INELASTIC PROTON SCATTERING FROM ^{6}Li, ^{12}C, ^{16}O AND ^{13}C

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Data on the inelastic scattering of 135 MeV protons from ^{12}C, ^{16}O and ^{6}Li, measured at laboratory angles from 8° to 80°, have been analyzed using the DWBA code MEPHISTO, which was made available by Dr. K. Amos. Excited states up to 20 MeV excitation energy were sought in ^{12}C and ^{16}O (see IUCF Annual Reports for 1977 and 1978), and differential cross sections were obtained for inelastic scattering to the first two excited states of ^{6}Li.

Optical model parameter sets were obtained by fitting the differential cross sections for elastic scattering from these three nuclei; and a parameter set, once chosen, was used for all calculations involving the particular target nucleus.

Differential cross sections, and DWBA fits, for representative spin-flip transitions, are shown in Figs. 1 and 2. Figure 1 shows the spin-flip, no isospin-flip transitions, and Fig. 2 the spin-flip, isospin-flip transitions.

The code MEPHISTO uses the nucleon-nucleon interaction given by Eikemeier and Hackenbroich[1]. This phenomenological potential, which is local, charge independent, and has a soft core, was derived from fits made to nucleon-nucleon scattering data. It contains central, spin-orbit and tensor terms, and radial dependences are represented by sums of Gaussian functions.

Figure 2 indicates that use of such a potential does poorly when combined with multi-term wave function forms. It is perhaps surprising then, that use of a single term wave function for the 4^{-}; T=0 states of ^{16}O does so well. That the calculated cross sections need to be multiplied by a normalizing factor greater than unity is not unexpected; it reflects the fact that the single term wave function does not reflect adequately the collectivity of the excited states. The

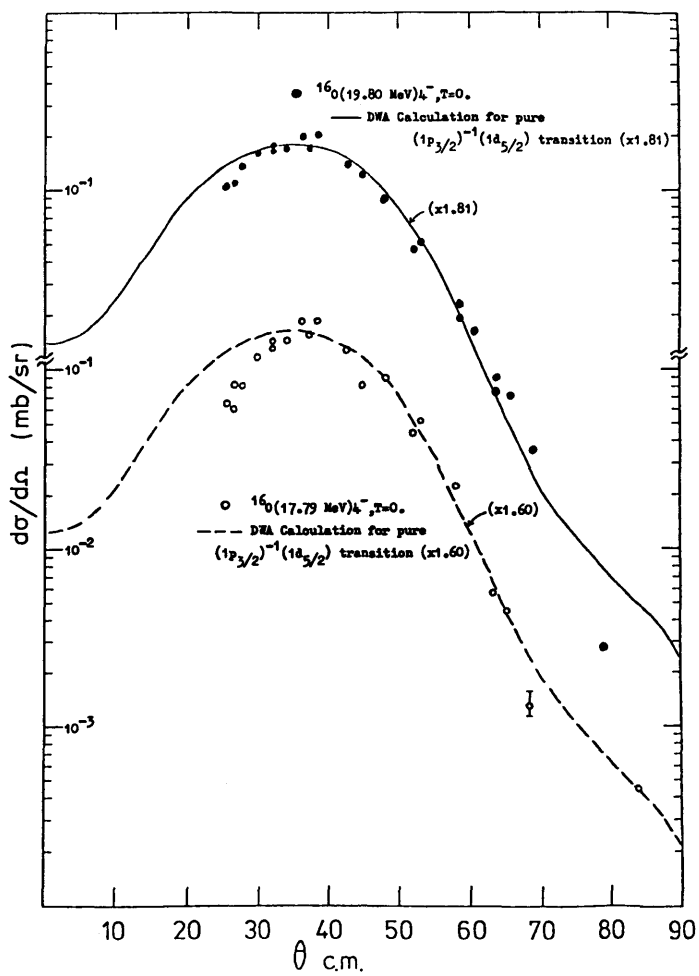

Figure 1. Differential cross section for the $^{16}O(p,p')$ reaction to the 4^{-}, T=0 states at 17.79 and 19.80 MeV.

