Optical Model Analysis of Proton-Nucleus Elastic Scattering Data in the Energy Range 8-17 MeV

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The proton nucleus elastic scattering data in the energy range 8 to 17 MeV have been analyzed using the Coulomb potential of a uniform charge distribution within a sphere of radius R_0 plus the following nuclear potential

$$V = V_{CR}\, \varrho(r) + i\, V_{CI}\, q(r) + V_{SR} \left(\frac{\hbar}{\mu c}\right)^2 \frac{1}{r} \frac{d\varrho(r)}{dr}\, \boldsymbol{\sigma} \cdot \boldsymbol{l}$$

where

$$\varrho(r) = \frac{1}{1+\exp\,(r-R_0)/a}\,,$$

and

$$\mathrm{q}(r) = \exp -\left[\frac{(r-R_0)^2}{b^2}\right],$$

$$R_0 = r_0\, A^{1/3}.$$

The notation used is that of RIESENFELD and WATSON. For all elements and energies $a = 0.65$, $b = 1.2$, $V_{CI} = 11$ and $R_0 = 1.25$. At each energy V_{CR} was increased with increasing mass number in the following way,

$$V_{CR} = V_0(E) + Z/A^{1/3}$$

V_0 decreased smoothly from 44.5 at 8 MeV to 40.7 at 17 MeV. The polarization and differential cross section curves are less sensitive to small changes in V_{SR} than to changes in the other parameters.

At 14 and 17 MeV $V_{SR} = 8 \pm 1$ MeV. At energies below 14 MeV it was necessary to reduce V_{SR} to 5 ± 1 MeV to obtain agreement with the experimental polarization and differential cross section data. Preliminary calculations indicate that the spin-orbit potential may be even smaller below 8 MeV.

The agreement with experimental data is good for medium weight and heavy nuclei becoming very poor for light elements.

For references to experimental data and other theoretical work see the review articles by: HELMUT FAISSNER, Ergebnisse der exakten Naturwissenschaften, Bd. XXXII, 1959, E. J. Squires A.E.R.E. t/p. 75.