Measurement of the Λ spin-flip B(M1) value in hypernuclei

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Properties of hadrons in dense matter such as nuclear medium are predicted to be different from free space. Such as Λ in nuclei, its magnetic moment, which is described by the constituent quark mass, may be changed due to partial restoration of chiral symmetry. It is difficult to measure the g-factor directly using spin precession because lifetimes of hypernuclei is short. However, we can derive the g-factor of Λ in nucleus by measuring B(M1) values are between the spin-doublet state [Λ spin-flip B(M1)] in hypernuclei through hypernuclear gamma-ray spectroscopy. B(M1) values of such transitions can be expressed as [1]

$$B(M1) = \frac{3}{8\pi}\frac{(2J_{low}+1)}{(2J_c+1)}(g_c - g_\Lambda)^2 \ ,$$

here g_c and g_Λ denote effective g-factors of core nucleus, and J_c and J_{low} is the spin of the core and the lower state of the doublet. B(M1) values can be derived from a lifetime τ of the excited state as

$$1/\tau = \frac{16\pi}{9}E_\gamma^3 B(M1) \ .$$

Lifetime can be obtained by analyzing a partly-Doppler-broadened gamma-peak shape measured by Ge detectors. This method is called Doppler Shift Attenuation Method (DSAM). To measure the B(M1) values of ground state spin doublets of ${}_\Lambda{}^{19}$F($3/2^+ \rightarrow 1/2^+$) and ${}_\Lambda{}^{7}$Li($3/2^+ \rightarrow 1/2^+$), we will perform Λ hypernuclear gamma-ray spectroscopy (E13) at the J-PARC hadron facility. Hypernulei are produced using the (K^-, π^-) reaction and gamma-rays are detected by Ge detector array, Hyperball-J. The transition energy of ${}_\Lambda{}^{19}$F is estimated to be ~300 keV [2] and that of ${}_\Lambda{}^{7}$Li is experimentally determined to be 692 keV [3]. Each lifetime of the $3/2^+$ state is estimated to be 6 ps and 0.5 ps, respectively. To apply DSAM under this condition, a HF target (ρ =1.0 g/cm^3) and a Li_2O target (ρ =2.0 g/cm^3) are selected. In this talk, an outline and the current status of the B(M1) measurement value in hypernuclei will be presented.

References

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