STUDIES OF KNOCK-OUT REACTIONS

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A detailed understanding of nuclear spectroscopy through nuclear reactions at IUCF energies is not possible without a detailed understanding of the mechanisms of the reactions. Many factors contribute to the difficulties one has in obtaining such an understanding. There has always been a question of the importance of multiple-step processes in nuclear reactions, and more recently the existence of two-step mechanisms has been established.[1)]

The extent to which two-step processes are important at IUCF energies is essential to establish: if they are important, they will complicate reaction formulations and make reliable spectroscopic information extraction difficult; at the very least, their role must be quantitatively understood or spectroscopic studies at IUCF can yield only qualitative information. We believe we have made significant progress in the understanding of two-step processes as exemplified by the (p,2p) reaction.

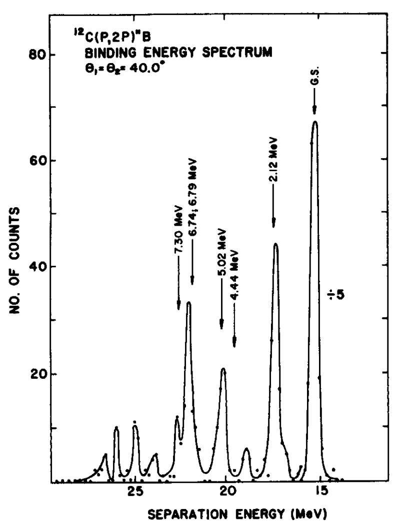

Figure 1.

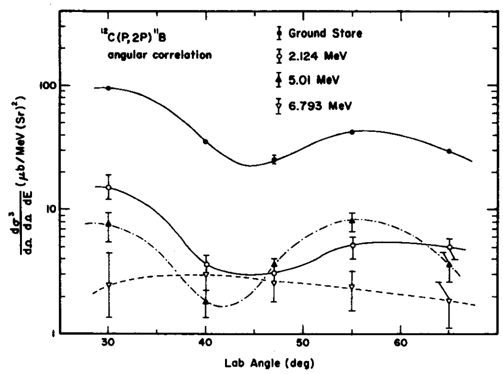

Figure 2.

Our 100 MeV $^{12}C(p,2p)^{11}B$ runs at the equal angle pairs 30^o, 40^o, 47^o, 55^o and 65^o have established an upper limit of 0.1 $\mu b/sr^2 MeV$ for the excitation of the 4.445 MeV $5/2^-$ state; see Figure 1.[2)] In a simple closed-shell model for ^{12}C, this state and a companion $7/2^-$ state at 6.743 MeV cannot be formed in a single-step proton knock-out. The nucleus ^{12}C does not have so simple a ground state wave function, but it seems unlikely that a significant amount of it is in a form required for direct excitation of these two states.[3)]

The peak at about 6.75 MeV in Figure 1 has an angular correlation (see Figure 2) suggestive of an L=0 knock-out; we conclude this peak is from 6.793 MeV $1/2^+$ state, rather than the 6.743 $7/2^-$ state as identified in an earlier 100 MeV study.[4)]

It is possible that because of two-step processes the evidence leading to this conclusion is illusory. We shall examine this possibility in detail later. If it is correct, neither of the two "one-step-forbidden" states is excited at 100 MeV in a symmetric geometry with approximately equal energy sharing. It is reasonable to conclude that this fact is a consequence of the lack of appropriate proton configurations in the ^{12}C ground state wave function. Another possibility is that such configurations do exist, but that their effects are being masked by interference caused by two-step processes. That such effects could persist over the wide momentum transfer region studied seems doubtful. The ramifications of the absence of direct knock-out to the $5/2^-$ and $1/2^-$ states and the strength of the $1/2^+$ state are being written up currently for publication.

Of the 16 shifts awarded the (p,2p) experiment for the current period, about half have been used to complete the 100 MeV symmetric experiment. The remainder, as mandated by the PAC, will be used for a 150 MeV survey and will be sufficient only for a few targets. Preliminary DWIA calculations[5)] are being used to select appropriate targets and running conditions.

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1) See, for example, Yagi et al., Phys. Rev. Letters 34, 96 (1975).

2) Devins, et al., submitted to Washington meeting, APS, April 1977.

3) C.M. McKay and B.M. Spicer, Austr. J. Phys. 28, 241 (1975).

4) R.K. Bhowmik et al., Phys. Rev. C13, 2105 (1976).

5) P. Roos, private communication.