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PARTICLE AND NUCLEAR ASTROPHYSICS AND COSMOLOGY

Cover Story (Issue 9, 2025): Precise measurement of χ_{c0} resonance parameters and branching fractions of $\chi_{c0,c2} \to \pi^+\pi^-/K^+K^-$

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Charmonia are bound states of charm quark and anti-quark. High precision measurements of their properties provide crucial information for us to understand their internal structures and the underlying dynamics of the hadron formation. For low-lying charmonia with masses below the $D\overline{D}$ threshold, their decay to light hadrons proceeds predominantly through the annihilation of the charm quark and antiquark into gluons. Since gluons are flavor neutral, the decay pattern of charmonia to light hadrons can be used to test the flavor SU(3) symmetry and its possible breaking owing to the quark mass difference.

In a recent article [1], based on the large $\psi(3686)$ event sample, the BESIII collaboration reported impressive achievements on the resonance parameter measurements of the $1P$ charmonium χ_{c0}, namely, $(m,\Gamma) = (3415.63 \pm 0.12, 12.52 \pm 0.18)\,\mathrm{MeV}$. The precision is increased by 2.5 times for χ_{c0} mass and one order of magnitude for the total width when comparing with the PDG data. Along with the PDG masses of $\chi_{c1,2}$, this updated mass value results in the center-of-gravity mass of the $1P$ spin triplet charmonia $\chi_{c0,1,2}(1P)$, $m_{1P}(\mathrm{COG}) = \left(m_{\chi_{c0}} + 3m_{\chi_{c1}} + 5m_{\chi_{c2}}\right)/9 = 3525.39 \pm 0.04\mathrm{MeV}$. Given the PDG mass value $m_{h_c}(1P) = 3525.37 \pm 0.17\mathrm{MeV}$ of the spin singlet $1P$ charmonium h_c, this result confirms the non-relativistic quark model expectation $m_{1P}(\mathrm{COG}) = m_{h_c}(1P)$ to an unprecedented level. On the other hand, this study also performed very precise measurements of the branching fractions of $\chi_{c0,2}$ decaying to $\pi^+\pi^-$ and K^+K^- final states, which manifest a fairly good SU(3) flavor symmetry and provide important information for understanding the mechanism of light hadron decays of charmonia.

References

[1] M. Ablikim et al. (BESIII Collaboration), Chin. Phys. C **49**, 093001 (2025) arXiv: 2502.08929 [hep-ex].