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Scalar and tensor structures in $J/\psi J/\psi$ scattering from lattice QCD

The S-wave scattering amplitudes of $J/\psi J/\psi$ with quantum numbers $J^{PC} = 0^{++}$ and 2^{++} are determined up to 6600\,MeV via lattice QCD simulation.
The calculation is performed on two lattice volumes, L12 and L16, with a single lattice spacing of approximately 0.136\,fm, and at two unphysical pion masses, $m_\pi \approx 420$ and 250\,MeV.
The ${}^1S_0$ $J/\psi J/\psi$ system exhibits a near-threshold attractive interaction, resulting in a virtual scalar bound state with a binding energy of approximately 30-40\,MeV.
In contrast, the ${}^5S_2$ $J/\psi J/\psi$ system exhibits a repulsive interaction near threshold.
These behaviors are primarily dominated by the quark rearrangement effect.
A tenser resonance is observed in the ${}^5S_2$ $J/\psi J/\psi$ channel, with a mass around 6540\,MeV and a width of approximately 540\,MeV.
The extracted mass and width are consistent with the $X(6600)$ (or $X(6400)$) observed by the ATLAS and CMS collaborations, and show little dependence on the two sea pion masses.

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