Study of ${}^4_\Lambda$H Formation Mechanism from K^- absorption at rest in Molecular Dynamics Approaches

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Abstract

We present the AMD/QMD results for K^- absorption at rest. Formation probabilities of ${}^4_\Lambda$H and π^- spectrum are well explained in these models.

1. Introduction

One of the most important problems in the current hypernuclear physics is to understand the single- and double-hyper fragment formation. Recently, Tamura *et al.* have measured the ${}^4_\Lambda$H formation probabilities from K^- absorption at rest on some light nuclear targets [1]. We have studied these hyperfragment formation within microscopic transport models — Quantum Molecular Dynamics (QMD) and Antisymmetrized Molecular Dynamics (AMD)[2] — which include the phase space dynamics, stochastic two-body collisions, particle productions and their decays with Pauli-blocking.

2. Results of Microscopic Transport Models

First, we discuss target dependence of ${}^4_\Lambda$H formation mechanisms. AMD + statistical decay (CASCADE) model gives following results[3]: in the ^{16}O and ^{12}C target case, ${}^4_\Lambda$H's are mainly formed through hyperon compound nucleus [4], but dynamical fragmentation plays a significant role for the formation of ${}^4_\Lambda$H in the case of ^{12}C target. In the lighter target cases such as ^{9}Be and ^{7}Li, however, AMD+CASCADE approach underestimates ${}^4_\Lambda$H formation probabilities. If we take into account the direct production of ${}^4_\Lambda$H (K^-+"α" $\to \pi^0$+${}^4_\Lambda$H), it is found that, the yield of ${}^4_\Lambda$H can be explained in ^{9}Be target case, however, for ^{7}Li target, there must be some other mechanisms (Fig.1). Thus we have found that the formation mechanism of ${}^4_\Lambda$H depends strongly on the target nuclei: as the target mass number decreases from ^{16}O, ^{12}C to ^{9}Be, the characteristic formation mechanism varies from statistical decay, followed by dynamical fragmentation, to direct formation in nuclear environment.

Secondly, we have studied the pion final state interaction effects in QMD model, by including pion-nucleon interaction via the delta resonance. QMD results show good agreement with experimental π^- spectrum (Fig.2). Good agreement of calculated pion spectrum with experimental data indicates that our simulation method correctly treats the dynamics from initial stage of the reaction to the final statistical decay process.

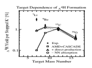

Fig.1 Target mass dependence of ${}^4_\Lambda$H formation probabilities. Boxes and triangles with solid lines represent AMD + CASCADE results without and with direct ${}^4_\Lambda$H production.

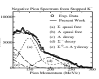

Fig.2 π^- spectrum from stopped K^- on ^{12}C. Comparison between QMD calculation(full line) and the experimental measurement(circles).

Finally, we show the calculated results of K^+ momentum spectrum from (K^-,K^+) reaction at $p_{K^-} = 1.65$ GeV/c. This is a preparatory work for the investigation of double-hyperfragment formation. Preliminary results in Intra Nuclear Cascade model is shown in Fig.3. It is clear that full calculation results (solid) well reproduces the data, and contributions of two-step processes (dotted) are comparable to those of direct processes including scalar and vector meson decay (dashed).

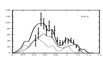

Fig.3 Calculated results of momentum spectra of K^+ for target Cu. The squares represent the experimental data of Iijima *et al.*[5].

3. References

1. H. Tamura *et al.*, Phys. Rev. **C40** R479, R483(1989).
2. T. Maruyama *et al.*,Prog. Theor. Phys. **87** 1367(1992), A. Ono *et al.*, Prog. Theor. Phys. **87** 1185 (1992); Phys. Rev. Lett. **68** 2898 (1992).
3. Y.Nara, A.Ohnishi and T.Harada, Phys. Lett.**B**, in press.
4. T. Yamazaki, Nuovo Cimento **103A** 78 (1989).
5. T.Iijima *et al.*, Nuc. Phys. **A546** 588 (1992).