What Does Free Space $\Lambda\Lambda$ Interaction Predict for $\Lambda\Lambda$ Hypernuclei?

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Data on $\Lambda\Lambda$ hypernuclei provide a unique method to learn details on the strangeness $S = -2$ sector of the baryon-baryon interaction. From the free space Bonn–Jülich potentials, determined from data on baryon-baryon scattering in the $S = 0, -1$ channels, we construct an interaction in the $S = -2$ sector to describe the experimentally known $\Lambda\Lambda$ hypernuclei. After including short–range (Jastrow) and RPA correlations, we find masses for these $\Lambda\Lambda$ hypernuclei in a reasonable agreement with data, taking into account theoretical and experimental uncertainties. Thus, we provide a natural extension, at low energies, of the Bonn–Jülich OBE potentials to the $S = -2$ channel. Results are presented in Table 1, where both the effect of the $\phi-$exchange and that of the RPA correlations can be seen. We have also investigated the dependence of the results on the $\phi\Lambda\Lambda$ couplings (g and f), by varying both couplings by $\pm 10\%$ around their $SU(6)$ values. We find appreciable changes of the energies for the two highest values of $\Lambda_{\phi\Lambda\Lambda}$. These changes become greater for variations of $f_{\phi\Lambda\Lambda}$ than of $g_{\phi\Lambda\Lambda}$, increase with A and are bigger when RPA effects are considered. For instance, for $\Lambda_{\phi\Lambda\Lambda} = 2.5$ GeV and with RPA the He, Be and B energies vary in the ranges 7.05–7.83, 16.0–17.7 and 26.0–28.2 MeV respectively. Some more detailes come be found in Ref. [1].

	$B^{\rm exp}_{\Lambda\Lambda}$	Without RPA $\Lambda_{\phi\Lambda\Lambda}$ [GeV]				With RPA $\Lambda_{\phi\Lambda\Lambda}$ [GeV]			
		no ϕ	1.5	2.0	2.5	no ϕ	1.5	2.0	2.5
$^{6}_{\Lambda\Lambda}$He	$7.25^{+0.38}_{-0.31}$	6.15	6.22	6.53	6.84	6.34	6.41	6.83	7.33
$^{10}_{\Lambda\Lambda}$Be	17.7 ± 0.4	13.1	13.2	13.7	14.2	14.5	14.6	15.5	16.8
$^{13}_{\Lambda\Lambda}$B	27.5 ± 0.7	22.5	22.6	23.2	23.8	24.2	24.2	25.4	27.0
$^{42}_{\Lambda\Lambda}$Ca	–	37.2	37.3	37.7	38.1	38.3	38.2	39.1	40.1
$^{92}_{\Lambda\Lambda}$Zr	–	44.1	44.2	44.4	44.7	44.6	44.7	45.2	46.0
$^{210}_{\Lambda\Lambda}$Pb	–	53.1	53.1	53.3	53.4	53.4	53.4	53.7	54.1

Table 1: Binding energies $B_{\Lambda\Lambda}$ (MeV). We show theoretical results with and without RPA effects and with different treatments of the $\phi-$exchange $\Lambda\Lambda$ potential. The used B_Λ values are 3.12,6.71,11.37,18.7,22.0 and 26.5 MeV.

References

[1] C. Albertus, J.E. Amaro and J. Nieves, nucl-th/0110046.