Neutron-rich Hypernuclei: observation of ${}^{6}_{\Lambda}$H and search for ${}^{9}_{\Lambda}$He

E. Botta[(a)] on behalf of the FINUDA Collaboration and A. Gal[(b)],

[(a)] INFN - Sezione di Torino and Torino University - Physics Department
via P. Giuria 1, Torino, Italy
[(b)] Racah Institute of Physics, The Hebrew University, Jerusalem 91904, Israel

The existence of and the possibility to observe neutron-rich Λ-hypernuclei dates back to 1963 (1). They are important both for nuclear structure studies, since the addition of a Λ-Hyperon may stabilize nuclear cores that are otherwise unstable, and for astrophysics, since they may shed light on the stiffness or softness of the equation of state for Hyperons in neutron-star matter. The simplest nuclear reactions in which they may be obtained are (K^-, π^+) or (π^-, K^+) on light nuclear targets, by detecting the outgoing meson. The expected production rates are lower by about 3 orders of magnitude than those for producing normal hypernuclei. No production of neutron-rich Hypernuclei in well-defined final states was observed. In the case of the (K^-, π^+) reaction with K^- at rest, the possible existence of peaks signaling the occurrence of the reaction was hindered by the occurrence of a background due to other reactions. In order to bypass this problem we developed a technique in which we considered not only the π^+ from the formation reaction, but also the π^- from the mesonic decay of the produced neutron-rich Hypernucleus. It is easy to see that, due to the delay related to the Hypernucleus's lifetime, the sum of the two kinetic energies is to a first order independent of the mass of the neutron-rich Hypernucleus. The method was successful in selecting unambiguously three events related to the production and decay of ${}^{6}_{\Lambda}$H. Its binding energy, evaluated jointly from production of ${}^{6}_{\Lambda}$H in the (K^-_{stop},π^+) reaction on ^{6}Li targets and its subsequent two-body weak decay to $\pi^- + {}^6He_{g.s.}$, is B_Λ=(4.0±1.1) MeV with respect to ^{5}H+Λ (2). The production rate is evaluated as $(5.9\pm4.0)\cdot10^{-6}/K^-_{stop}$.

A similar investigation was carried out for the ^{9}Be stopping target, leading possibly to ${}^{9}_{\Lambda}$He, interesting since it could be a neutron-halo Hypernucleus. No event was found, and an upper limit for production of $(5.0\pm4.1)\cdot10^{-6}/K^-_{stop}$ was deduced. The experimental reason for a null observation, obtained with a similar number of K^- stopped in the ^{6}Li and ^{9}Be target, can be shared among a lower production rate, a lower rate of mesonic decay expected for ${}^{9}_{\Lambda}$He and a lower acceptance of detection.

[1] R.H. Dalitz and R. Levi-Setti, Nuovo Cimento 30 (1963) 489.

[2] M. Agnello et al., Physical Review Letters 108 (2012) 042501.

E-mail: botta@to.infn.it , avragal@savion.huji.ac.il