HIGH-EXCITATION HOLE STATES IN THE (p,d) REACTION

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The intent of this experiment is to study the structure of high-excitation hole states in ^{27}Si and ^{23}Mg, as discussed in the last IUCF annual report.[1] As a first step, the mechanism of reactions leading to known low-lying states in these nuclei is being studied by seeking reasonable DWBA fits to the observed angular distributions. Then, DWBA fits to the higher states, taken together with comparisons of observed spectroscopic factors with detailed nuclear structure calculations, may allow determination of the character of the states at high excitation.

During the past year, additional points were obtained on the angular distributions obtained earlier[2] for the ^{28}Si (p,d)^{27}Si reaction at Ep = 97 and 135 MeV, and dead-time corrections to the earlier results were established. New data over the extended angular range from 6° to 88° laboratory were obtained at Ep = 94.8 MeV for the $^{24}Mg(p,d)^{23}Mg$ reaction leading to states up to 11.8-MeV excitation in ^{23}Mg. The QDDM spectrograph system gave an overall energy resolution of about 0.09% (85 keV) for most of the 95-MeV (p,d) runs, in contrast to $\lesssim$ 0.04% obtained in (p,p') runs at 100 MeV. Further ray-tracing tests of the spectrograph have been carried out since, and modifications are indicated which may lead to improved resolution in future (p,d) runs.

Figure 1 shows a composite spectrum obtained at 8° lab for the $^{24}Mg(p,d)^{23}Mg$ reaction covering a range of excitation in ^{23}Mg up to 12 MeV. Data obtained for the known low-lying states of ^{23}Mg up to 4.36-MeV have already been analyzed. Sample angular distributions are shown in Fig. 2. The curves shown serve simply as guides to the eye. The angular distributions for the $\ell = 0$ transitions exhibit very pronounced oscillations. By contrast, the $\ell = 1$ and $\ell = 2$ transitions exhibit only very modest oscillations superimposed upon a rapid decrease of nearly four orders of magnitude in the 90° interval observed. The deuteron group leading to the known $7/2^+$ state at 2.05 MeV displays a single broad maximum; this state is presumably excited by a two-step process.

Analysis of the data for the higher excited states or groups of states shown in Fig. 1 is in progress. Based on the very similar results obtained for the ^{28}Si(p,d) reaction,[2] and the spectroscopic factors for transitions to states in ^{27}Si calculated by Sven Maripuu,[3] it is likely that the pronounced peaks observed in the vicinity of 10-MeV excitation in ^{23}Mg are due to $1p^{3/2}$ pickup strength in this reaction. It remains to be seen whether the out-of-phase character of the $\ell = 1$ and $\ell = 2$ transitions around 30°, or the $\ell = 2$ maximum suggested at 10° in Fig. 2 will be sufficiently distinctive in the angular distributions extracted for the highly-excited states to make definitive ℓ-assignments possible.

DWBA calculations for the low-lying states in

Fig. 1 will be undertaken shortly. The very careful calculations of Shepard et al.[4] for other (p,d) reactions carried out at IUCF at similar energies will be used as a starting point. Optical potentials for elastic scattering of protons from Si at 80 and 135 MeV obtained at IUCF by Schwandt et al.[5] will also be helpful.

1) IUCF Technical and Scientific Report for 1976, p.37 (unpublished).

2) D.W. Miller, D.W. Devins, R.E. Pollock, and R. Kouzes, Bull. Am. Phys. Soc. 21, 978 (1976).

3) S. Maripuu, private communication.

4) R.E. Anderson, J.R. Shepard, and J. Comfort, Bull. Am. Phys. Soc. 21, 979 (1976). J.R. Shepard, Bull. Am. Phys. Soc. 23, 11(1978). Also see p. 41, p. 70 of this report.

5) P. Schwandt *et al.*, this report, p. 79.

