

Exotic Structure of Light Hypernuclei

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We describe full-coupled-channel *ab initio* calculations among the octet baryons for $S = -2$ s -shell hypernuclei, ${}_{\Lambda\Lambda}{}^4\text{H}$, ${}_{\Lambda\Lambda}{}^5\text{H}$ and ${}_{\Lambda\Lambda}{}^6\text{He}$. The wave function of a system with strangeness $S = -2$, comprising A octet baryons, has four isospin-basis components. For example, ${}_{\Lambda\Lambda}{}^6\text{He}$ has four components as $ppnn\Lambda\Lambda$, $NNNNN\Xi$, $NNNN\Lambda\Sigma$ and $NNNN\Sigma\Sigma$. We abbreviate these components as $\Lambda\Lambda$, $N\Xi$, $\Lambda\Sigma$ and $\Sigma\Sigma$, referring the last two baryons. The hamiltonian of the system is hence given by 4×4 components as

$$H = \begin{pmatrix} H_{\Lambda\Lambda} & V_{N\Xi-\Lambda\Lambda} & V_{\Lambda\Sigma-\Lambda\Lambda} & V_{\Sigma\Sigma-\Lambda\Lambda} \\ V_{\Lambda\Lambda-N\Xi} & H_{N\Xi} & V_{\Lambda\Sigma-N\Xi} & V_{\Sigma\Sigma-N\Xi} \\ V_{\Lambda\Lambda-\Lambda\Sigma} & V_{N\Xi-\Lambda\Sigma} & H_{\Lambda\Sigma} & V_{\Sigma\Sigma-\Lambda\Sigma} \\ V_{\Lambda\Lambda-\Sigma\Sigma} & V_{N\Xi-\Sigma\Sigma} & V_{\Lambda\Sigma-\Sigma\Sigma} & H_{\Sigma\Sigma} \end{pmatrix}, \quad (1)$$

where $H_{B_1B_2}$ operates on the B_1B_2 component, and $V_{B_1B_2-B'_1B'_2}$ is the sum of all possible two-body transition potential connecting B_1B_2 and $B'_1B'_2$ components. In the present calculation, we use Minnesota potential[1] for the NN interaction, $D2'$ for the YN and Nijmegen model D simulated (ND(S)) for the YY interaction.[2] The calculations were made by using stochastic variational method.[3, 4]. This is essentially in same line as was made in Ref. [5] except for the isospin function. The isospin function has four components. Table 1 lists the B_Λ and $B_{\Lambda\Lambda}$ values for $S = -1$ and -2 hypernuclei. The $D2'$ YN potential well reproduces all the B_Λ values for $A = 3 - 5$, $S = -1$ hypernuclei. Bound state solutions of the $\Lambda\Lambda$ hypernuclei, ${}_{\Lambda\Lambda}{}^4\text{H}$, ${}_{\Lambda\Lambda}{}^5\text{H}$ and ${}_{\Lambda\Lambda}{}^6\text{He}$, are obtained. This is a first attempt to explore the few-body problem of the full-coupled channel scheme for $A = 4 - 6$, $S = -2$ multistrangeness hypernuclear systems.

The calculations were made using the RCNP SX-5 computer.

Table 1: Λ and $\Lambda\Lambda$ separation energies, given in units of MeV, of $A = 3 - 6$, $S = -1$ and -2 s -shell hypernuclei. Numbers in parentheses are errors in the last digit.

	$B_\Lambda({}^3_\Lambda\text{H})$	$B_\Lambda({}^4_\Lambda\text{H})$	$B_\Lambda({}^4_\Lambda\text{H}^*)$	$B_\Lambda({}^5_\Lambda\text{He})$	$B_{\Lambda\Lambda}({}_{\Lambda\Lambda}{}^4\text{H})$	$B_{\Lambda\Lambda}({}_{\Lambda\Lambda}{}^5\text{H})$	$B_{\Lambda\Lambda}({}_{\Lambda\Lambda}{}^6\text{He})$
Calc	0.056	2.23	0.91	3.18	0.107	4.03	7.91
Exp	0.13(5)	2.04(4)	1.00(4)	3.12(2)			7.3(3)

References

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