An Estimate of the R.M.S. Radius of the 1s-State Orbital of the Λ-Particle in Hypernuclei

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The r.m.s. radius of the 1s-orbital of Λ-hypernuclei is calculated in the case of Woods-Saxon potentials by assuming that the Δ_{sp} spacing (obtained by a relativistic treatment) can be approximated by $\hbar\omega_\Lambda$.

In an earlier paper [1], assuming that the motion of the Λ particle in hypernuclei is described by the Dirac equation with an average Λ-nucleus potential made up by an attractive part U_S and a repulsive part U_V, both of the Woods-Saxon shape, we were able, using a least square fitting procedure, to determine the parameters of the potentials and also give the binding energies of the Λ-particle in its ground as well as in its excited states for a number of hypernuclei. Also we calculated the spacings Δ between the various levels.

In this note, assuming that the spacing Δ_{sp} between the ground and the first excited state can be approximated by the spacing $\hbar\omega_\Lambda$ of a Λ-particle moving in a harmonic oscillator potential (as was suggested in [1], see also [2] and [4]), we calculate the root mean square radius $\langle r_\Lambda^2\rangle^{1/2}$ of the ground state orbital of the Λ-particle in hypernuclei, using the formula [2]

$$\hbar\omega_\Lambda = \frac{3}{2}\frac{\hbar^2}{\mu}\frac{1}{\langle r_\Lambda^2\rangle} \simeq \Delta_{sp}\,.$$

The results obtained are compared with those of Rayet [3] obtained by a more sophisticated approach, and also with those of Daskaloyannis et al. [4] (see Figure 1). Our results are shown in Table 1, while in Fig. 1 the $\langle r_\Lambda^2\rangle^{1/2}$ is plotted versus $A^{1/3}$. Dots correspond to the present study while squares correspond to Rayet and crosses to Daskaloyannis et al. From the figure we observe that for the heavier hypernuclei $\langle r_\Lambda^2\rangle^{1/2}$ shows a linear dependence on $A^{1/3}$, i.e. it is of the form

$$\langle r_\Lambda^2\rangle^{1/2} = c\,A^{1/3} + b\,.$$

Also from the figure we find $c \simeq 0.5$ fm and $b \simeq 0.8$ fm. Since there are no experimental results concerning the

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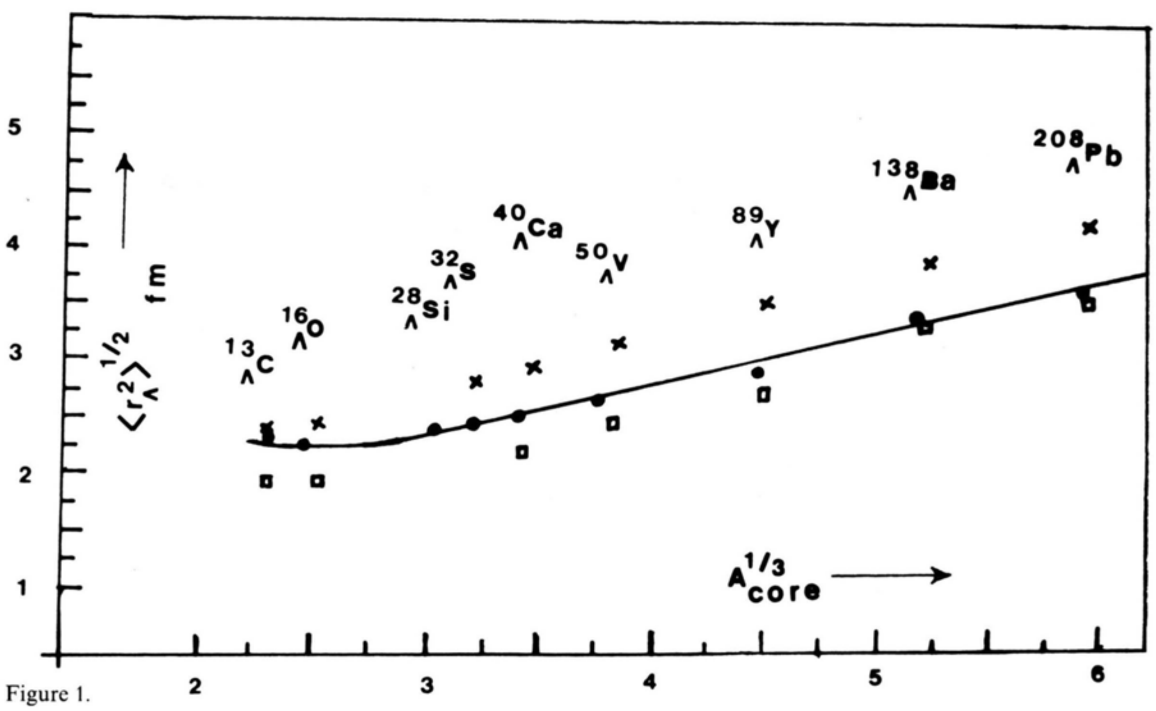

Figure 1.

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Table 1.

A_{core}	Hyper-nuclei	Δ_{sp} MeV	$\langle r_\Lambda^2 \rangle^{1/2}$ fm
12	$^{13}_{\Lambda}C$	10.9	2.30
15	$^{16}_{\Lambda}O$	11.0	2.27
27	$^{28}_{\Lambda}Si$	9.8	2.36
31	$^{32}_{\Lambda}S$	9.5	2.39
39	$^{40}_{\Lambda}Ca$	8.7	2.49
50	$^{51}_{\Lambda}V$	7.9	2.61
88	$^{89}_{\Lambda}Y$	6.2	2.93
137	$^{138}_{\Lambda}Ba$	4.8	3.32
207	$^{208}_{\Lambda}Pb$	3.8	3.72

root mean square radius of the Λ-particle, we cannot compare our results directly with experimental ones and see how close they are. We have, though, experimental results concerning the Δ_{sp} spacing to which our theoretical results show a very good agreement (see [1]). So we believe that our results concerning $\langle r_\Lambda^2 \rangle^{1/2}$ must not be unrealistic. Of course a more detail calculation would require to make use of the radial Dirac wave functions of the Λ-particle.

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