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

M. Hassanvand,[*1,*2] Y. Akaishi,[*1,*3] and T. Yamazaki[*1,*4]

A recent successful observation of a dense and deeply bound $\bar{K}$ nuclear system, K^-pp, in the $p+p \to K^+ + K^-pp$ reaction in a DISTO experiment[1)] indicates that the double-$\bar{K}$ dibaryon, K^-K^-pp, which was predicted to be a dense nuclear system[2,3)], can also be formed in $p+p$ collisions.

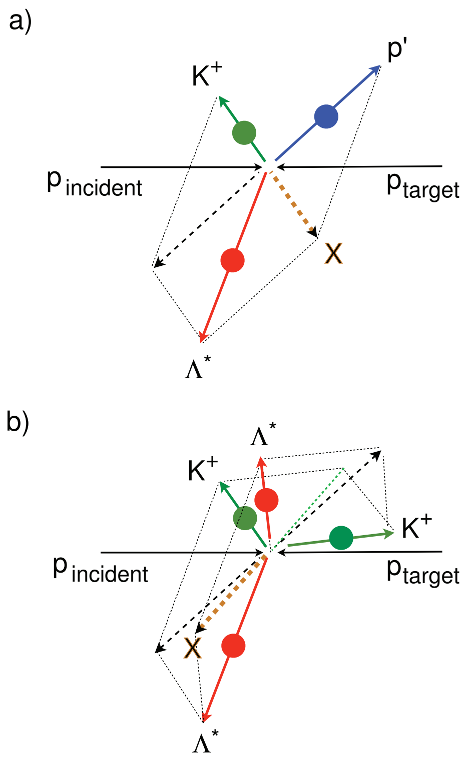

Fig. 1. Reaction diagrams in the center-of-mass system of pp collisions. a) For $pp \to K^+ + K^-pp$ and b) for $pp \to K^+ + K^+ + K^-K^-pp$. The $\Lambda(1405)$ resonance particle as a doorway is indicated by Λ^*.

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

$$p + p \to K^+ + K^+ + \Lambda^* + \Lambda^*,$$
$$\to K^+ + K^+ + K^-K^-pp,$$
$$\to K^+ + K^+ + \Lambda + \Lambda,$$

where Λ^* is a quasi-bound K^-p state corresponding to the $\Lambda(1405)$ resonance[4,5)]. 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 (~ 1.8 GeV/c) and a short collision length (~ 0.3 fm), which helps to enlarge the $\Lambda^* - \Lambda^*$ sticking into a dense K^-K^-pp system. See details in Ref.[4,5)]. This mechanism is similar to that for a single $\bar{K}$ cluster (K^-pp) formation[6,7)], which has just been proven by the DISTO experiment.

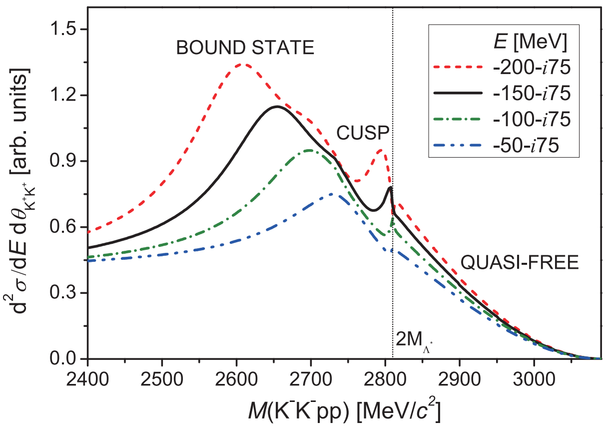

Fig. 2. (Color online) Differential cross sections for various bound-state energies, E, of the K^-K^-pp system for T_p = 7.0 GeV, Γ = 150 MeV, b = 0.3 fm and θ_{12} = 180.

References

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*1 RIKEN Nishina Center
*2 Department of Physics, Isfahan University of Technology
*3 College of Science and Technology, Nihon University
*4 Department of Physics, University of Tokyo