Contribution ID: **45** Type: **contributed parallel talk**

Precise determination of the decay rates of $\eta_c \to \gamma\gamma$, $J/\psi \to \gamma\eta_c$ and $J/\psi \to \eta_c e^+e^-$ from lattice QCD

Tuesday, 18 July 2023 14:20 (20 minutes)

We present results from our calculation of decays rates for $\eta_c \to \gamma\gamma$, $J/\psi \to \gamma\eta_c$ and $J/\psi \to \eta_c e^+e^-$ in lattice QCD with the effect of u, d, s and c quarks in the sea for the first time. We use the Highly Improved Staggered Quark formulism, four values of the lattice spacing and sea u/d quarks down to their physical values. Our results are accurate at the 1-2% level and are therefore now more accurate than results from experiment. We find $\Gamma(\eta_c \to \gamma\gamma) = 6.788(45)_{\rm fit}(41)_{\rm syst}$ keV, which agrees well with experimental results for $\gamma\gamma \to \eta_c \to K\overline{K}\pi$. This is in tension with the global PDG fit at the 4σ level, however, and we therefore advise this fit is revisited. We find $\Gamma(J/\psi \to \gamma\eta_c) = 2.219(17)_{\rm fit}(18)_{\rm syst}(24)_{\rm expt}(4)_{\rm QED}$ keV, which agrees well with results from CLEO. Finally, we predict $\Gamma(J/\psi \to \eta_c e^+e^-) = 0.01349(21)_{\rm latt}(13)_{\rm QED}$ keV. We compare our results with other theoretical approaches, while simple relationships between form factors and the J/ψ decay constant in the nonrelativistic limit are also tested.

Consent

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Session Classification: Parallel A

Track Classification: decays