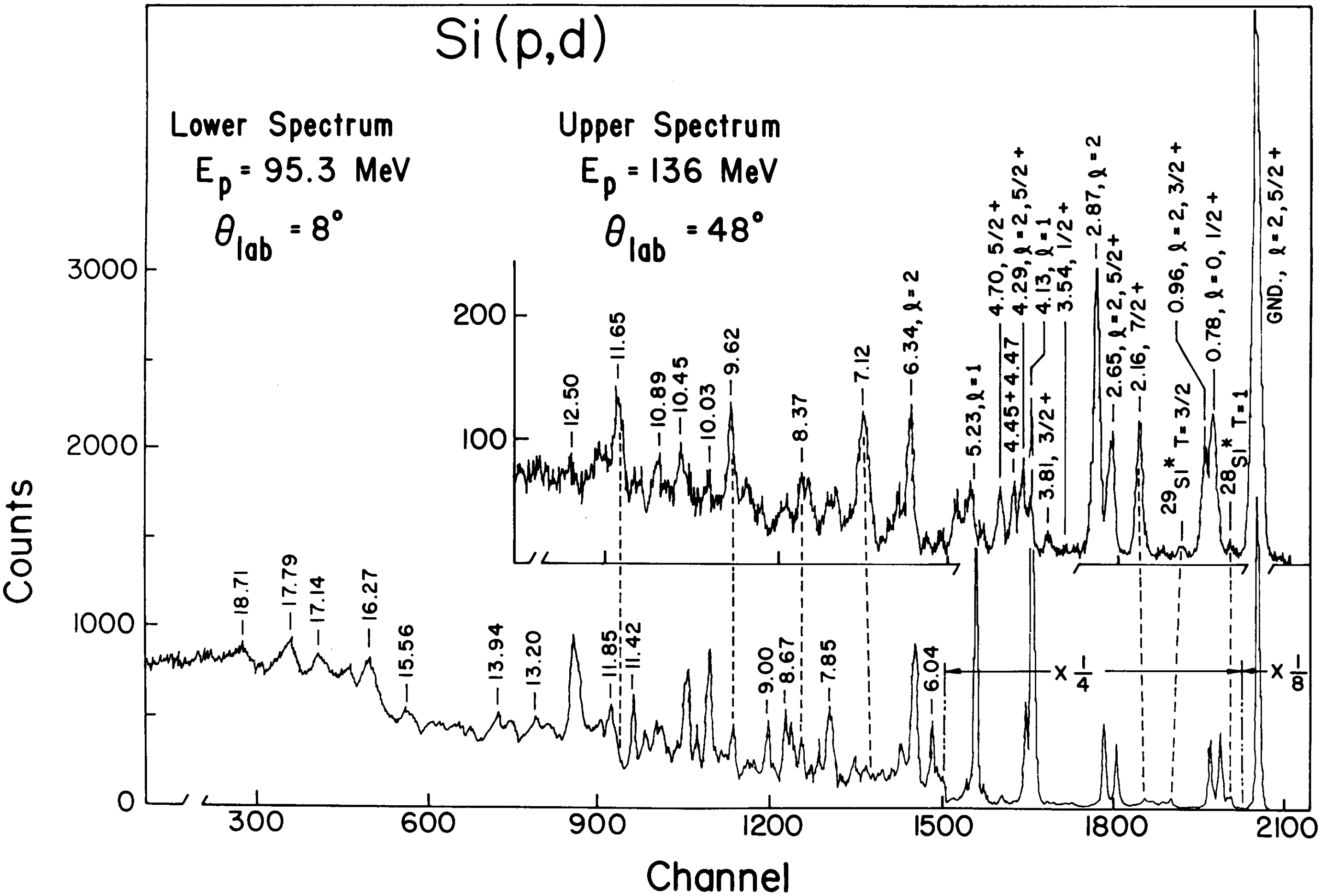

Figure 3. *Comparison of spectra from the* $^{28}Si(p,d)^{27}Si$ *reaction for the largest (upper plot) and smallest (lower plot) momentum transfer. Corresponding states in both spectra are labelled by excitation energy (MeV) and spin/parity assignment where known.*

DEEP HOLE STATES IN MEDIUM MASS NUCLEI

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Studies of deep hole states by single nucleon transfer reactions are limited by the fact that the angular distributions in general determine only the ℓ of the transferred neutron but not the J. However, Distorted Wave calculations of the analyzing power in (p,d) reactions using polarized protons imply that these analyzing powers should be a very good signature of the J of the final state. Earlier measurements of the (p,d) reaction at 90 MeV on a series of Sn isotopes showed that the deep hole states at 5 and 8 MeV excitation energy were strongly excited (See IUCF annual report 1979, p. 71). One run has therefore been made on the targets ^{90}Zr and ^{120}Sn with polarized protons to measure the analyzing powers.

