ANALYTICAL APPROXIMATION TO A DOUBLE FOLDING

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A density - dependent effective nucleon - nucleon interaction, created by two of us[1] as a tool for self - consistent computations of nuclear structure, has been successfully tested in a double folding with nuclear density distributions in order to obtain the real part of the optical potential to be used in the description of heavy ion elastic scattering: Some twenty experimental angular distributions have been reproduced accurately with such folded real potentials associated to a Woods - Saxon imaginary part[2]. Little renormalization (unity in most cases) was needed. The lengthy fivefold integrals required in our folding are

$$V(R) = -U_o\left(1-\frac{N_1-Z_1}{A_1}\,\frac{N_2-Z_2}{A_2}\,\alpha\right)\int d^3\vec r_1\int d^3\vec r_2\,\rho_1(r_1)\,\rho_2(r_2)\,\exp\left\{-\left(\frac{r_{12}}{a}\right)^2\right\}$$

$$\times\left\{1-c\left[\rho_1(r_1)+\rho_2(|\vec r_2-\vec r_{12}|)\right]^{1/3}\left[\rho_1(|\vec r_1+\vec r_{12}|)+\rho_2(r_2)\right]^{1/3}\right\}$$

with $U_o = 264.84$ MeV $\alpha = 0.49$ $c = 1.73\ \mathrm{fm}^2$ $a = 0.87$ fm

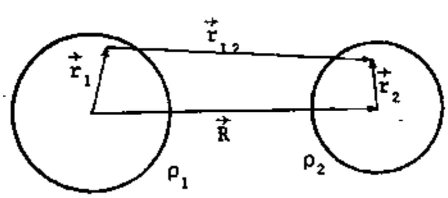

Figure 1. Notation.

They are computed only for six or eight points around the strong absorption radius, and the potential given by the analytical form

$$V(R)\begin{cases} = -V_o\, s^n\, e^{-s/a} & s > an \\ = -V_o(an)^n\, e^{-n} & s \leqslant an \end{cases}$$

$$s = R - C_1 - C_2$$

$$C_i = R_i - 1/R_i$$

$$R_i = (1.13 + 0.0002\,A_i)\,A_i^{1/3}$$

where parameters V_o a n are fitted to the computed points, and distances are given in fm.

The work of Ref. 2, summarized in the previous paragraph, is being continued in several directions. In the first step only the interaction of the projectile nucleons with the target nucleons had been considered in the folding. However the use of a desnity - dependent nucleon - nucleon interaction implies that the internal energy of each nucleus is modified by the penetration of the other colliding nucleus by an amount

$$\Delta V_1(R) = \frac{1}{2} U_o \left\{ 1 - \frac{1-\alpha}{A_1} - \alpha \left(\frac{N_1 - Z_1}{A_1} \right)^2 \right\} c$$

$$\times \int d^3\vec{r}\ \rho_1(r) \int d^3\vec{r}\,'\ \rho_1(r') \exp\left\{ - \left(\frac{\vec{r} - \vec{r}\,'}{a} \right)^2 \right\}$$

$$\times \left\{ \left[\rho_1(r) + \rho_2(|\vec{r} - \vec{R}|) \right]^{1/3} \left[\rho_1(r') + \rho_2(|\vec{r}\,' - \vec{R}|) \right]^{1/3} - \rho_1(r)^{1/3}\ \rho_1(r')^{1/3} \right\}$$

and similarly $\Delta V_2(R)$ with the change $1 \leftrightarrow 2$. And the total nuclear interaction energy becomes less negative. This effect was neglected in the first study. Now we have verified in some examples that this correction diminishes the depth of the folded potential by 4 to 8 % in the relevant region. But we cannot say as yet whether this change causes a general improvement of our model or not.

Some reactions with ^{6}Li projectile have been studied with our model and various prescriptions of Li density. The need for a drastic renormalization, typically 0.6, noted by other authors[3], is not healed by the above - mentioned correction.

References

1) F. J. Viñas and G. Madurga, An. Fis. 73 (1977) 92.

2) F. J. Viñas, M. Lozano, and G. Madurga, Phys. Rev. C23 (1981) 780.

3) G. R. Satchler and W. G. Love, Phys. Rep. C55 (1979) 183.