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Helicity amplitude analysis of chi_cJ -> phi phi

Charmonium state decays provide critical insights into Quantum Chromodynamics (QCD) dynamics. Early theoretical frameworks interpreted two-meson charmonium decays as perturbative QCD (pQCD) processes following helicity selection rules (HSR). BESIII observations of comparable chic1⟶phi + phi and chic0/chic2⟶phi + phi branching fractions demonstrate explicit HSR violations, compelling incorporation of non-perturbative QCD mechanisms. Three competing frameworks, pQCD with phi meson polarisation, 3P0 quark creation models, and DD-loop model, predict distinct helicity amplitude ratios for chicj⟶phi phi decays. Validation is performed through dedicated helicity amplitude analysis of 448.1 million psi(3686) events. Measured helicity amplitude ratios exhibit discrepancies from all theoretical predictions, challenging current chicj decay interpretations. These results necessitate the new non-perturbative QCD mechanisms and provide more constraints for further developing the models.

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