Kaonic Nuclear State Probed by in-flight (K,N) Reaction

T. Kishimoto[a], T. Hayakawa[a], S. Ajimura[a], S. Minami[a], Y. Simizu[a], A. Sakaguchi[a], and P959 collaboration[b]

[a] *Department of Physics Osaka University*

[b] *BNL, CMU, Tohoku, and Tokyo collaboration*

The kaon-nucleon interaction at low energy region is particularly important nowadays because of the current interest in the dense nuclear matter in neutron stars where so-called kaon condensed state may be achieved by a strong attractive interaction[1,2]. Recently, effective kaon mass in dense nuclear matter has been derived by the Chiral SU(3) effective Lagrangian including $\bar{K}N$, $\pi\Sigma$, $\pi\Lambda$ systems [3]. Such a theoretical model reproduces well the $\Lambda(1405)$ as a $\bar{K}N$ bound state due to the strong $\bar{K}N$ attractive interaction [3].
Recent extensive analysis of kaonic X-ray data concludes that the potential is strongly attractive [4]. The derived depth is around -200 MeV which opens a possibility of kaon condensation at around three times normal nuclear density although earlier studies gave much shallower potentials in which case no kaon condensation is relevant[4].
If $\bar{K}$-nuclear potential is strongly attractive, then deeply-bound kaonic nuclei should exist[5,6]. The observation of kaonic nuclei gives directly the K^- optical potential and gives decisive information on the existence of kaon condensation in neutron stars. We pointed out the in-flight (K^-, N) reaction is suited to study such state[5]. We proposed an experiment to search for the state [7].
We carried out an experiment to study the $^{16}O(K^-, n)$ reaction as a parasitic experiment of AGS-E930 which studied gamma rays from hypernuclei. Clear detection of neutrons were verified by the observation $p(K^-, n)K^0$ reaction where protons are in a water target. We also were able to observe neutrons from the quasifree knockout process of the $p(K^-, n)K^0$ or the $n(K^-, n)K^-$ reactions on nucleons in a ^{16}O nucleus. The observed quasifree spectrum has a clear tail to the bound region which shows that the K-nucleus interaction is attractive.

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