Phys. 115c Midterm Extra Points

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(15 pts) Imagine that the neutron and the proton interact via a square-well potential, of range 1 fermi (10^{-15} m or 10^{-13} cm). The well must have a minimum depth in order to have at least one bound state. Use the exact solution you've learned earlier (in 115A or 115B), and obtain a numerical answer for the minimum depth in MeV. After you do that, then make one further improved calculation... assume that the range of the potential is 2 fermi, which results from 1 fermi for the neutron and 1 fermi for the proton. You must look up the masses of the proton, neutron, and other fundamental constants yourself. This problem is a fair representation of the deuteron, which is just barely bound (binding energy of about 2.2 MeV), and also the neutron-neutron interaction, where the two neutrons are just barely not bound (by about 0.1 MeV).

(5 pts) Use the minimum depth potential for the range of 1 fermi, and then use the results of Problem 3 of the midterm to get the lowest upper limit (for the trial function from Problem 3) on the binding energy.

For these extra points, you must write up your answers independently, and you must do a good write up; partial credit will be less easy to obtain than on the midterm itself.