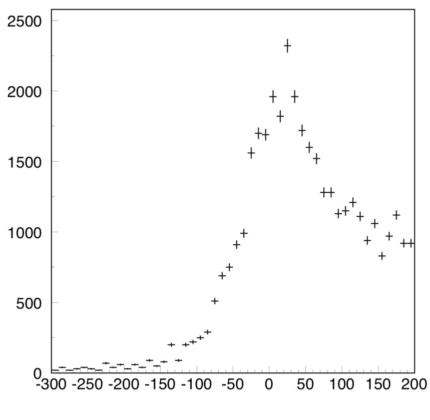
E548: Study of Kaonic Nuclei by the (K^-, N) reactions

KEK-PS E548 experiment was performed to study both kaonic nuclei by the in-flight (K^-, N) reactions and to search for X particles[2] at KEK-PS K2 beam line in April in 2005 for the beam time of 52 shifts. Study of the kaon-nucleus potential becomes a current issue since it can answer the question on whether kaon condensation takes place in neutron stars. This reaction is expected to have the least background and could be the key experiment[1].

In the experiment we measured both neutrons and protons from the in-flight (K^-, N) reactions by the hybrid neutron detector system and KURAMA spectrometer respectively, and observed decay products, such as π and protons, from kaonic nuclei by decay counter system which consists of NaI array and plastic scintillator hodoscopes around targets simultaneously. Carbon, Oxygen(water), and polyethylene were used as experimental targets in order to study relative heavy kaonic nuclei, and deeply bound kaonic nuclear states have been searched by missing mass technique. The detail experimental setup and procedure can be found in ref[3].

The data analysis is underway. We show a missing mass spectrum of the ^{16}O(K^-, n) reaction at $\theta_{lab} = 0°$ in a figure. It is preliminary thus subject to future change. It is a semi-inclusive spectrum where more than one charged particles are detected in the decay counter system. This procedure enhances the kaonic nuclear signal and reduces backgrounds from K_L produced by the $p(K^-, K_L)n$ reaction substantially. The K_L is the dominant background sources in the very deeply bound region (BE>500MeV). The shape of ^{16}O(K^-, n)X missing mass spectrum in the bound region is almost consistent with the previous test experiment[4, 5]. We can see appreciable amount of strength in the deeply bound region which indicates the deep kaon-nucleus potential. Quantitative estimation of the potential depth requires comparison of the spectrum shape with theoretical calculations.

In order to reproduce the spectrum shape, we need to understand not only the spectrum shape in bound region but also that in unbound region. The yield in the unbound region comes from the physical process irrelevant to the (K^-, n) reaction and could have substantial contribution at around threshold region. These studies will lead us the extraction of the K$^-$-nucleus optical potential.



(a) ^{12}C(K^-, n)X

Figure: missing mass spectrum of the O(K^-, n) reaction at $\theta_{lab} = 0°$ (preliminary). BE=0MeV corresponds to sum of the residual nucleus and K^- masses. The calibration of the energy scale (μb/sr/10MeV) was done using the elementary $p(K^-, n)K$ reactions on a hydrogen in polyethylene target, and the sensitivity is 5μb/sr/event. The missing mass resolution is 10MeV(σ) at BE=100MeV.

References

[1] T. Kishimoto, PRL 83,(1999) 4701
[2] T. Kishimoto, hep-ex/0312003 (2003)
[3] T. Hayakawa et al, OULNS annual report (2004)
[4] T. Hayakawa et al, OULNS annual report (2003)
[5] T. Kishimoto et al, Prog.Theor.Phys.Suppl.149:265-27,2003