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Proton Distribution in Heavy Nuclei*

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November 13, 1953

The Coulomb repulsion tends to force protons as far apart as possible, thereby lowering the proton density at the center of a nucleus. One might conclude that such an expansion would cause a proton excess on the nuclear surface. It is easy to see that the stability against β-decay brings about the opposite result, a neutron excess on the surface.

The top part of Fig. 1 gives a qualitative picture of the average potential acting on neutrons and protons. It is assumed that the proton potential and the neutron potential are the same except for the electrostatic energy. The dashed line indicates the highest filled energy state in the Fermi distribution for both protons and neutrons. Beta-stability requires that the highest filled proton state have the same energy as the highest filled neutron state (actually the proton should have .79 Mev more energy, a difference that may be neglected compared to the Coulomb potential in heavy nuclei). If the nuclear potential at the surface has a finite slope, the dashed line intercepts the potential at a somewhat smaller radius for protons. Consequently, the proton distribution lies inside the neutron distribution. For the heaviest elements the difference in radii could easily be 1/3 to 1/2 the thickness of the sloping part of the nuclear potential; the latter is likely to be of the order of the meson Compton wavelength. Thus the radius of the proton

*Work supported by the AEC

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