

Observation of X(6900) and evidence of X(7100) in the $J/\psi\psi(2S) \rightarrow \mu^+\mu^-\mu^+\mu^-$ mass spectrum

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In the study of the $J/\psi J/\psi$ invariant mass spectrum, the CMS collaboration has observed three distinct structures, labeled as X(6600), X(6900), and X(7100). A comprehensive analysis of the experimental data indicates that a theoretical model incorporating quantum interference effects among three resonant states provides the best description of the observed mass spectrum distribution. This finding suggests that these three states share the same spin-parity quantum numbers (J^{PC}), offering crucial insights into the nature of these exotic states.

As an extension, this research systematically investigates potential structures near the threshold region in the $J/\psi\psi(2S) \rightarrow \mu^+\mu^-\mu^+\mu^-$ decay channel, utilizing proton-proton collision data collected by the CMS detector, with center-of-mass energies of 13 TeV and 13.6 TeV. The corresponding integrated luminosity is 315 fb^{-1} . In the mass spectrum, a prominent threshold structure is observed near 6900 MeV/ c^2 , with a statistical significance exceeding 5 standard deviations ($>5\sigma$). By introducing a model that accounts for interference effects between structures, evidence for a second peak is identified in the analysis, with a statistical significance of 4.3σ . The masses and widths of these two peaks are measured as $m_1 = 6876^{+46+100}_{-29-110}$, $\Gamma_1 = 253^{+290+120}_{-100-120}$ MeV and $m_2 = 7169^{+26+74}_{-52-70}$, $\Gamma_2 = 154^{+110+140}_{-82-160}$ MeV, respectively, consistent with previously observed results in the $J/\psi J/\psi$ channel.

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