DIRAC OPTICAL MODEL CALCULATIONS ON ELASTIC PROTON SCATTERING AT 500 MeV BY ^{90}Zr

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Calculations are presented on the differential cross section and polarization characteristics for elastic proton scattering at T_p = 500 MeV by ^{90}Zr in the eikonal approximation within a relativistic optical model.

There are two distinct lines in the Dirac approach to elastic proton scattering by nuclei [1-3]: 1) deriving the proton-nuclear potential and 2) defining suitable ways of solving Dirac's equation approximately. One thus needs the best form for the eikonal approximation, which should give results close to those from an exact calculation by the partial-wave method. The author has calculated the differential cross section and polarization characteristics for elastic scattering at T_p = 500 MeV by ^{90}Zr in a relativistic optical model.

The scattering amplitude is derived in the eikonal approximation [4], which the author has previously used for elastic scattering by ^{40}Ca; the proton-nuclear potential appears in Dirac's equation and does not contain components other than the scalar and vector ones, and it can be calculated in the momentum approximation by means of the two-particle scattering amplitudes for zero angle:

$$U_{S,V}(r) = -\frac{2\pi}{m}\{f^{(pp)}_{S,V}(0)\rho^{(p)}_{S,V}(r) + f^{(pn)}_{S,V}(0)\rho^{(n)}_{S,V}(r)\}. \quad (1)$$

Equation (1) contains the scalar and vector proton and neutron densities $\rho^{(p)}_{S,V}(r)$ and $\rho^{(n)}_{S,V}(r)$, which can be calculated if one knows the relativistic nuclear wave function [1,2,5]; there is however evidence that incorporating the differences between the vector and scalar densities is not the decisive point in calculating the potential [6], so the author has assumed that $\rho^{(p,n)}_S(r) = \rho^{(p,n)}_V(r)$, with the proton and neutron densities represented in the form

$$\rho^{(i)}(r) = \rho^{(i)}_0 \left(1 + w_i \frac{r^2}{c_i^2}\right)\left(1 + \exp\frac{r^2 - c_i^2}{a_i^2}\right)^{-1}, \quad i = p, n$$

with the parameters w_i, c_i, and a_i from [7]; the NN amplitudes used in calculating the (1) potential have been tabulated [8] (Table VIII).

Figures 1 and 2 show the results where the solid are the differential cross section and polarization characteristics (analyzing power A_y and spin-flip function Q) for elastic scattering at T_p = 500 MeV by ^{90}Zr derived from the eikonal

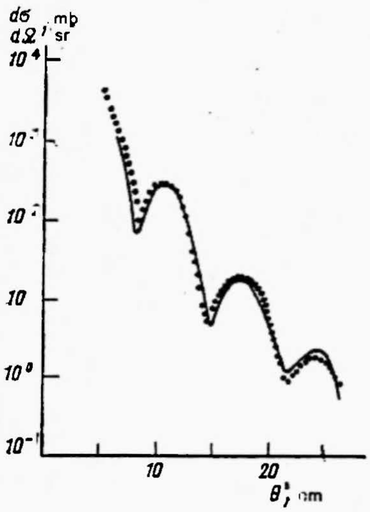

Fig. 1

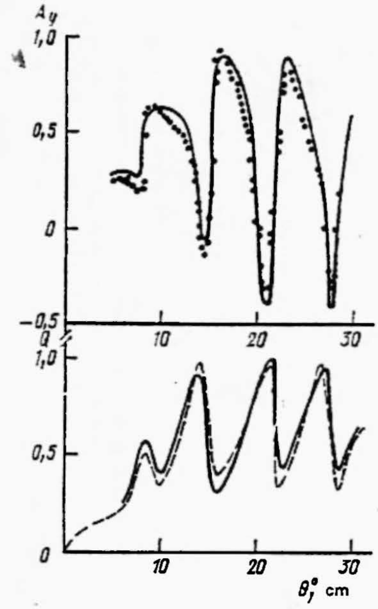

Fig. 2

Fig. 1. Differential cross section dσ/dΩ for elastic proton scattering at T_p = 500 MeV by ^{90}Zr; measurements from [9].

Fig. 2. Polarization characteristics $A_y(\theta)$ and $Q(\theta)$ for elastic scattering at T_p = 500 MeV by ^{90}Zr; dashed line [5] calculation, measurements from [9].

approximation from [4]; the dotted lines show the [5] results, where Dirac's equation was solved by the partial-wave model and the optical potential was calculated on the basis of four different nuclear densities. The eikonal calculation is very close to the exact one and reproduces the [9] measurements well.

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