

# Study of Light Single Hypernuclei with Nuclear Emulsion

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Searching for light hypernuclei in nuclear emulsion is ongoing. We target to measure binding energies of  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$ , which are mirror hypernuclei to provide effective information on charge symmetry breaking in  $\Lambda\text{N}$  interaction.

**KEYWORDS:** Charge symmetry breaking (CSB), A=4 mirror  $\Lambda$  hypernuclei, nuclear emulsion

## 1. Introduction

In hypernuclear physics, both theoretical and experimental groups are approaching the charge symmetry breaking (CSB) effect in  $\Lambda\text{N}$  interaction by studying mirror  $\Lambda$  hypernuclei. Binding energy differences of mirror  $\Lambda$  hypernuclei lead to the existence of CSB in  $\Lambda\text{N}$  interaction. Motivation of our current work is to study CSB with A=4 mirror  $\Lambda$  hypernuclei. Since 1960s, emulsion experiments reported  $B_{\Lambda}$  of  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$  in ground state ( $0^+$ ) [1- 3]. The combined results for  $B_{\Lambda}(0^+)$  of  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$  were reported by M. Juric et al. [4] to be  $2.04 \pm 0.04$  MeV and  $2.39 \pm 0.03$  MeV, respectively. This combined data gave a large binding energy difference between  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$ ,  $\Delta B_{\Lambda}(0^+) = 0.35 \pm 0.05$  MeV and thus CSB effect appears significantly.

CSB effect in excited states ( $1^+$ ) was studied in  $\gamma$ -ray spectroscopy experiments by measuring the  $\gamma$ -rays from ( $1^+ \rightarrow 0^+$ ) transition. To draw the level schemes of mirror hypernuclei ( ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$ ), it completely depends on ground state ( $0^+$ ) energy [5]. Recently, MAMI-C reported  $B_{\Lambda}({}^4_{\Lambda}\text{H}(0^+)) = 2.12 \pm 0.01(\text{sta.}) \pm 0.09(\text{sys.})$  MeV and  $\Delta B_{\Lambda}$  in A=4 mirror hypernuclei becomes small. We will measure  $B_{\Lambda}$  for both  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$  under the same experimental and analysis procedures in the emulsion. This may be very effective to study CSB effect in  $\Lambda\text{N}$  interaction of  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$ .

To collect events of  ${}^4_{\Lambda}\text{H}$  and  ${}^4_{\Lambda}\text{He}$  hypernuclei, we use one emulsion stack of E176 experiment exposed by 1.66 GeV/c  $\text{K}^-$  beam [6]. Dimension of emulsion plate is 23cm×23cm× 0.11cm and a stack consists of 43 emulsion plates. Searching for single hypernuclear events is ongoing.

## 2. Detection system of light single- $\Lambda$ hypernuclear events