

A note on the mean-internucleon distance in the central region of heavy nuclei

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Abstract. The density distribution of nucleons in a heavy nucleus is used to show that the mean-internucleon distance in the central region of heavy nuclei is 1.99 fm.

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Recently there is much interest in the study of many-nucleon system starting from the basic constituents of nucleon or quarks. In these studies one likes to know how well a system of nucleons can be described as clusters of three quarks, six quarks etc. (Miller 1985; Sato *et al* 1986). The mean internucleon distance plays a crucial role in the development of all such models, e.g. if the mean-internucleon distance is quite large then the quarks effects in many-nucleon wave function will be quite small and the vice versa. Recently Cook and Dallacasa (1987) have given a value of 2.026 fm for internucleon distance using fcc model. They have also remarked that the fcc model may have some problems with the stability of nuclei. The purpose of the present note is to predict the mean internucleon distance using a recently (Nazakat Ullah 1987) derived form of the density distribution of nucleons in heavy nuclei.

We do this by first considering a system of N nucleons moving in one dimension only in a common harmonic oscillator potential. The density of nucleons is then given by

$$\rho(x) = \sum_{i=0}^{N-1} \phi_i^2(x), \quad (1)$$

where $\phi_i(x)$ are the one-dimensional harmonic oscillator wave functions. They are given by

$$\phi_i(x) = (\sqrt{\pi} 2^i i!)^{-1/2} \exp(-\frac{1}{2}x^2) H_n(x), \quad (2)$$

$H_n(x)$ being Hermite polynomials. $\rho(x)$ is normalized such that

$$\int_{-\infty}^{\infty} \rho(x) dx = N. \quad (3)$$

Looking at expression (1) we find that it is nothing but the probability density function of single eigenvalue (Mehta 1967) for the case of Gaussian unitary ensemble