obtained by other methods: for ^{154}Sm, $\beta_2 \approx 0.28$ and $\beta_4 \approx 0.06$, and for ^{166}Er, $\beta_2 \approx 0.28$ and $\beta_4 \approx 0.01$. However, the values of β_6 we find are for ^{154}Sm, $\beta_6 \approx 0.008$, and for ^{166}Er, $\beta_6 = -0.007$. Although these values are consistent with the predictions of Nilsson et al.,[3] the ^{154}Sm result disagrees with earlier alpha scattering results[4] which indicated a value with the same magnitude but opposite sign.

We plan more meaningful comparisons between our results and those from different experiments in terms of a multipole moment analysis.[5] Also we are comparing the cross section angular distributions with those from the analytic eikonal model of Amado and co-workers.[6]

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THE PRELIMINARY OPTICAL MODEL ANALYSIS OF 200 MeV $\vec{p}$ + ^{9}Be ELASTIC SCATTERING

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The cross section and analyzing power angular distributions have been measured for 200 MeV elastically scattered polarized protons from ^{9}Be. The angular distributions were measured to $\theta_{cm}=130°$ which corresponds to a momentum transfer of $q \sim 5.3\ \mathrm{fm}^{-1}$. The data are displayed in Fig. 1, along with the preliminary results of optical model calculations employing two different parameterizations for the real part of the central potential. A discussion of the data and how the measurements were made are described elsewhere[1] and will not be repeated here. Only the results of the optical model analysis of the data will be reported here.

The optical model calculations were performed using the computer code SNOOPY8.[2] The standard optical model analysis employs the following parameterization to describe the local nucleon-nucleus potential U(r):

$$U(r) = V_R f_R(r) + iWf_W(r) + \lambda_\pi^2\,[V_{so}\, g_{RSO}(r) + iW_{so}\, g_{WSO}(r)]\,(\vec{L}\cdot\vec{\sigma}) \qquad (1)$$

where

$$f_i(r) = \{1 + \exp[(r - r_i A^{1/3})/a_i]\}^{-1} \qquad (2)$$

and

$$g_j(r) = (1/r)(d/dr)\{1 + \exp[(r - r_j A^{1/3})/a_j]\}^{-1} \qquad (3)$$

The calculations using the single Woods-Saxon parameterization for the central potentials (Eq. 2) and the Thomas form (Eq. 3) for the spin-orbit will be labeled as 'SWS' throughout this discussion.

A second parameterization used in the optical model analysis consists of substituting for the term $V_R f_R(r)$ in Eq. 1 the expression

$$V_R f_R(r) = V_{R1} f_{R1}(r) + V_{R2}[f_{R2}(r)]^n,\ n = 1,2$$

and the central imaginary potential remains unchanged. Calculations using this double Woods-Saxon form with n=2 will be denoted by 'DWS'. This shape modification introduces three new parameters. The motivation for the DWS parameterization is given elsewhere[3] and will not be repeated here.

In this preliminary optical model analysis of the p + ^{9}Be elastic scattering data, the optical model parameter sets obtained for 200 MeV p + ^{12}C elastic scattering[4] were used as the starting parameters for both the SWS and DWS parameterizations. All parameters were searched on until there was no improvement in the χ^2. The resulting parameters are listed in Table I, and the calculated cross sections and analyzing powers are shown in Fig. 1.

From Fig. 1 observe that the data, especially the analyzing power data, is represented better by calculations employing the DWS optical potential than by the SWS optical potential. From a plot of the potentials, one notes that the DWS representation of the central real potential is more attractive near the nuclear surface and becomes repulsive in the nuclear interior. This characteristic depression in the central real potential is completely analogous to that required for an adequate description of the 200 MeV p + ^{12}C elastic scattering data.[4]

