



Contribution ID: 201

Type: Talk

Precise decay rate for $\eta_b \rightarrow \gamma\gamma$ with Highly Improved Staggered Quarks

Thursday, 1 August 2024 10:40 (20 minutes)

We calculate the decay rate for the η_b meson to two photons for the first time in lattice QCD, building on our previous accurate calculation of the rate for $\eta_c \rightarrow \gamma\gamma$. Using the Highly Improved Staggered Quark formalism for valence and sea quarks, we work at lattice spacings from 0.12 fm down to 0.03 fm. Gluon configurations with the effect of u , d , s and c quarks in the sea were provided by the MILC Collaboration. Extracting a form factor, $F(0, 0)$, for two on-shell photons over a range of heavy quark masses m_h between that of the b and c quarks, we can accurately determine the value of the ratio $f_{\eta_h} / (F_{\eta_h}(0, 0) M_{\eta_h}^2)$, with f_{η_h} and M_{η_h} the pseudoscalar meson decay constant and mass. This can be compared to the approximate value of 0.5 from leading order nonrelativistic QCD. We determine the decay rate $\Gamma(\eta_b \rightarrow \gamma\gamma)$ at the b quark mass, providing a precise prediction for searches by the Belle II Collaboration.

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Session Classification: Hadronic and nuclear spectrum and interactions

Track Classification: Hadronic and Nuclear Spectrum and Interactions