Novel Aspect of ${}^{5}_{\Lambda}$He and Tensorial $\Lambda N - \Sigma N$ Coupling

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Few-body calculations for s-shell hypernuclei with mass number $A = 3 - 5$ are important not only to explore exotic nuclear structure, including the strangeness degrees of freedom, but also to clarify the characteristic features of the hyperon-nucleon (YN) interaction. Recently, we performed *ab initio*-type variational calculations for the s-shell hypernuclei by explicitly including Σ degrees of freedom[1]. Four sets of YN interactions (SC97d(S), SC97e(S), SC97f(S) and SC89(S))[2] and a set of NN interaction (G3RS)[3] were used. The SC97d-f(S) and SC89(S) are set to reproduce the low-energy S matrix of the original Nijmegen YN potentials[4].
The purpose of this contribution is to study the structural aspects of ${}^{5}_{\Lambda}$He with an appropriate YN interaction which is consistent with all of the s-shell hypernuclear data. SC97e(S) was the most appropriate among the YN interactions employed in the calculation (see Table 1). The bound-state solution of ${}^{5}_{\Lambda}$He was obtained, which is a *first ab initio* calculation using realistic NN and YN interactions with explicit Σ admixture. A sizable amount of $P_{\Sigma}({}^{5}_{\Lambda}\mathrm{He})$ due to strong tensor $\Lambda N - \Sigma N$ transition potential and a large energy expectation value of the tensor $\Lambda N - \Sigma N$ transition part were found. As a result of that, the internal energy of the ^{4}He subsystem was strongly affected by the presence of a Λ particle with the strong tensor $\Lambda N - \Sigma N$ transition potential.

Table 1: Λ separation energies (B_{Λ}), given in units of MeV, and probabilities of finding a Σ particle (P_{Σ}), given in percentage, of $A = 3-5$ Λ-hypernuclei. SC97e(S) YN interaction was used.

	${}^{3}_{\Lambda}$H	${}^{4}_{\Lambda}$H	${}^{4}_{\Lambda}$H*	${}^{4}_{\Lambda}$He	${}^{4}_{\Lambda}$He*	${}^{5}_{\Lambda}$He
B_{Λ}(calc)	0.09	2.01	0.82	1.95	0.77	2.07
B_{Λ}(expt)	0.13 ± 0.05	2.04 ± 0.04	1.00 ± 0.04	2.39 ± 0.03	1.24 ± 0.04	3.12 ± 0.02
P_{Σ}	0.15	1.44	0.91	1.40	0.89	1.38

References

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