This result is in good agreement with DWIA calculations using Cohen-Kurath wave functions while p-shell wave functions, which admit no ΔS=1 strength, produce substantial disagreement with the data.

In conclusion, the goal of this program is the exploration of the spin-flip probability as an additional probe of nuclear structure and reaction mechanisms in (p,p'). Since this is the first such endeavor at intermediate energies we will in the future seek to broaden our data base in terms of the types of excitations studied. Strong and weak transitions involving both ΔT=0 and ΔT=1 transfer for relatively pure proton and neutron promotions to both low and high spin states (particularly stretched configurations) need to be probed at a variety of momentum transfers. Also, we hope to investigate the prediction that intermediate-energy spin-flip measurements can be used to elucidate the ΔJ≠0 contributions to <u>elastic</u> scattering from odd mass nuclides. This should yield information on the <u>diagonal</u> matrix elements of the spin-dependent operators which is complementary to that contained in the transverse form factors derived from elastic electron scattering. Finally, we will consider the potential utility that a broad-range, second-generation focal-plane polarimeter might have in searches for new magnetic modes of excitation which lie in a background of more strongly excited electric multipoles.

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135 MeV PROTON SCATTERING FROM ^{13}C

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Spectra from the scattering of 135 MeV protons from ^{13}C have been measured at angles from 8° to 80° in the laboratory, using the QDDM spectrograph. Four momentum bites were used at each angle, covering the region from 0 to 24 MeV in excitation. A preliminary report on the spectra in the 2 higher energy bites was given in last year's report.1)

Peak areas have been extracted using the code GENFIT2) at IUCF and GAUSSFIT2 at Melbourne. The target used had a thickness of 9.5 mg/cm^2 and was isotopically enriched to 92% ^{13}C. Angular distributions from the impurity ^{12}C(p,p') reaction for the prominent states agreed well with those measured previously by this group. Runs on different targets were consistent to within ±6% in calculated cross sections. The data are presented in Figs. 1-3. Where error bars are not shown in these figures, the error is less than 3%.

The angular distribution for the elastic scattering of protons from ^{13}C has been analyzed using a form of the nonrelativistic optical-model code JIB. To simulate relativistic kinematics the incoming proton energy was set at 142 MeV in order to obtain the correct relativistic center-of-mass momentum. The optical potential was taken to have the usual form:

$$V(r) = V_c(r) - V_R f_R(r) - iW_S f_I(r) + \left(\frac{\hbar}{m_\pi c}\right)^2 (V_{SO} + iW_{SO}) \frac{1}{r}\frac{d}{dr} f_{so}(r)\, \vec{L} \cdot \vec{\sigma}$$

with

$$f_i(r) = \left[1 + \exp((r - R_i A^{1/3})/A_i)\right]^{-1}$$

and V_c the usual Coulomb potential, with R_c obtained from the results of elastic electron scattering from ^{13}C.3)

The optical-model parameters obtained after an exhaustive search are given in Table 1, and the calculated fit to the data is shown in Figure 1. Overall the fit is satisfactory but clearly more data would be useful at the larger angles to establish properly the behavior at larger momentum transfer.

Microscopic DWBA analysis of the inelastic scattering is continuing using the code DWBA70.4) The distorted waves for both incoming and outgoing channels are generated using the optical-model parameters given in Table 1. The nucleon-nucleon interaction used is the Reid potential of Bertsch et al5). Harmonic oscillator wavefunctions were used for the single

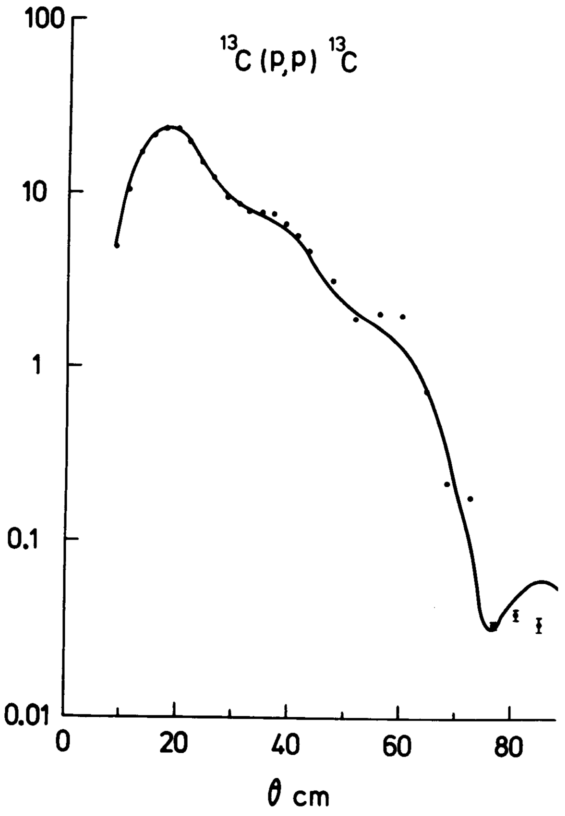

Figure 1. p + ^{13}C elastic scattering cross section at 135 MeV, plotted as a ratio to Rutherford scattering. The solid line is the optical-model calculation using the parameters given in Table 1.

