Physics 492 homework IV, due Fri Feb 13

Reminder!
I should receive the topic of your term paper, with a brief description the planned content, on Monday, Feb. 9.

Reading: Chapters 3, 4

Problems:

1. Williams, Problem 3.1. Start from the formula at the bottom of Table 3.1. Expand the r.h.s. there with respect to q. The derivative in the Problem is with respect to q^2. In addition to Problem 3.1, calculate $\langle r^2 \rangle$ for a uniformly charged sphere of radius R. Verify the validity of the equation in Problem 3.1, for the form factor of the sphere obtained in class and reproduced in Problem 3.2 in Williams. [*Hint:* Use again a q-expansion.]

2. Williams, Problem 3.4.

3. Williams, Problem 4.1.

4. The Coulomb term in the semi-empirical mass formula is

$$a_C \, Z^2/A^{1/3} \, .$$

Using the result of Problem 4.1, calculate the value of a_C in MeV. Assume that the nuclear radius is given by $R = 1.12 \times A^{1/3}$ fm.

Using $a_V = 15.85$ MeV, $a_S = 18.34$ MeV, and $a_A = 23.22$ MeV and the fact that the binding energy of ${}^{181}_{73}\mathrm{Ta}$ is 1454 MeV, crosscheck your value of a_C. Comment on any discrepancy you may find. *Note:* For use in this and future problems, you may find it helpful to program the binding-energy formula.

The nucleus ${}^{235}_{92}\mathrm{U}$ can undergo spontaneous fission (see Ch. 5.5) and one of the many fission channels is

$${}^{235}_{92}\mathrm{U} \rightarrow {}^{87}_{35}\,\mathrm{Br} + {}^{145}_{57}\,\mathrm{La} + 3\mathrm{n} \, .$$

Estimate the energy released in this channel. How do the surface and Coulomb energies separately contribute to this release?

(This is a modified Problem 4.2 in Williams.)