The experiment was carried out in the large scattering chamber using the 90 MeV polarized proton beam. The beam polarization was measured between the two cyclotrons before and after each data taking run and was found to be extremely stable at a value of around 70% polarization in both spin directions. The spin direction was flipped every minute during data taking runs which were typically a few hours long. Two detector telescopes were used consisting of a pair of Si and Ge detectors. These telescopes were run on different sides of the beam, in some cases at the same angle as a check and at other times at different angles to obtain a more extensive angular range. Measurements were made from 15° to 45° in the lab. Particle identification was carried out using NIM modules so as to reduce the dead time in the

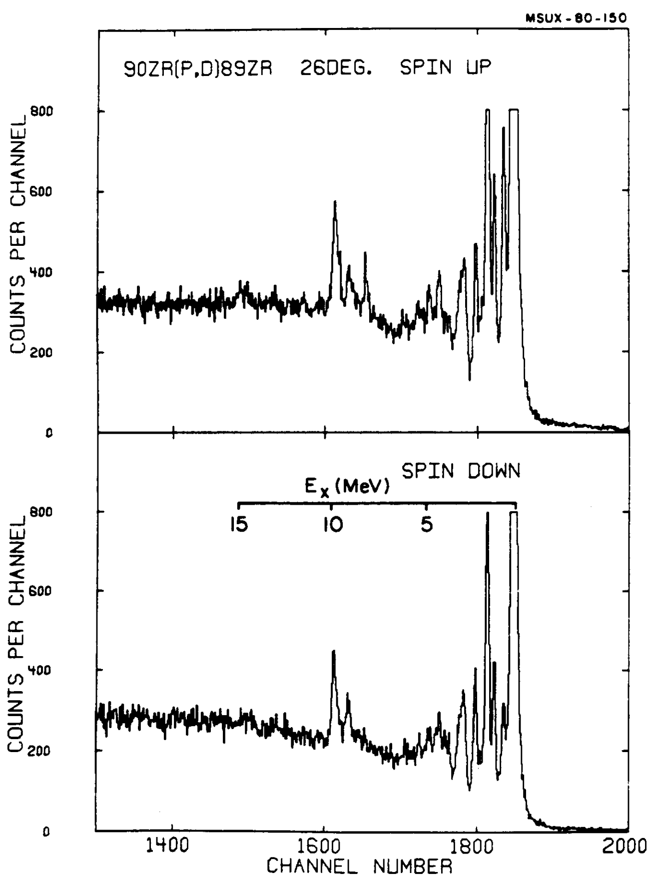

Figure 1. *Spectra for $^{90}Zr(\vec{p},d)^{89}Zr$ at 25° taken with proton spin up and down.*

