Due: Tuesday, 03/08

13. Can you think of a plausible explanation for the second Hund's rule: for a given electronic configuration of a multi-electron atom, and for a given value of the total spin S, the lowest-energy term corresponds to the maximum possible value of the total orbital angular momentum L ?

14.

In this problem (Budker 1998a), intended to illustrate the basic principles of the Thomas-Fermi method, we consider the case of a large number of electrons at zero temperature placed inside a spherical cavity of radius a with impenetrable walls. This is like an atom without the nucleus (of course, the walls are necessary to keep the electrons from flying apart due to the electrostatic repulsion). In the following problem we ignore all numerical factors, such as 4π, in order to simplify expressions and concentrate on the scaling of various effects. Assume $a \gg a_0$, where $a_0 = \hbar^2/(me^2)$ is the Bohr radius. Note that under the stated conditions, the Thomas-Fermi model (Problem 1.7) is applicable.

(a) Argue that the electrons collect in a thin shell of thickness δ at the edge of the spherical cavity. Determine the scaling of δ with respect to the number of electrons N and radius of the cavity a.

(b) For what N does the assumption that the electrons are nonrelativistic break down?

(c) What is the lower bound on N for which the assumptions of the Thomas-Fermi model are satisfied? Estimate δ for the case of low N.

Budker, D. (1998a). Electrons in a shell. *American Journal of Physics*, **66** (7), 572-3.