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Three pentaquark states or more?

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The LHCb collaboration has reported recently three pentaquark states found in the $J/\psi N$ mass distribution. Based on the constraints of the heavy quark spin symmetry combined with the local hidden gauge symmetry, we investigate the $\bar{D}^{(*)}\Sigma_c^{(*)}$ interactions, together with $J/\psi N$ and other coupled channels, using a coupled channel approach. From the poles found in the second Riemann sheets, we dynamically reproduce the three states identified with the masses and the widths. Thus, we determine their quantum numbers and approximate molecular structure as $1/2^- \bar{D}\Sigma_c$, $1/2^- \bar{D}^*\Sigma_c$, and $3/2^- \bar{D}^*\Sigma_c$, and isospin $I = 1/2$. In our research procedure, we also predict some other states: (1) one $3/2^- \bar{D}\Sigma_c^*$ state with the mass of around 4374 MeV, for which indications appear in the experimental spectrum; (2) two other near degenerate states of $1/2^- \bar{D}^*\Sigma_c^*$ and $3/2^- \bar{D}^*\Sigma_c^*$, found around 4520 MeV; (3) a $5/2^- \bar{D}^*\Sigma_c^*$ state, appeared at the same energy. Our findings also serve as a guide for further experimental studies.

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