

# Decay behaviors of hadronic molecule pentaquark states

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The  $P_c(4380)$  and  $P_c(4450)$  states observed recently by LHCb experiment were proposed to be either  $\bar{D}\Sigma_c^*$  or  $\bar{D}^*\Sigma_c$  bound states. We analyze the decay behaviors of such two types of hadronic molecules within the effective Lagrangian framework. With branching ratios of ten possible decay channels calculated, it is found that the two types of hadronic molecules have distinguishable decay patterns. While the  $\bar{D}\Sigma_c^*$  molecule decays dominantly to  $\bar{D}^*\Lambda_c$  channel with a branching ratio by 2 orders of magnitude larger than to  $\bar{D}\Lambda_c$ , the  $\bar{D}^*\Sigma_c$  molecule decays to these two channels with a difference of less than a factor of 2. Our results show that the total decay width of  $P_c(4380)$  as the spin-parity- $\frac{3}{2}^-$   $\bar{D}\Sigma_c^*$  molecule is about a factor of 2 larger than the corresponding value for the  $\bar{D}^*\Sigma_c$  molecule. It suggests that the assignment of  $\bar{D}\Sigma_c^*$  molecule for  $P_c(4380)$  is more favorable than the  $\bar{D}^*\Sigma_c$  molecule. In addition,  $P_c(4450)$  seems to be a  $\bar{D}^*\Sigma_c$  molecule with  $J^P = \frac{5}{2}^+$  in our scheme. Based on these partial decay widths of the  $P_c$  states, we estimate the cross sections for the reactions  $\gamma p \rightarrow J/\psi p$  and  $\pi p \rightarrow J/\psi p$  through the s-channel  $P_c$  states. The forthcoming  $\gamma p$  experiment at JLAB and  $\pi p$  experiment at JPARC should be able to pin down the nature of these  $P_c$  states. We also study the decay behaviors of the strange partners of these  $P_c$  states.

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