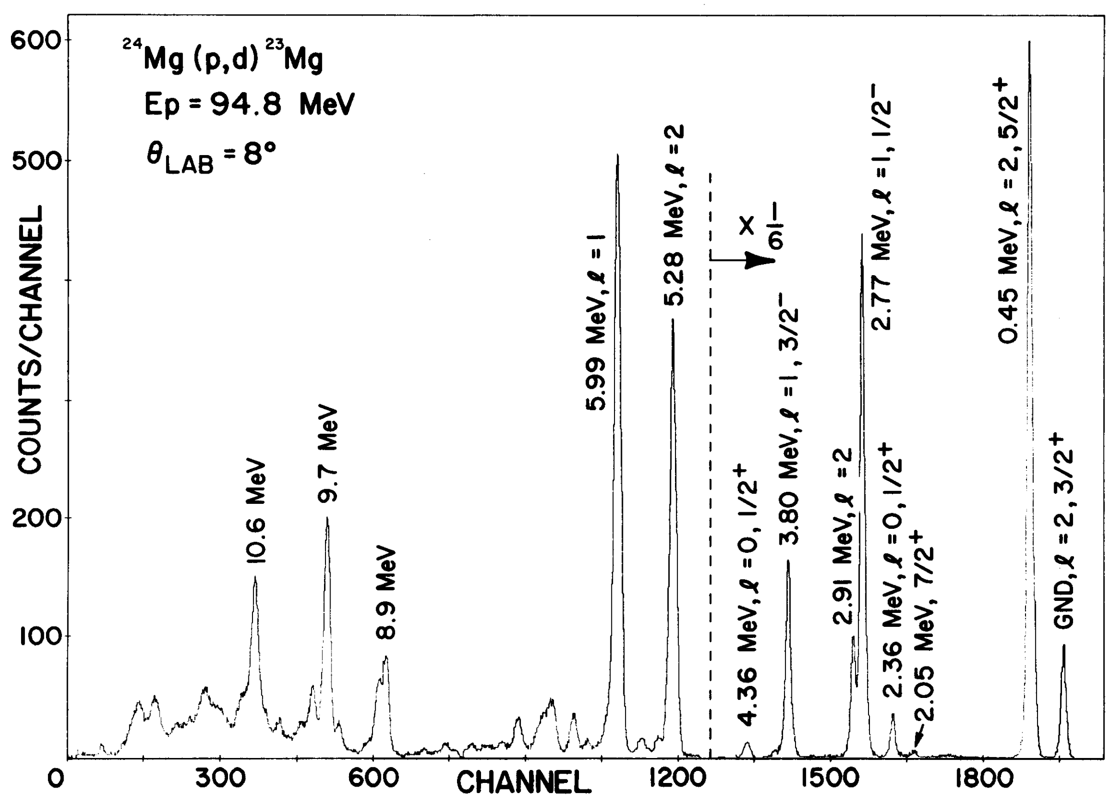

Fig. 1. Deuteron spectrum from the $^{24}Mg(p,d)^{23}Mg$ reaction.

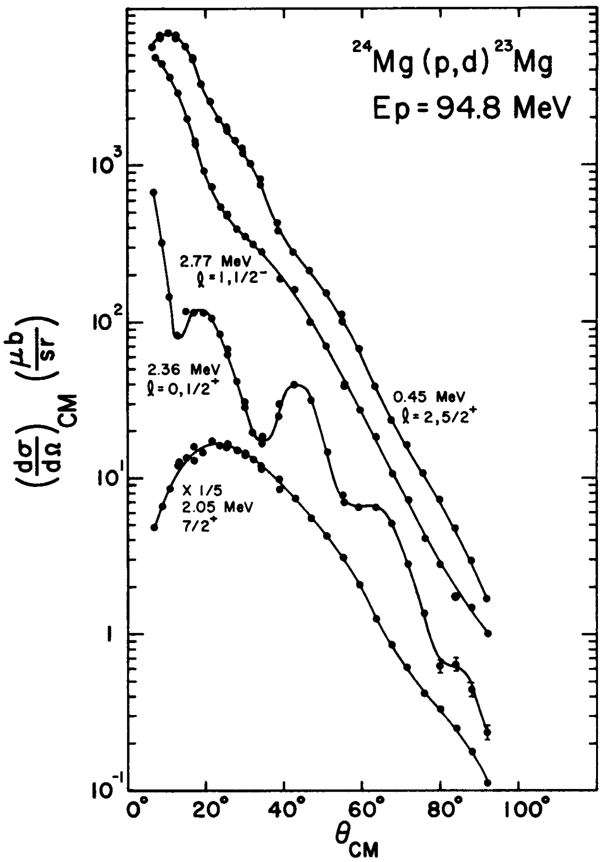

Fig. 2. Deuteron angular distributions for states in ^{23}Mg populated in the $^{24}Mg(p,d)^{23}Mg$ reaction.