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Observing true tauonium via two-photon fusion at e+e– colliders

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The feasibility of observing true tauonium, the bound state of two tau leptons, $\mathcal{T}_0 \equiv (\tau^+\tau^-)_0$, via photon-photon collisions at e^+e^- colliders and at the LHC, is studied. The production cross sections of the process $\gamma\gamma \to \mathcal{T}_0 \to \gamma\gamma$ —as well as those of all relevant backgrounds: spin-0 and 2 charmonium resonances decaying to diphotons, and light-by-light scattering— are computed in the equivalent photon approximation for e^+e^- collisions at BES III ($\sqrt{s} = 3.8$ GeV), Belle II ($\sqrt{s} = 10.6$ GeV), and FCC-ee ($\sqrt{s} = 91.2$ GeV), as well as for ultraperipheral p-p, p-Pb, and Pb-Pb collisions at the LHC. Despite small $\mathcal{T}_0$ production cross sections and a final state swamped by decays from overlapping pseudoscalar and tensor charmonium states —the χ_{c2}, $\eta_c(2S)$, and χ_{c0} states have masses only 2.5, 84, and 139 MeV away, respectively, from the $\mathcal{T}_0$ peak— evidence a nd observation of the ground state of the heaviest leptonium appears feasible at Belle II and FCC-ee, respectively, with in-situ high-precision measurements of the irreducible charmonium backgrounds.

Category

talk

Primary author: D\'ENTERRIA, David (C)

Co-author: Mr SHAO, Hua-Sheng (Peking University)

Presenter: D\'ENTERRIA, David (C)

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