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WINE-BOTTLE BOTTOM SHAPE OF THE NUCLEON-NUCLEUS POTENTIAL AT INTERMEDIATE ENERGY

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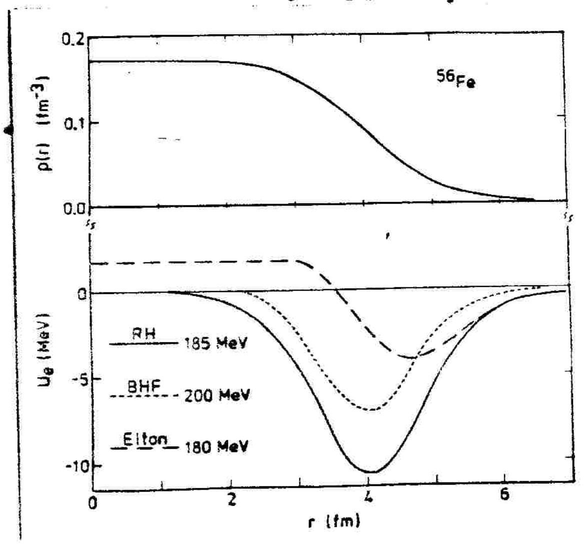
We have studied the nucleon-nucleus optical potential in the framework of a relativistic quantum field model, in which the nucleon field is coupled to two massive fields, associated with the exchange of a scalar meson (σ) and of a vector meson (ω), respectively. In spherical nuclei this optical potential, which should be introduced in a Dirac equation, is the sum of a Lorentz-scalar operator U_s and of a Lorentz-vector component U_o. In the relativistic Hartree approximation, these quantities are independent of energy. It is possible to construct a Schroedinger-equivalent average nucleon-nucleus potential U_e, which is energy-dependent and should be introduced in a Schroedinger equation. The quantity U_e can thus be compared to empirical potentials.

We have extended the work of Brockmann[1]) and performed a self-consistent Hartree calculation of U_e for ^{16}O and ^{40}Ca. The sole input of this calculation is the contribution of σ- and of ω-exchange to the nucleon-nucleon OBEP of Erkelenz, Holinde and Machleidt. At low and intermediate energy, the agreement between calculated and empirical optical potentials is quite good[2]).

One of the striking features of the calculated optical potential is that it has an attractive pocket at the nuclear surface at the energy ($E \simeq 200$ MeV) at which the optical potential becomes repulsive in the nuclear interior[2]). We now show that this "wine-bottle bottom shape" also emerges in the framework of a local density approximation. In the upper part of the figure, we have plotted the density distribution of ^{56}Fe. The full curve in the lower part represents the Schroedinger-equivalent potential U_e at 185 MeV, as calculated in the framework of the relativistic Hartree approximation and of the local density approximation. This theoretical optical potential is strikingly similar to the empirical potential determined by Elton [3]) (long dashes), and also to the potential calculated in the framework of the non-relativistic Brueckner-Hartree-Fock approximation (short dashes) with Reid's hard core nucleon-nucleon interaction[4]).



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2. M. Jaminon, C. Mahaux and P. Rochus, Phys.Rev.Lett.43 (1979) 1097
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4. J.P. Jeukenne, A. Lejeune and C. Mahaux, in Nuclear Self-Consistent Fields, ed. G. Ripka and M. Porneuf (North-Holland Publ.Comp., Amsterdam, 1975) p. 155.

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