3–7 Search for $^{6}_{\Lambda}$H Hypernuclei

— Can We Make Neutron-Rich Hypernuclei? —

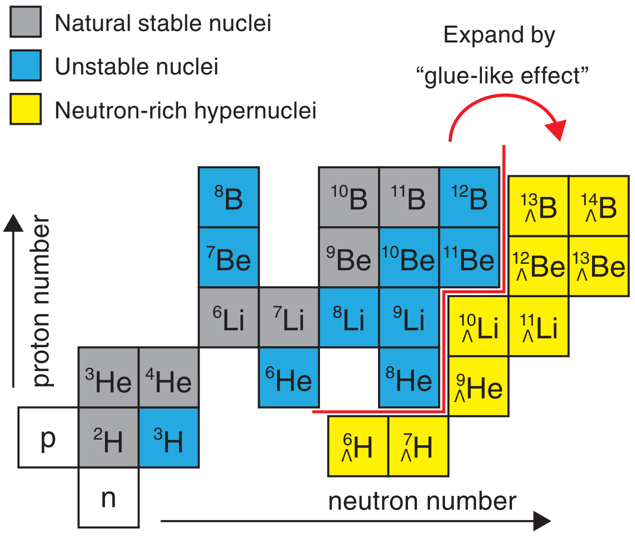

Fig.3-14 Nuclear chart of ordinary nuclei and hypernuclei
The horizontal axis shows the number of neutrons, and the vertical axis shows the number of protons. The grey boxes correspond to existing natural nuclei. The blue boxes correspond to unstable nuclei measured by experiments. The production of hypernuclei, indicated by yellow boxes, is possible using glue-like effects at J-PARC.

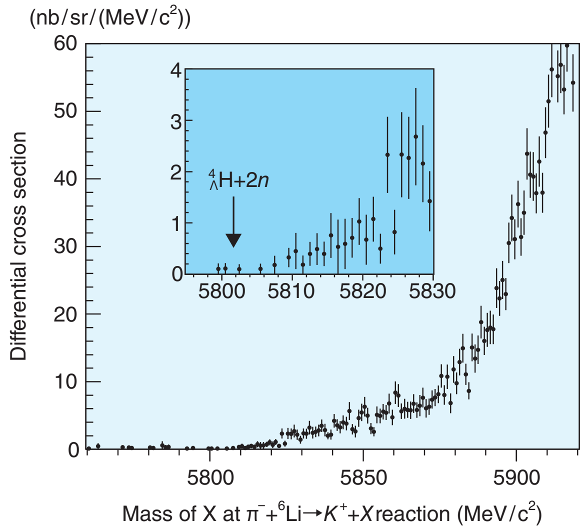

Fig.3-15 Mass of X in the reaction: $\pi^- + {}^6$Li ⟶ K^+ + X
A magnified view of the Λ bound region is shown in the inset. The arrow labeled $^{4}_{\Lambda}$H + 2*n* shows the particle decay threshold (5801.7 MeV/c^2).

Ordinary nuclei comprise nucleons, i.e., protons and neutrons. On the other hand, Λ hypernuclei comprise one Λ particle together with nucleons. The Λ particle, which is of the species "hyperon," has a new degree of freedom: *strangeness*. This introduces an additional attractive force between the Λ particle and the nucleons, and causes a shrinkage of the nuclei. We call this a "glue-like effect." Using this, the nuclear chart expands in the strangeness sector. Fig.3-14 shows the nuclear chart of ordinary and hypernuclei. The region of hypernuclei (represented by yellow boxes) can be expanded into the neutron-rich region.

Thus, we attempted to produce a $^{6}_{\Lambda}$H hypernucleus, which comprises one proton, four neutrons, and one Λ. The core nucleus ^{5}H is unbound. Success in making $^{6}_{\Lambda}$H by adding a Λ could allow the production of very neutron-rich nuclei, with neutron-proton ratios as large as four.

The FINUDA (FIsica NUcleare a DAfne) group has reported three candidate events for $^{6}_{\Lambda}$H. However, the error in the mass was as large as about 1 MeV/c^2. We should confirm the mass with a larger amount of data.

This study was conducted with the K1.8 beam line of J-PARC's Hadron Experimental Facility. $^{6}_{\Lambda}$H is produced via the reaction $\pi^- + {}^6\mathrm{Li} \rightarrow K^+ + X (X = {}^{6}_{\Lambda}\mathrm{H})$, which changes two protons to one neutron and one Λ particle. Fig.3-15 shows the mass spectrum of *X*. The arrow in the inset indicates the sum of $^{4}_{\Lambda}$H and two neutrons, and thus, the maximum-mass threshold of $^{6}_{\Lambda}$H. Unfortunately, no significant peak structure was observed around this arrow. An upper limit of the cross section was estimated to be 1.2 nb/sr. From this result, we determined that the production cross section of $^{6}_{\Lambda}$H must be much lower if it exists and indicated that there is room for the discussion of the theoretical model of the production mechanism.

Reference
Sugimura, H. et al., Search for $^{6}_{\Lambda}$H Hypernucleus by the ^{6}Li(π^-, K^+) Reaction at p_{π^-} = 1.2 GeV/*c*, Physics Letters B, vol.729, 2014, p.39–44.