

New insight into the OZI suppression and the $X_0(4140)$, $X_1(4140)$ and $X_1(4685)$ as hadronic molecules

The coupled channel scattering $\{D_s\bar{D}_s, J/\psi \phi, D_s^* \bar{D}_s^*\}$ involving a dip lineshape is studied in effective range expansion method in $B \rightarrow D_s \bar{D}_s K$, and sheds light on $X_0(4140)$ spectrum. The $X_0(4140)$ corresponds to a pole near $J/\psi \phi$ threshold, where $J/\psi \phi$ scattering length in single channel is $(1.11 \pm 0.65) \text{ fm}$

extracted, and an effective scattering length is $(0.12^{+0.20}_{-0.10} + i0.78^{+0.20}_{-0.40}) \text{ fm}$ in the coupled channel scattering. Assuming the spin interaction in $J/\psi \phi$ scattering is negligible, a virtual state near the $J/\psi \phi$ threshold in $J^{PC}=1^{++}$ sector enhances the lineshape in $J/\psi \phi$ invariant mass distribution, and plays a crucial role to pin down the puzzles in $X_1(4140)$ widths. Heavy quark spin symmetry adapts a similar interaction to interpret a molecular $\psi(2S)\phi$ state, $X_1(4685)$. These three states provide a new way to probe OZI suppression in low-energy scattering.

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