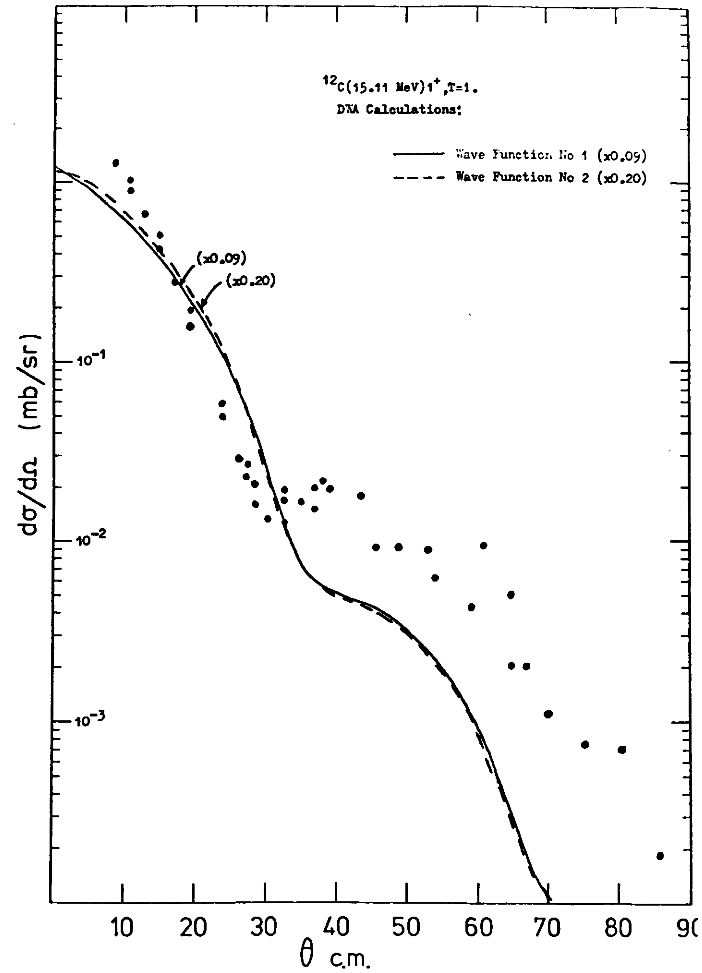

Figure 2. Differential cross section for the $^{12}C(p,p')$ reaction to the 15.11 MeV state (1^+, T=1). Wave function No. 1 is that given by Gillet and Vinh-Mau[2]. Wave function No. 2 was provided by G.E. Walker from the Oak Ridge shell model code.

potential of Eikemeier and Hackenbroich does fairly well in accounting for the spin-flip isospin-flip transition differential cross sections in ^{12}C and ^{16}O.

The differential cross section for inelastic scattering to the 0^+, T=1 state of ^{6}Li (3.56 MeV) is not fitted at all (see Fig. 3). The reason for this is not known, particularly since the optical model parameters derived from elastic scattering fit the shape of the inelastic scattering differential cross section to the 2.18 MeV state (3^+, T=0) reasonably well. Again, in this latter case, the magnitude of the cross section is poorly given, reflecting again that a wave function containing 1p-shell terms only is an inadequate description of the collective nature of the state.

One interesting feature is the similarity of the inelastic scattering differential cross sections for the 15.11 MeV state of ^{12}C (1^+, T=1) and the 3.56 MeV state of ^{6}Li (0^+, T=1). This must result from the similar radial sizes of the two nuclei.

The DWBA program has limited success in fitting the magnitudes of the differential cross sections for these transitions in that the magnitude of the cross section is rarely given correctly to within a factor of two. The reason for the discrepancy is most

