Observation of double-hypernuclei and Λ-Λ interaction

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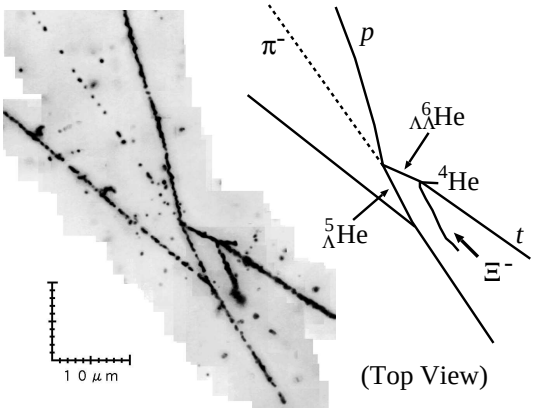
A hybrid-emulsion experiment E373 was carried out at the KEK 12 GeV proton synchrotron using a 1.66 GeV/c K^- meson beam. The purpose of this experiment is to study double-strangeness nuclei produced via Ξ^- hyperon capture at rest with ten times as large statistics as past experiments.
Until now about 35% of the total emulsion has been analyzed. Among them, we have successfully detected two events of sequential weak decay of double-Λ hypernucleus, named "Demachiyanagi" and "Nagara" [1], and two events of twin single-Λ hypernuclei [2].
The figure below shows a photograph of the double-Λ hypernucleus event, "Nagara". The nuclide and its decay mode were identified uniquely as

$$^{12}\mathrm{C} + \Xi^- \;\rightarrow\; {}^{6}_{\Lambda\Lambda}\mathrm{He} + {}^{4}\mathrm{He} + t, \quad {}^{6}_{\Lambda\Lambda}\mathrm{He} \;\rightarrow\; {}^{5}_{\Lambda}\mathrm{He} + p + \pi^-.$$

The Λ-Λ interaction energy, $\Delta B_{\Lambda\Lambda}$, is determined for the first time without the ambiguities due to the possibilities of excited states. The value of $\Delta B_{\Lambda\Lambda}$ is $1.01 \pm 0.20\ ^{+0.18}_{-0.11}$ MeV. It is considerably smaller than that previously expected, and past experimental results [3,4] should be reinterpreted taking account of the possibilities of excited states.
The weak decay mode of double-hypernuclei is also studied. Double-hypernuclei have hyperon-induced non-mesonic decay modes, $\Lambda\Lambda \rightarrow \Lambda N$ and $\Lambda\Lambda \rightarrow \Sigma N$. The search for these decays are now in progress using both emulsion and scintillating-fiber-detector data. In this talk, the results of these E373 events as well as those of past experiments will be summarized, and the branching ratios of weak decay modes of double-hypernuclei will be presented.



Photograph and schematic drawing of the double-Λ hypernucleus event, "Nagara".

References

[1] H.Takahashi *et al.*, Phys. Rev. Lett. **87** (2001) 212502.
[2] A.Ichikawa *et al.*, Phys. Lett. **B 500** (2001) 37.
[3] R.H.Dalitz *et al.*, Proc. R. Soc. London **A 426** (1989) 1.
[4] S.Aoki *et al.*, Prog. Theor. Phys. **85** (1991) 1287.