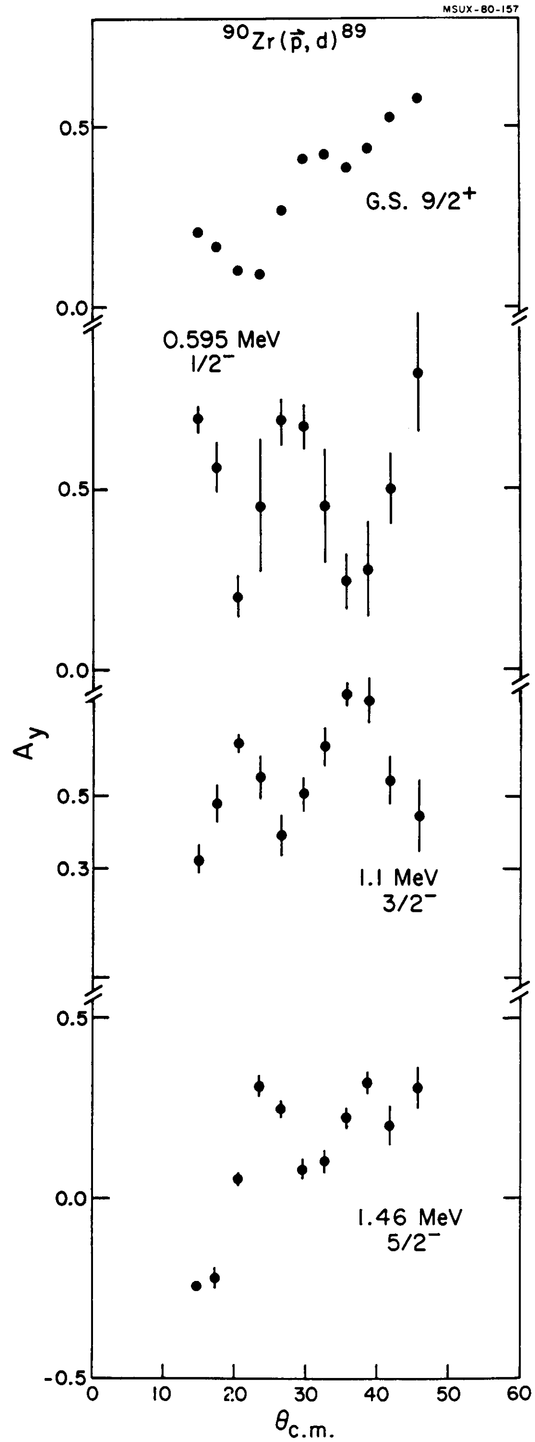

Figure 2. *Analyzing power angular distributions for four transitions in the $^{90}Zr(\vec{p},d)^{89}Zr$ reaction at 90 MeV. The transitions are marked with excitation energy, spin, and parity.*

computer.

Spectra from the $^{90}Zr(\vec{p},d)^{89}Zr$ reaction at 25^{o}

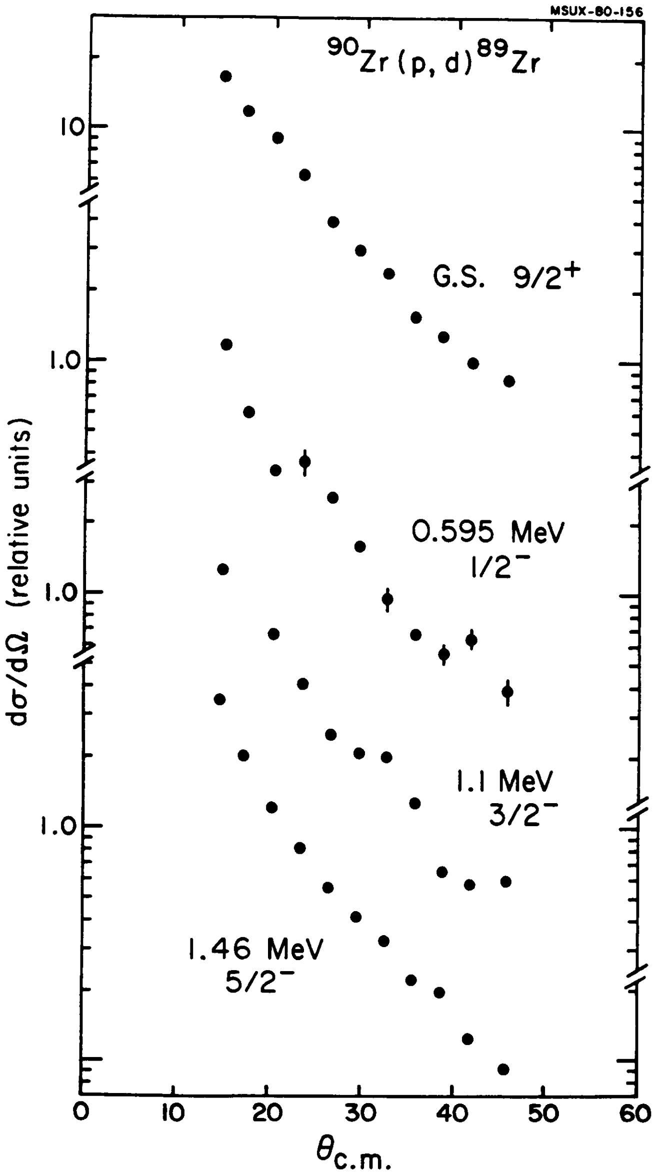

Figure 3. Cross section angular distributions for four transitions in the $^{90}Zr(\vec{p},d)^{89}Zr$ reaction at 90 MeV. The transitions are marked with excitation energy, spin, and parity.

for both spin up and spin down are shown in Fig. 1. The discrimination of the analyzing power measurements is readily discernable in this figure. Perhaps the clearest indicator is the relative sizes of the second and third excited states. These two states are both ℓ=1 but one is 1/2^{-} (0.595 MeV) and the other 3/2^{-} (1.1 MeV). With the proton spin up the 1/2^{-} state is substantially stronger than the 3/2^{-} state but for spin down the situation is reversed.

Analyzing power measurements on a number of the low lying states of ^{89}Zr are shown in Fig. 2. These measurements show clearly that A_y is out of phase for the two ℓ=1 states discussed above. Most of the measured A_y values are positive with the exception of the 1.46 MeV (5/2^{-}) state where A_y is negative at angles forward of 20^{o}. A particularly interesting case will be the analyzing power for the cluster of states at 4 MeV which are expected to contain substantial $f_{7/2}$ strength.

Angular distributions have also been extracted for a few low lying states and these are shown in Fig. 3 In general these show little structure particularly for the higher ℓ-values. However, the slopes of the angular distribution do differ, becoming less steep for the higher ℓ-transfer.

Attempts to fit both the angular distributions and analyzing powers simultaneously is continuing using the program DWUCK.