New way to produce dense double-antikaonic dibaryon system, $K^-K^-pp$, through $Λ(1405)$-doorway sticking in $p+p$ collisions

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A recent successful observation of a dense and deeply bound $K$ nuclear system, $K^-pp$, in the $p+p\rightarrow K^++K^-pp$ reaction in a DISTO experiment1 indicates that the double-$K$ dibaryon, $K^-K^-pp$, which was predicted to be a dense nuclear system2,3, can also be formed in $p+p$ collisions.

We have formulated and calculated the differential cross section for the formation of the simplest double-$K$ nuclear cluster system, $K^-K^-pp$, in the reaction process

$$p+p \rightarrow K^++K^++Λ^++Λ^*,$$
$$\rightarrow K^++K^++K^-K^-pp,$$
$$\rightarrow K^++K^++Λ+Λ^*,$$

where $Λ^*$ is a quasi-bound $K^-p$ state corresponding to the $Λ(1405)$ resonance4,5. From a comprehensive study of the calculated effects of the binding and density of $K^-K^-pp$ on the cross section, we find that the bound-state peak of $K^-K^-pp$ dominates over the spectrum when and only when the system is dense. This is understood as the two $Λ^*$ doorway particles interact immediately within a short distance, assisted by a large momentum transfer ($\sim 1.8$ GeV/c) and a short collision length ($\sim 0.3$ fm), which helps to enlarge the $Λ^*+Λ^*$ sticking into a dense $K^-K^-pp$ system. See details in Ref.4,5. This mechanism is similar to that for a single $K$ cluster ($K^-pp$) formation6,7, which has just been proven by the DISTO experiment.

Fig. 2. (Color online) Differential cross sections for various bound-state energies, $E$, of the $K^-K^-pp$ system for $T_p = 7.0$ GeV, $Γ = 150$ MeV, $b = 0.3$ fm and $θ_{12} = 180$.

References