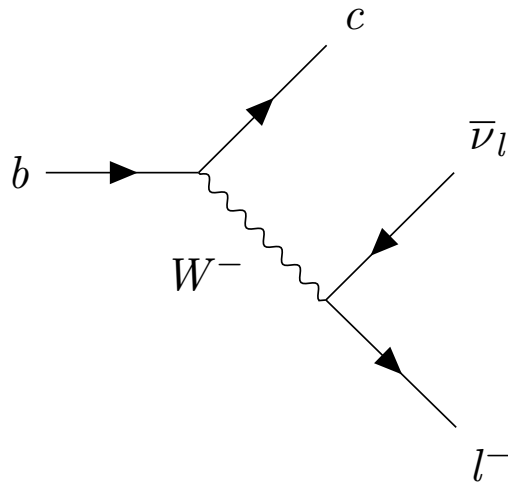


The standard model predicts that in a semi-leptonic decay of a B -meson, the Branching ratio should be the same for each lepton. ¹

¹S. Weinberg, The quantum theory of fields. 1995

The $R_{D^{(*)}}$ Anomaly I

But instead the relation between the decay to a τ and other charged lepton it's enhanced by roughly 30%².



$$R_{D^{(*)}} = \frac{\mathcal{B}(\bar{B} \rightarrow D^{(*)} \tau \bar{\nu}_\tau)}{\mathcal{B}(\bar{B} \rightarrow D^{(*)} l \bar{\nu}_l)} \quad (1)$$

²M. Huschle, T. Kuhr, M. Heck, P. Goldenzweig, A. Abdesselam. Measurement of the branching ratio of $\mathcal{B}(\bar{B} \rightarrow D^{(*)} \tau \bar{\nu}_\tau)$ relative to $\mathcal{B}(\bar{B} \rightarrow D^{(*)} l \bar{\nu}_l)$ decays with hadronic tagging at belle. Phys. Rev. D, 92:072014, Oct 2015.

The Crossing Symmetry I

In particle physics if an interaction like

$$A + B \rightarrow C + D \quad (2)$$

is observed, related interactions can be anticipated from the fact that any of the particles can be replaced by its antiparticle on the other side of the interaction ³.

$$\begin{aligned} A &\rightarrow \bar{B} + C + D \\ A + \bar{C} &\rightarrow \bar{B} + D \\ \bar{C} &\rightarrow \bar{A} + \bar{B} + D \\ \bar{C} + \bar{D} &\rightarrow \bar{A} + \bar{B} \end{aligned} \quad (3)$$

³Michael Peskin. An introduction to quantum field theory. CRC press, 2018

The Topology

In order to consider the mayor contribution to the possible cross section our main topology will be:

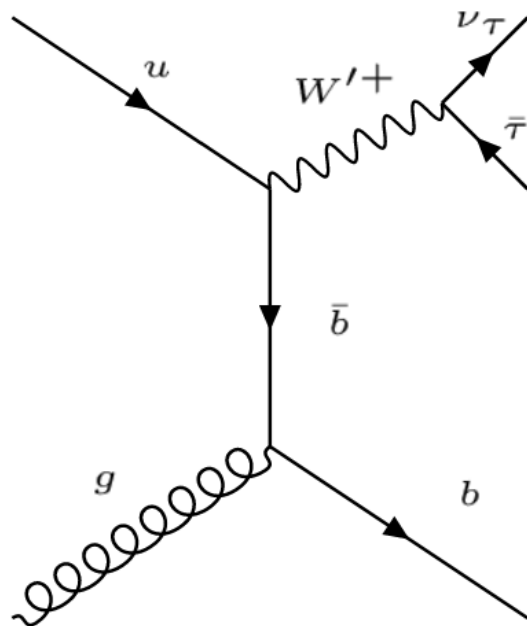


Figure 1: Process of a proton-proton collision with final state $b \bar{\tau} \nu$ mediated with a W'

The Aim

- Find restrictions for different models as a W' or an effective field theory.

The How:

- 1 Produce Montecarlo samples.
- 2 Exploratory analysis.
- 3 Optimize the event selection.
- 4 Use the obtained event selection criteria on real data.

Some interesting variables are

- Transverse Mass
- Invariant Mass
- Total Mass

Objects related

- 1 Missing energy transverse.
- 2 b jets.
- 3 τ jets.

End

Thanks for your attention.