Study of Doubly Strangeness Nuclei at BNL

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The study of double-Λ hypernuclei (S = -2) provides hitherto unavailable information concerning the Λ-Λ force, which is important in order to understand the baryon-baryon interaction in a unified way, and in particular for its application to multi-strange systems, such as hyperon-mixed neutron star and strangelet.

The experiment for the production of double-Λ hypernuclei in (K^-,K^+) reactions on ^{9}Be was carried out at the D6 line in the BNL-AGS . The observational procedure used was the detection of pairs of decay pions, each one indicating one unit of strangeness change in sequential mesonic weak decay of a $\Lambda\Lambda$ system. The pions are tracked in the Cylindrical Detector System (CDS) comprised of cylindrical drift chambers in a solenoidal magnetic field surrounding a target. The details of the experiment have been described in Ref. [1].

The results indicate two regions of event concentration for two pions momenta; one near (104,114) and one near (114,133) in the pion momentum axes (MeV/c). The latter is attributed to the production of the twin hypernuclei $^4_\Lambda$H and $^3_\Lambda$H and the former is considered as the production of the double-Λ hypernucleus $^{\ 4}_{\Lambda\Lambda}$H;

$$\begin{aligned} {}^{\ 4}_{\Lambda\Lambda}\mathrm{H} &\rightarrow {}^4_\Lambda\mathrm{He}^* + \pi^- \qquad (\sim 104\ MeV/c) \\ & \qquad {}^4_\Lambda\mathrm{He}^* \rightarrow {}^3_\Lambda\mathrm{H} + p \\ {}^3_\Lambda\mathrm{H} &\rightarrow {}^3\mathrm{He} + \pi^- \qquad (114.3\ MeV/c), \end{aligned}$$

The observation of numerous $\Lambda\Lambda$ hypernuclei in this experiment argues against the existence of an S=-2 dibaryon with a mass less than a few MeV below that of a $\Lambda\Lambda$ system. The details of the interpretation as well as a simple model of the production mechanism will be presented. We will also discuss the future experiment to reconfirm the production of $^{\ 4}_{\Lambda\Lambda}$H with 10 times higher statistics and to get its binding energy or pairing energy of the Λ's within the mass 4 double-Λ hypernucleus, i.e. a deuteron plus two Λ's, with an accuracy of at least 0.5 MeV.

References

[1] J. K. Ahn et al., Phys. Rev. Lett. **87** (2001) 132504-1.