Possibility of Ξ Hypernuclear Spectroscopy at BNL-AGS

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Ξ hypernuclei supply a unique opportunity for the study of the Ξ-nucleus and ΞN interactions. Although Ξ hypernuclear states decay via the conversion process $\Xi N \rightarrow \Lambda\Lambda$ and would be broaden depending directly on the strength of the ΞN-$\Lambda\Lambda$ coupling, recent calculations predict that their states maintain narrow widths of order of $1-1.5$ MeV[1] and claim that Ξ hypernuclear spectroscopy is promising. If discrete Ξ hypernuclear states can be observed with high resolution, we can observe not only the Ξ-nucleus and ΞN interactions but also the ΞN-$\Lambda\Lambda$ coupling interaction through their widths. In this connection, it is interesting to see the aspect of the admixture of $\Lambda\Lambda$ hypernuclear states into a Ξ hypernuclear state, which will be closely related to the current interests on the $\Lambda\Lambda$-ΞN-$\Sigma\Sigma$ configuration mixing in $S=-2$ system and also the H dibaryon. The small energy difference (28.3 MeV) between the Ξ^--p and Λ-Λ systems implies a non-negligible configuration mixing between the Ξ^-+A and $\Lambda\Lambda+(A-1)$ states.

Although Ξ hypernuclei include much interesting physics, the experimental studies are very limited and the existence is not even well established yet. Ξ hypernuclei can be directly produced via the p$(K^-,K^+)\Xi^-$ reaction and observed in the (K^-,K^+) missing mass spectrum. Recently, the $^{12}C(K^-,K^+)$ missing mass spectrum was measured in KEK E224[2] and later in AGS E885[3]. While their missing mass resolution ($\sim$10 MeV fwhm) was not sufficient to observe discrete bound Ξ states, their spectrum shows the evidence for Ξ hypernuclei produced in the (K^-,K^+) reaction and defines the sensitivity needed for observation of discrete bound Ξ states.

We consider a Ξ hypernuclear spectroscopy experiment with 1.8 GeV/c K^- beam available at the AGS D6 line introducing a spectrometer called MRS as a forward K^+ spectrometer. The MRS consists of a quadrupole and two dipole magnets (QD$\overline{\text{D}}$), and is available from LANL. The acceptance amounts to 17 msr considering some refinements. The cross section for Ξ hypernuclei is sharply peaked at 0 degrees, falling by a factor of 2 around 6 degrees in Motoba's calculations. Since the MRS has a relatively symmetric acceptance in θ and ϕ which maximizes the solid angle at small angles, the MRS efficiently accumulates Ξ hypernuclear events. The estimate for $^{12}C(K^-,K^+)^{12}_{\Xi}Be$ reaction shows that sufficient statistics for the Ξ $1s$ state can be collected within modest running times under the beam condition available at the D6 line. The momentum resolution of the MRS is 0.1% fwhm, which enables us to achieve 2.5 MeV fwhm missing mass resolution. Realizing this attempt will be significant also in terms of bridge to further studies at JHF. The strategy of this experiment and also simulation of its results will be presented.

References

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