

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

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The r.m.s. radius of the 1s-orbital of A -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 $\hbar\omega_A$.

In an earlier paper [1], assuming that the motion of the A particle in hypernuclei is described by the Dirac equation with an average A -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 A -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 $\hbar\omega_A$ of a A -particle moving in a harmonic oscillator potential (as was suggested in [1], see also [2] and [4]), we calculate the root mean square radius $\langle r_A^2 \rangle^{1/2}$ of the ground state orbital of the A -particle in hypernuclei, using the formula [2]

$$\hbar\omega_A = \frac{3}{2} \frac{\hbar^2}{\mu} \frac{1}{\langle r_A^2 \rangle} \simeq \Delta_{sp}.$$

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 $\langle r_A^2 \rangle^{1/2}$ 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 $\langle r_A^2 \rangle^{1/2}$ shows a linear dependence on $A^{1/3}$, i.e. it is of the form

$$\langle r_A^2 \rangle^{1/2} = cA^{1/3} + b.$$

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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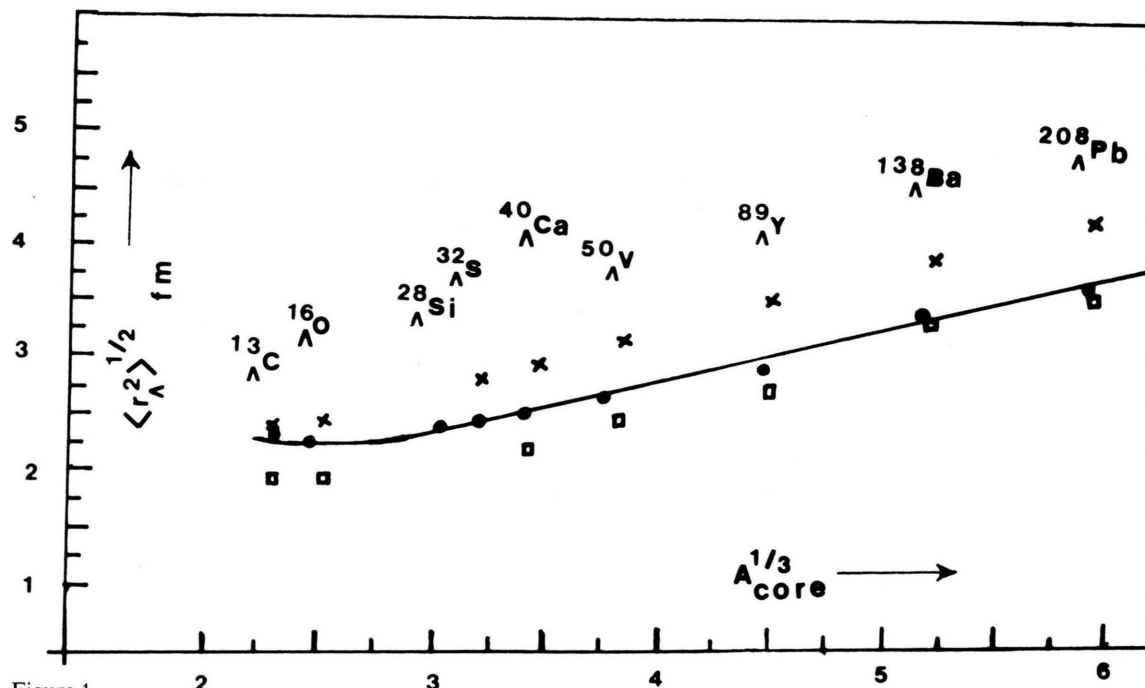


Figure 1.

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Table 1.

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

root mean square radius of the A -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 $\langle r_A^2 \rangle^{1/2}$ must not be unrealistic. Of course a more detail calculation would require to make use of the radial Dirac wave functions of the A -particle.

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- [1] C. G. Koutroulos, Z. Naturforsch. **44a**, 1234 (1989); In press.
 [2] C. B. Daskaloyannis, M. E. Grypeos, C. G. Koutroulos, S. E. Massen, and D. S. Saloupis, Proceedings of the International Conference on Nuclear Physics, Vol. 1, C87, 405 (1983). Contributed Papers.
 [3] M. Rayet, Ann. Phys. **102**, 226 (1976).
 [4] C. B. Daskaloyannis, M. E. Grypeos, C. G. Koutroulos, S. E. Massen, and D. S. Saloupis, Phys. Lett. **134B**, 147 (1984).