

Due Date: 09-24-08

Nuclear Physics 621

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Homework 1 - Shapes and Radii

- 1) Assuming the nucleus is a spherical object with a sharp surface and constant nucleonic density $\rho_0 = 0.16$ nucleons/fm³, demonstrate the relation:

$$R = r_0 A^{1/3}; \quad r_0 = 1.2 \text{ fm}$$

- 2) Consider a spherical square-well potential such as in the figure. The energy of the last occupied neutron state is $\varepsilon < 0$ and its quantum numbers are n and $\ell = 0$. We assume: $\varepsilon \approx 0$.

Prove that the r.m.s radius of the neutron orbit, defined as

$$R_{rms} = \sqrt{\langle \hat{r}^2 \rangle}$$

obeys the following relation:

$$R_{rms} \sim (-\varepsilon)^{-1/2}$$

Discuss the result.

Hint: The asymptotic behavior of the Bessel function at large distance is:

$$H_\ell(z) \xrightarrow{r \rightarrow +\infty} 1 \times 3 \times \dots (2\ell - 1) z^{-\ell-1}$$

