Calculation of Nuclear Radius

The nuclear radius (R) is considered to be one of the basic quantities that any model must predict. For stable nuclei (not halo nuclei or other unstable distorted nuclei) the nuclear radius is roughly proportional to the cube root of the mass number (A) of the nucleus, and particularly in nuclei containing many nucleons, as they arrange in more spherical configurations:

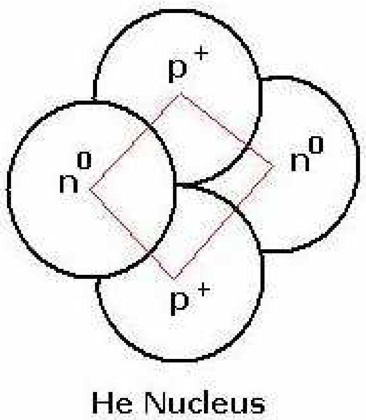
The stable nucleus has approximately a constant density and therefore the nuclear radius R can be approximated by the following formula,

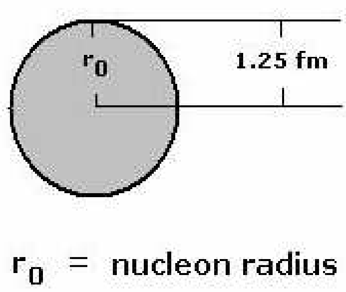
$$R = r_0 A^{1/3}$$

R = nuclear radius in meters (m)
r_0 = is the radius of a nucleon approx 1.3 fm
A = number of nucleons [or atomic mass number, or Z + N]

where A = Atomic mass number (the number of protons Z, plus the number of neutrons N) and r_0 = 1.25 fm = 1.25×10^{-15} m. In this equation, the constant r_0 varies by 0.2 fm, depending on the nucleus in question, but this is less than 20% change from a constant.

In other words, packing protons and neutrons in the nucleus gives *approximately* the same total size result as packing hard spheres of a constant size (like marbles) into a tight spherical or almost spherical bag (some stable nuclei are not quite spherical, but are known to be prolate).





$R_{\text{He Nucleus}} = 1.98 \times 10^{-15}$ m