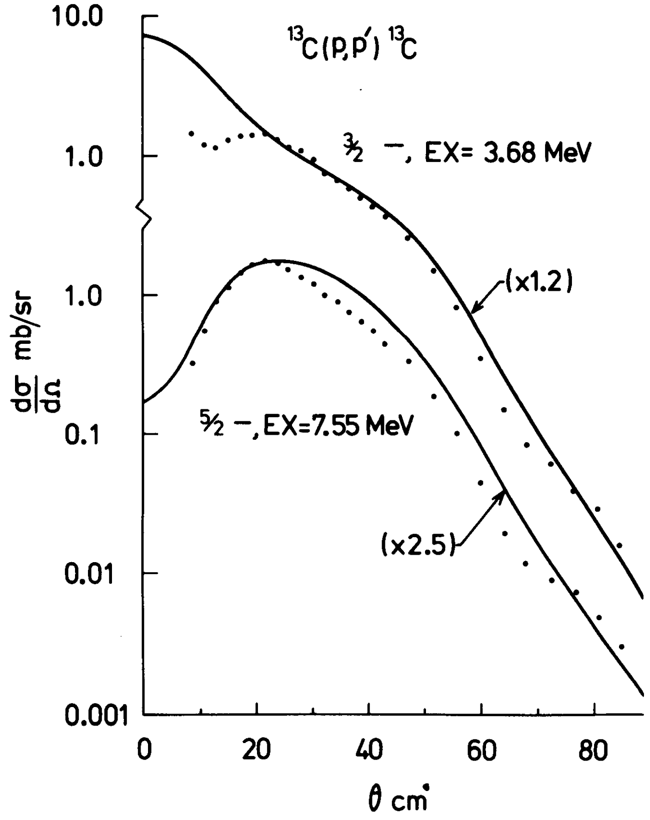

Figure 2. Data and DWBA fits for the 3/2⁻ state at 3.68 MeV, and the 5/2⁻ state at 7.55 MeV.

particle states. The spectroscopic amplitudes used were obtained, using the Glasgow shell-model code, by Amos and Morrison.[6)] The negative-parity states are a purely 1p-shell calculation using the Cohen and Kurath (8-16)2BME potential, whereas the positive-parity states are a complete 1s + 1p + 2s + 1d shell-model calculation using a composite matrix element set.

In the weak coupling model of ^{13}C, the ground state is described as $p_{1/2}$ neutron x ^{12}C, 0^+ (ground state). The coupling $p_{1/2}$ neutron x ^{12}C, 2^+ (4.44 MeV) then gives rise to the $3/2^-$ state at 3.68 MeV and the $5/2^-$state at 7.55 MeV. The angular distributions for these states closely resemble that for the $^{12}C(p,p')^{12}C^*$, 4.44 MeV ($\Delta J = 2$) transition, and are shown in Figure 2. We see however, that the $3/2^-$ state contains a significant proportion of $\Delta J = 1$ in the transition amplitude, thus giving the forward-angle rise which is in fact overestimated by the calculation. (Note that in the version of DWBA70 used the contributions to the cross section from different ΔJ's are added incoherently.) The $5/2^-$ state has only a neglible proportion of $\Delta J = 3$ in the transition amplitude.

The $9/2^+$ state at 9.50 MeV has been discussed in some detail in the literature recently.[7)] Inelastic scattering of π^+ and π^- particles from ^{13}C at LAMPF at 162 MeV reveals a marked asymmetry

$$\frac{\sigma(\pi^-) - \sigma(\pi^+)}{\sigma(\pi^+) + \sigma(\pi^-)} = 0.8 \pm 0.2$$

consistent with a pure neutron excitation. The shell-model calculation referred to above predicts spectroscopic amplitudes for the excitation of a $1p_{3/2}$ neutron or proton to a $1d_{5/2}$ state ($\Delta J = 4$) to be 1.957 and -0.113, respectively. This is consistent with the pion results. The fit to the data is shown in Fig. 3 and confirms the spectroscopy used.

Table 1. Optical potential parameters for p + ^{13}C scattering at 135 MeV.

V_R = 13.477 MeV	R_R = 1.395 fm	A_R = 0.565 fm
W_S = 20.855 MeV	R_I = 1.002 fm	A_I = 0.693 fm
V_{SO}= 3.336 MeV	R_{SO}= 0.799 fm	A_{SO}= 0.607 fm
W_{SO}= -4.881 MeV	R_C = 1.347 fm	

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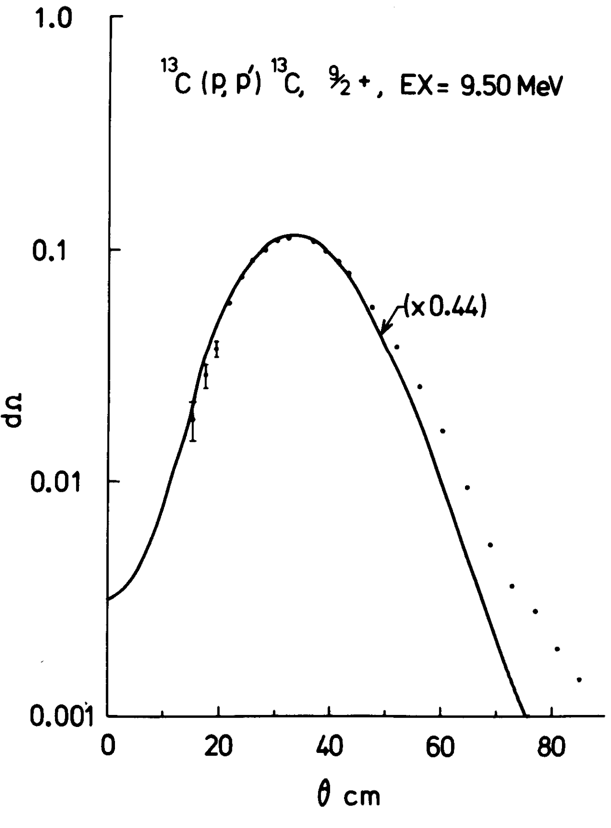

Figure 3. Data and DWBA fit for the "single neutron excitation" of the $9/2^+$ state at 9.50 MeV.