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The pole structures of the X(1840)/X(1835) and the X(1880)

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Whether the $N\bar{N}$ interaction could form a state or not is a long standing question, even before the observation of the $p\bar{p}$ threshold enhancement in 2003. The recent high statistic measurement in the $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$ channel would provide a good opportunity to probe the nature of the peak structures around the $p\bar{p}$ threshold in various processes. By constructing the $N\bar{N}$ interaction respecting chiral symmetry, we extract the pole positions by fitting the $p\bar{p}$ and $3(\pi^+\pi^-)$ invariant mass distributions of the $J/\psi \rightarrow \gamma p\bar{p}$ and $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$ processes. The threshold enhancement in the $p\bar{p}$ invariant mass distribution is from the pole on the third Riemann sheet, which more couples to the isospin triplet channel. The broader structure in the $3(\pi^+\pi^-)$ invariant mass comes from the pole on the physical Riemann sheet, which more couples to the isospin singlet channel. Furthermore, the large compositeness indicates that there should exit $p\bar{p}$ resonance based on the current experimental data. In addition, we also see a clear threshold enhancement in the $n\bar{n}$ channel, but not as significant as that in $p\bar{p}$ channel, which is useful and compared with further experimental measurement.

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