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Interpretation of the LHCb Pc States as Hadronic Molecules and Hints of a narrow Pc(4380)

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Three hidden-charm pentaquark P_c states, $P_c(4312)$, $P_c(4440)$, and $P_c(4457)$ were revealed in the $\Lambda_b^0 \to J/\psi p K^-$ process measured by LHCb using both run I and run II data. For the first time, such an analysis is performed employing a coupled-channel formalism with the scattering potential involving both one-pion exchange as well as short-range operators constrained by heavy quark spin symmetry. We find that the data can be well described in the hadronic molecular picture, which predicts seven $\Sigma_c^{(*)}\bar{D}^{(*)}$ molecular states in two spin multiplets. We also show that there is evidence for a narrow $\Sigma_c^*\bar{D}$ bound state in the data which we call $P_c(4380)$, different from the broad one reported by LHCb in 2015. With this state included, all predicted $\Sigma_c\bar{D}$, $\Sigma_c^*\bar{D}$, and $\Sigma_c\bar{D}^*$ hadronic molecules are seen in the data, while the missing three $\Sigma_c^*\bar{D}^*$ states are expected to be found in future runs of the LHC or in photoproduction experiments.

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