Recent Results on Kaonic Nuclear Clusters from FINUDA

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The issue of the existence of bound kaonic states in nuclei is presently controversial. Bound states in light nuclear aggregates with narrow decay width were predicted by Akaishi and Yamazaki[1], and they can be understood as an extension of the $\Lambda(1405)$ as a KN bound state. Formation by stopped K^- on a nucleus is suggested in their paper, which led the KEK-PS E471 experiment with a liquid ^4He target.
The FINUDA experiment was mainly conceived for the study of Λ-hypernuclei through the stopped K^- reaction $^AZ(K^-_{stop},\pi^-)^A_\Lambda Z$. Slow kaons come from the decay of Φ mesons, which are abundantly produced by the DAΦNE electron-positron collider. The apparatus characteristics have turned out to be excellent to investigate the topic of Kaon nuclear clusters, thanks to its capability to reconstruct all the particles coming from the $K^-_{stop}A$ absorption reactions with a large acceptance ($\sim 2\pi$), a good PIED ($> 96\%$) and high momentum resolution ($\Delta p/p \sim 0.6\%$ FWHM for 200 MeV/c pions). This allows the determination of the invariant mass (and other observables) of the final state particles, thus giving a direct picture of the kaon-nucleon aggregates. Missing-mass spectroscopy is also possible by tagging decay particles of kaon-bound states.
A first data taking has been performed from October 2003 to March 2004, with eight different targets (two^{6}Li, one^{7}Li, three^{12}C, one^{27}Al, one^{51}V), corresponding to $200 pb^{-1}$.
The first analysis[2] was done for Λ-proton pairs from light nuclear targets (^{6}Li,^{7} Li,^{12} C). They are strongly back-to-back correlated and their invariant mass distribution shows a significant large shift from the threshold of $K^- + p + p\,(2.370 GeV/c^2)$. This can be interpreted as two-body decay of K^-pp into $\Lambda+p$. Magas et al. pointed out the possibility of a final state interaction effect after kaon two-nucleon absorption, contrary to FINUDA interpretation[3]. In order to have a better understanding about the two-nucleon absorption process, the comparison with $\Lambda + n$ and $\Sigma^- + p$ pairs is in progress. A heavier system K^-ppn via $\Lambda + d$ pairs is also being studied.
For the missing-mass spectroscopy, we found a narrow peak structure around 500MeV/c in the inclusive proton spectrum only for the ^6Li target, which is more or less similar to the peak observed in the KEK-PS E471 experiment. However, the origin of the peak is interpreted as the absorption of the kaon into a quasi-free deuteron inside the nucleus, decaying into a Σ^- and an almost back-to-back proton, because the proton around the peak strongly correlates with a fast π^- in the opposite direction[4].
In a quest for much higher statistics to clarify the situation, FINUDA is taking data from November 2006 to June 2007, with a different set of targets (two^{6}Li, two^{7}Li, two^{9}Be, one^{13}C, oneD_2O). The integrated luminosity goal is 1 fb^{-1}. I will show the status of the new analysis in addition to the result of previous data-taking.

References

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