

Pole determination of $P_{\psi_s}^\Lambda(4338)$ and possible $P_{\psi_s}^\Lambda(4254)$ in $B^- \rightarrow J/\psi\Lambda\bar{p}$

First hidden-charm pentaquark candidate with strangeness, $P_{\psi_s}^\Lambda(4338)$, was recently discovered in $B^- \rightarrow J/\psi\Lambda\bar{p}$ by the LHCb Collaboration. $P_{\psi_s}^\Lambda(4338)$ shows up as a bump at the $\Xi_c\bar{D}$ threshold in the $J/\psi\Lambda$ invariant mass ($M_{J/\psi\Lambda}$) distribution. The $M_{J/\psi\Lambda}$ distribution also shows a large fluctuation at the $\Lambda_c\bar{D}_s$ threshold, hinting the existence of a possible $P_{\psi_s}^\Lambda(4254)$. In this work, we determine the $P_{\psi_s}^\Lambda(4338)$ and $P_{\psi_s}^\Lambda(4254)$ pole positions for the first time. For this purpose, we fit a $B^- \rightarrow J/\psi\Lambda\bar{p}$ model to the $M_{J/\psi\Lambda}$, $M_{J/\psi\bar{p}}$, $M_{\Lambda\bar{p}}$, and $\cos\theta_{K^*}$ distributions from the LHCb simultaneously; $\chi^2/\text{ndf} \sim 1.29$. Then we extract $P_{\psi_s}^\Lambda$ poles from a unitary $\Xi_c\bar{D}-\Lambda_c\bar{D}_s$ coupled-channel scattering amplitude built in the model. The $P_{\psi_s}^\Lambda(4338)$ pole is found at $(4339.2 \pm 1.6) - (0.9 \pm 0.4) i$ MeV while the $P_{\psi_s}^\Lambda(4254)$ pole at 4254.4 ± 0.9 MeV. Without the coupled-channels, $P_{\psi_s}^\Lambda(4338)$ is a bound $\Xi_c^+ D^-$ -virtual $\Xi_0^+ \bar{D}^0$ state while $P_{\psi_s}^\Lambda(4254)$ is a $\Lambda_c\bar{D}_s$ virtual state. The data disfavors a hypothesis of $P_{\psi_s}^\Lambda(4338)$ as merely a kinematical effect. This pole determination, which is important in its own right, sets a primary basis to study the nature of the $P_{\psi_s}^\Lambda$ states.

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