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Neutron-rich hypernuclei beyond ${}^{6}_{\Lambda}$H

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Recent experimental evidence presented by the FINUDA Collaboration for a particle-stable ${}^{6}_{\Lambda}$H [1] has stirred renewed interest in charting the limits of particle-stable neutron-rich Λ hypernuclei, particularly when the nuclear core is unbound. Ongoing few-body calculations of ${}^{6}_{\Lambda}$H have been reported in HYP2012 [2], and a (π^-, K^+) experiment on ^{6}Li and ^{9}Be targets is underway at J-PARC [3].

We have studied theoretically within a shell-model approach several neutron-rich Λ hypernuclei in the nuclear p shell that may be formed in (π^-, K^+) or in (K^-, π^+) reactions on stable nuclear targets. The relevant hypernuclear shell-model matrix elements are taken from a theoretically-inspired successful fit [4] of γ-ray transitions in p-shell Λ hypernuclei [5] which includes also $\Lambda N \leftrightarrow \Sigma N$ coupling. Predictions will be given for the binding energies of ${}^{9}_{\Lambda}$He, ${}^{10}_{\Lambda}$Li, ${}^{12}_{\Lambda}$Be, ${}^{14}_{\Lambda}$B. None of the large effects conjectured by Akaishi and Yamazaki [6] to arise from $\Lambda N \leftrightarrow \Sigma N$ coupling is borne out by these detailed realistic shell-model calculations. This is evident from the relatively modest $\Lambda N \leftrightarrow \Sigma N$ component of the total beyond-mean-field contribution to the Λ hypernuclear g.s. binding-energy, marked $\Delta B_{\Lambda}^{\rm g.s.}$ in Table 1. A detailed exposition will be given during the presentation.

Table 1: Beyond mean field $\Delta B_{\Lambda}^{\rm g.s.}$ shell-model contributions (in keV) to g.s. of neutron-rich hypernuclei

target	n–rich	less $2n$	$\Lambda-\Sigma$	$\Lambda-\Sigma$	induced	$\Delta B_{\Lambda}^{\rm g.s.}$
${}^{A}Z$	${}^{A}_{\Lambda}(Z-2)$	${}^{(A-2)}_{\Lambda}(Z-2)$	last $2n$	total	$l_N \cdot s_N$	total
^{6}Li	${}^{6}_{\Lambda}$H(0^+)	${}^{4}_{\Lambda}$H(0^+)	101	101	176	278
^{9}Be	${}^{9}_{\Lambda}$He$(\frac{1}{2}^+)$	${}^{7}_{\Lambda}$He$(\frac{1}{2}^+)$	152	253	619	879
^{10}B	${}^{10}_{\Lambda}$Li(1^-)	${}^{8}_{\Lambda}$Li(1^-)	115	275	595	1022
^{12}C	${}^{12}_{\Lambda}$Be(0^-)	${}^{10}_{\Lambda}$Be(1^-)	123	158	554	748
^{14}N	${}^{14}_{\Lambda}$B(1^-)	${}^{12}_{\Lambda}$B(1^-)	152	255	458	785

[1] M. Agnello et al. (FINUDA + A. Gal), Phys. Rev. Lett. 108 (2012) 042501, Nucl. Phys. A 881 (2012) 269.
[2] B.F. Gibson, I.R. Afnan, to appear in the proceedings of HYP2012, Nucl. Phys. A (2013); E. Hiyama, to appear in the proceedings of HYP2012, Nucl. Phys. A (2013).
[3] See http://j-parc.jp/researcher/Hadron/en/Proposal_e.html for J-PARC experiment E10.
[4] D.J. Millener, Nucl. Phys. A 881 (2012) 298, and references therein.
[5] H. Tamura et al., Nucl. Phys. A 835 (2010) 3, and references therein.
[6] Y. Akaishi, T. Yamazaki, in *Physics and Detectors for DAΦNE*, Eds. S. Bianco et al., Frascati Physics Series Vol. XVI (INFN, Frascati, 1999) pp. 59-74.