BSM Constraints from $\Lambda_b \to \Lambda\tau^+\tau^-$

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This project aims to provide the theory prediction of $\mathcal{B}(\Lambda_b \to \Lambda\tau^+\tau^-)$, which has not been measured experimentally so far. We also show how some current BSM models can significantly enhance this branching ratio.

1 SM prediction

The underlying $b \to s\ell\ell$ transition in the decay we described by the operators $\mathcal{O}_7, \mathcal{O}_9$ and $\mathcal{O}_{10}$ in low energy effective field theory (LEFT). For the hadronic parts of the amplitude we use the latest form factor results from lattice QCD.

We also implement long-distance contributions from four-quark operators and intermediate resonances. The most relevant contributions come from the $\bar{c}c$ resonances J/ψ and $\psi(2S)$, which we model as narrow resonances. In this model we need to determine the strength and the complex phases for each resonance empirically. The strength can be estimated by assuming that the branching ratio with an intermediate resonance factorises into the production of the resonance and the decay of the resonance which are both well measured. The phases could be determined from a fit of the theory prediction to the differential branching fraction of $\Lambda_b \to \Lambda\mu^+\mu^-$. However, the data quality of this measurement is currently not good enough to allow a confident fit. Figure 1 shows our prediction of the differential branching fraction, with the most dominant sources of uncertainty being the form factors as well as the unknown resonance phases.

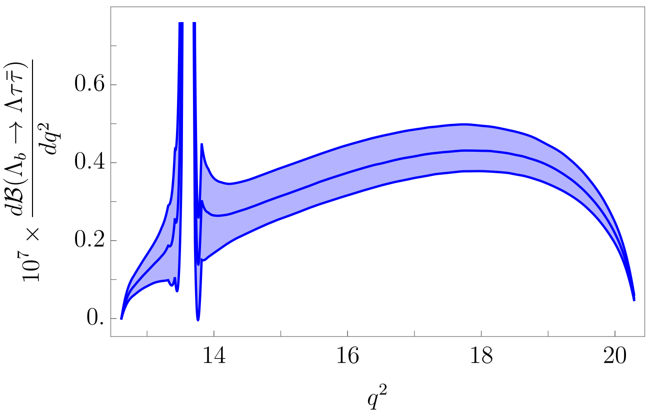

Abbildung 1: SM prediction of the differential branching fraction of $\Lambda_b \to \Lambda\tau^+\tau^-$ including effects form $c\bar{c}$ resonances

2 BSM Constraints

To quantify possible NP contributions to the branching ratio of $\Lambda_b \to \Lambda\tau^+\tau^-$ we assume that they lead to a shift to the Wilson coefficients C_9 and C_{10}.

In this analysis, we choose to adopt a $U(2)^5$ flavour symmetry and an EFT model where new physics predominantly couples to third-generation fermions. To allow also suppressed interactions of the NP with quarks of the first two generations, we introduce a $U(2)_q$ spurion to break the flavour symmetry in a SM like way. In this particular model the branching fraction is enhanced by a factor of 300 compared to our SM prediction.

With how difficult the measurement of the final state tauons is, it is very unlikely that our predicted $\mathcal{B}(\Lambda_b \to \Lambda\tau^+\tau^-)$ can be measured in the near future, but even an upper bound can lead to strong constraints of some of our current BSM models.