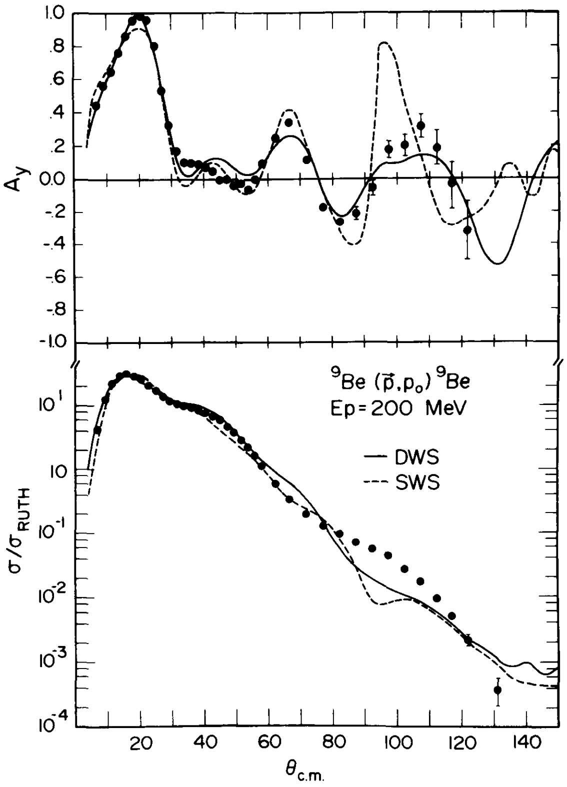

Figure 1. Elastic scattering cross sections and analyzing power angular distributions for 200 MeV polarized protons from ^{9}Be are shown with the results from optical model calculations employing the parameter sets in Table I.

It should be noted from Table I that both parameterizations fail to predict the total and reaction cross sections. The reaction cross section has been measured at 232 MeV[5] and at 180 MeV[6] and was found to be 190.0 ± 6.8 mb and 185.5 ± 4.5 mb, respectively. The total cross section has been measured to be 235.7 ± 5.2 mb at 225 MeV.[7]

Table I.

	SWS	DWS	UNITS
V_{R1}	- 8.44	-74.00	MeV
r_{R1}	1.52	.856	fm
aR_1	.495	.628	fm
V_{R2}		86.17	MeV
r_{R2}		1.046	fm
aR_2		.676	fm
W	-41.00	-28.0	MeV
r_W	.552	.764	fm
a_W	.647	.881	fm
V_{SO}	-1.90	-3.027	MeV
r_{RSO}	1.14	1.146	fm
a_{RSO}	.60	.572	fm
W_{SO}	.990	1.247	MeV
Y_{WSO}	1.10	.658	fm
a_{WSO}	.545	.670	fm
χ^2_σ	3956	4674	
χ^2_{Ay}	1594	809	
σ_{TOT}	197.2	318.8	mb
σ_R	138.3	251.2	mb

From Fig. 1, one sees that the shape of the analyzing power angular distributions are adequately reproduced by both the SWS and DWS potential parameterizations. However, the DWS optical potential does describe the analyzing power data beyond $\theta_{cm} \sim 80°$ much better than the SWS parameterization. Both the SWS and DWS optical potentials give reasonable fits to the cross section data forward of $\theta_{cm} \sim 80°$. Beyond this angle, both parameterizations produce a diffractive minimum, whereas the data appear to develop a maximum.

One possible explanation for this discrepancy between the calculations and the cross section data is that since ^{9}Be is a deformed nucleus the coherent contribution to elastic scattering from higher-order multipoles may not be negligible. And indeed, the contributions from higher-order multipoles were found to be important in describing pion scattering from ^{9}Be.[8] Also, it has been shown in heavy-ion elastic and inelastic scattering studies that higher-order multipoles must be included in calculations to obtain an adequate description of ^{9}Be scattering from spin-zero targets.[9] We are currently investigating whether contributions from higher-order multipoles must be included in order to obtain a better description of the proton elastic data presented here.

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THE OPTICAL MODEL ANALYSIS OF 200 MeV $\vec{p}$ + ^{16}O ELASTIC SCATTERING

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The microscopic description of a nucleon moving in a nuclear environment leads to a single-particle potential which is energy- and density-dependent. As the particle's energy increases, the single-particle potential becomes less attractive in the nuclear interior than near the nuclear surface. Thus, the single-particle potential develops a characteristic depression near the nuclear surface. We refer specifically to the treatment of the nucleon-nucleon interaction in nuclear matter in terms of a Brueckner-Hartree-Fock expansion, and its application to finite nuclei via a local density approximation.[1-3] The resulting real part of the central optical potential exhibits the same characteristic energy-dependent features as those given in the discussion above.

Phenomenological optical model analyses of elastically scattered polarized protons from ^{12}C at laboratory bombarding energies of 122, 160 and 200 MeV have shown that the real part of the central potential does indeed exhibit the energy-dependent features expected from microscopic considerations.[4,5] In Refs. 4 and 5, the central real potential had to be modified from the standard single Woods-Saxon (SWS) shape in order to obtain an adequate description of the large momentum transfer data (up to ~ 5 fm^{-1}). The phenomenological modification of the real central potential consisted of adding a short-ranged repulsive