

E518: Gamma-Ray Spectroscopy of ${}_{\Lambda}^{11}\text{B}$

Using a large germanium detector array called Hyperball (Fig. 1), we have been studying precise structure of Λ hypernuclei by high-resolution γ -spectroscopy technique. We have studied ${}_{\Lambda}^7\text{Li}$ in KEK E419 [1,2], ${}_{\Lambda}^9\text{Be}$ [3], ${}_{\Lambda}^{15}\text{N}$ and ${}_{\Lambda}^{16}\text{O}$ [4] in BNL E930, and various hyperfragments in KEK E509 [5]. The purpose of the E518 experiment is to investigate the structure of ${}_{\Lambda}^{11}\text{B}$ hypernucleus. In this experiment, we aim at measuring the transition probability, $B(M1)$, of the Λ -spin-flip $M1$ transition ${}_{\Lambda}^{11}\text{B}(3/2^+ \rightarrow 1/2^+)$. Using Doppler shift attenuation method, which we successfully applied to the $B(E2)$ measurement of ${}_{\Lambda}^7\text{Li}$ in E419 [2], we can obtain the lifetime of the ${}_{\Lambda}^{11}\text{B}(3/2^+)$ state and determine the $B(M1)$ value. From this $B(M1)$ value we can extract the magnetic moment of a Λ in a nucleus for the first time. The magnetic moment might be significantly changed from the value in free space due to possible medium effect of a baryon in nuclear matter. In addition, the level energies of ${}_{\Lambda}^{11}\text{B}$ provide us with quantitative information on the ΛN interaction, particularly, on the strength of the spin-spin force (Δ) and that of the nucleon-spin-dependent spin-orbit force (S_N). The values of Δ and S_N are compared with those obtained from the ${}_{\Lambda}^7\text{Li}$ structure in the previous Hyperball experiment (E419) [1], and their consistency will confirm validity of the theoretical framework.

The experiment was performed in September and October in 2002 for the approved beam time of 80 shifts. The experimental method and setup are almost identical to those of E419 [1,2]. Employing the K6 beam line and SKS (Superconducting Kaon Spectrometer), bound states of ${}_{\Lambda}^{11}\text{B}$ are produced by the (π^+, K^+) reaction at 1.04 GeV/c on an enriched ${}^{11}\text{B}$ metal target. γ rays are detected using Hyperball installed around the target.

Data analysis is currently in progress. In a preliminary γ -ray spectrum, we have successfully observed seven γ transitions from ${}_{\Lambda}^{11}\text{B}$. One of them is assigned as the $E2(1/2^+ \rightarrow 5/2^+)$ transition from the peak shape and the yield. The observed energy of this $E2$ transition (1482 keV) is significantly different from the value predicted by shell model [6] using the Δ and S_N parameters determined from the ${}_{\Lambda}^7\text{Li}$ data. It implies that more theoretical and experimental efforts are necessary to completely understand the spin-dependent ΛN forces and their effects to hypernuclear structure. Assignment of the observed peaks and reconstruction of the level scheme will be done.

References

- [1] H. Tamura *et al.*, Phys. Rev. Lett. 84 (2000) 5963.
- [2] K. Tanida *et al.*, Phys. Rev. Lett. 86 (2001) 1982.
- [3] H. Akikawa *et al.*, Phys. Rev. Lett. 88 (2002) 082501.
- [4] H. Tamura *et al.*, Mod. Phys. Lett. 18 (2003) 85.
- [5] K. Tanida *et al.*, Nucl. Phys. A 721 (2003) 999c.
- [6] D.J. Millener, private communication (2002).

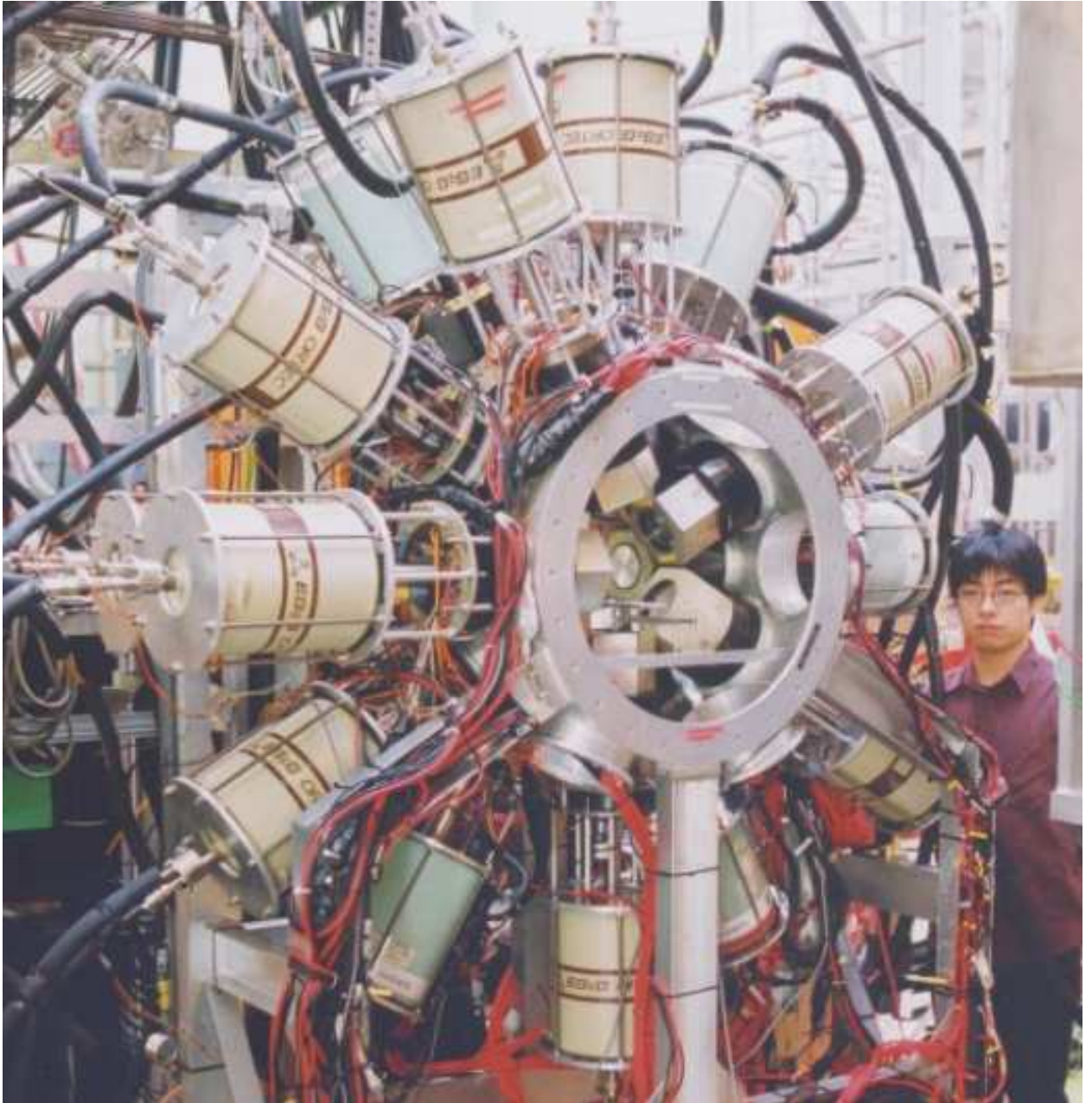


Figure 1: Picture of Hyperball in the E518 experiment.