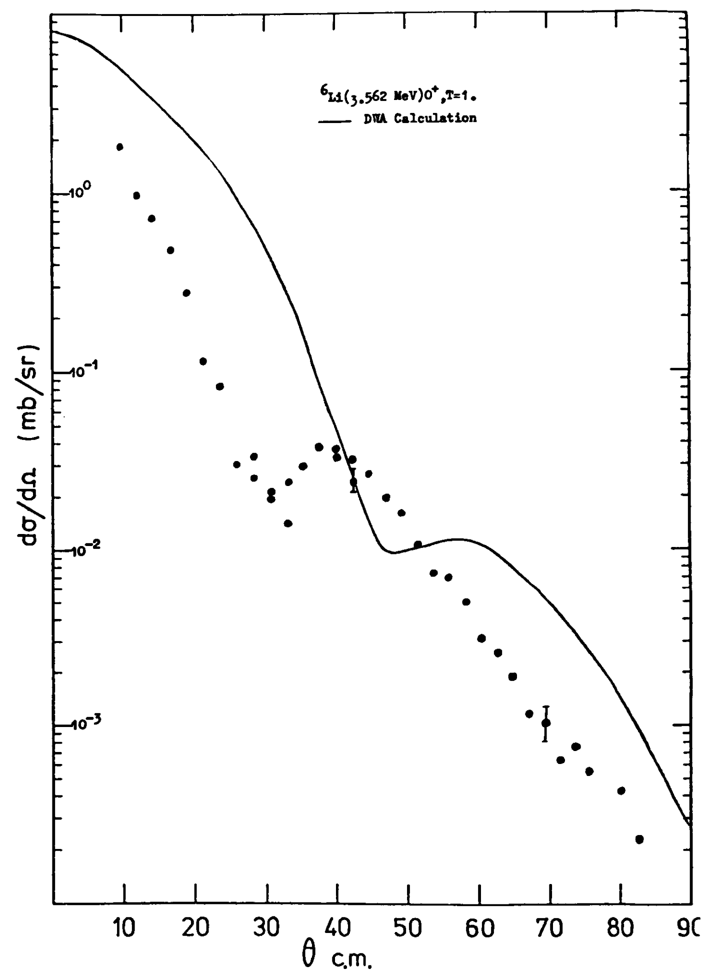

Figure 3. Differential cross section for the $^{6}Li(p,p')$ reaction to the 3.56 MeV state (0^+, T=1). The wave functions for the ground and first two excited states were approximated by those obtained from considering only the $1p_{3/2}$ and $1p_{1/2}$ subshells, and fixing the strength of a surface delta residual interaction to put the 0^+, T=1 state at the correct energy.

probably as described above. However, the shapes of these differential cross sections are generally farily well given.

The particle-hole model wave functions given by Gillet and Vinh-Mau[2] have been used frequently in using the DWBA program. For some even parity states, only a collective model parameterization was used; the microscopic description of these states is sufficiently complex to make a microscopic DWBA calculation very difficult.

The data obtained from inelastic scattering of 135 MeV protons from ^{13}C are partially analyzed, and experimental differential cross sections have been obtained for all states up to 10 MeV excitation. The magnetic dipole state at 15.11 MeV excitation ($3/2^-$, T=3/2) is also excited, as well as states at higher excitation. One or more states giving rise to a peak ($\Gamma \sim 300$ keV), corresponding to an excitation of 21.3 MeV, have a differential cross section which qualitatively resembles those seen in neighboring nuclides for "high spin", or orbital flip, states. Another neighboring state, at 21.8 MeV excitation, is observed to be excited by 135 MeV incident proton energy, but does not appear in spectra taken at 80 MeV bombarding energy[3]. Work is continuing both on the reduction of experimental data, and on making DWBA fits to the experimental differential cross sections.

1) H. Eikemeier and H.H. Hackenbroich, Nucl. Phys. A169, 407 (1971).

2) V. Gillet and N. Vinh-Mau, Nucl. Phys. 54, 321 (1964).

3) D.W. Devins et al., submitted to the APS Washington Meeting (1980).

ASYMMETRY MEASUREMENTS FOR THE $^{12}C(\vec{p},p')^{12}C$ REACTION

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In continuation of a program to study microscopic effective nucleon-nucleus interactions, measurements have been made of the analyzing powers of the $^{12}C(\vec{p},p')^{12}C$ reaction at 120 MeV to the ground state and several excited states. An experiment to measure the cross sections for several transitions has been completed and submitted for publication.[1]

There are four states of ^{12}C that are of particular interest for elucidating the features of microscopic effective interactions. These are the 2^+ states at 4.44 MeV (T=0) and 16.11 MeV (T=1), and the 1^+ states at 12.71 MeV (T=0) and 15.11 MeV (T=1). Each of these is particularly sensitive to a different term of the central part of the effective interaction, which must then be combined with spin-orbit and tensor terms. A successful description of the effective interaction must also have a good description of these latter terms. While differential cross section measurements can show some sensitivity to the effective interaction, analyzing power data have an even greater sensitivity.

The previous interpretation of the cross-section data in terms of a detailed microscopic interaction was reasonably successful.[1] The best results were