(p,n) EXPERIMENTS AT IUCF

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Early results from the (p,n) program show that the (p,n) spectra for proton energies above about 100 MeV are qualitatively different from those for proton energies below about 40 MeV. In the low energy spectra the most prominent feature is the excitation of the isobaric analog state (IAS). In the high energy spectra the most prominent feature is the spin-flip transition (see IUCF Technical and Scientific Report, February 1, 1977 to January 31, 1978, p. 118).

No new (p,n) data have been acquired in the present reporting period. However, considerable progress has been made in interpreting the preliminary data. In particular, two theoretical groups--W.G. Love and F. Petrovich, and G.E. Walker and A. Picklesimer--have developed reaction calculations for the (p,n) data.

The nuclear structure relationships between the target state and the various final states are being exploited to explore selectively particular components of the nucleon-nucleon force. It is assumed that the reaction is direct and that the impulse approximation is valid. Thus, the force that gives rise to the transition is a component of the N-N force.

Transitions from self-conjugate 0^+ target states to certain 1^+ final states select a force component of the form $(\sigma_1 \cdot \sigma_2)\ (\tau_1 \cdot \tau_2)$. The central term in OPEP has this form, and if OPEP is an important component of the N-N force, its effect should manifest itself in the excitation of these special 1^+ states. Examples are $^{12}C(p,n)\ ^{12}N(g.s.)$ and $^{28}Si(p,n)\ ^{28}P(2.1\ MeV)$. These states are seen to stand out prominently in the data.

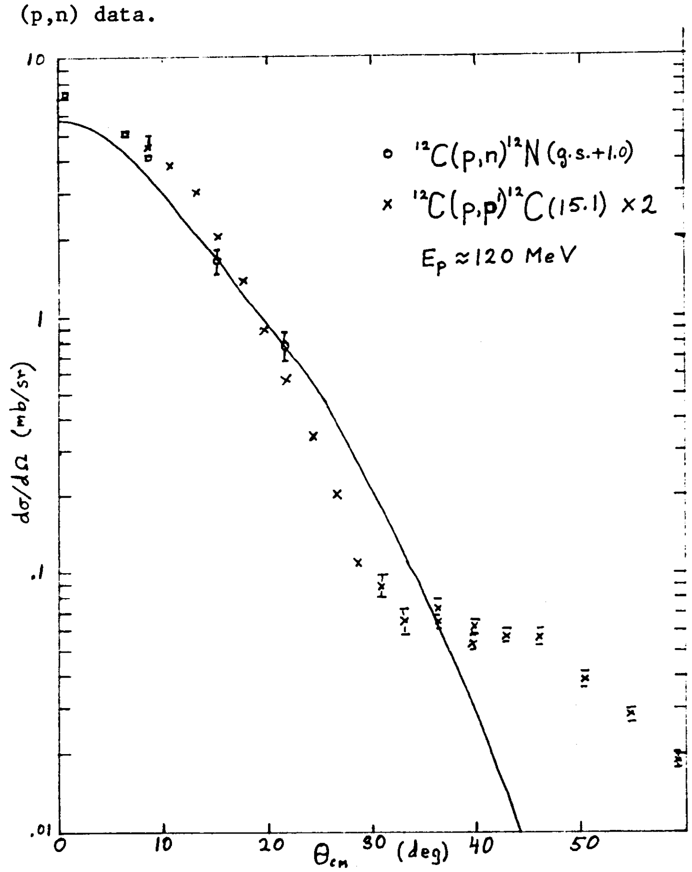

Figure 1.

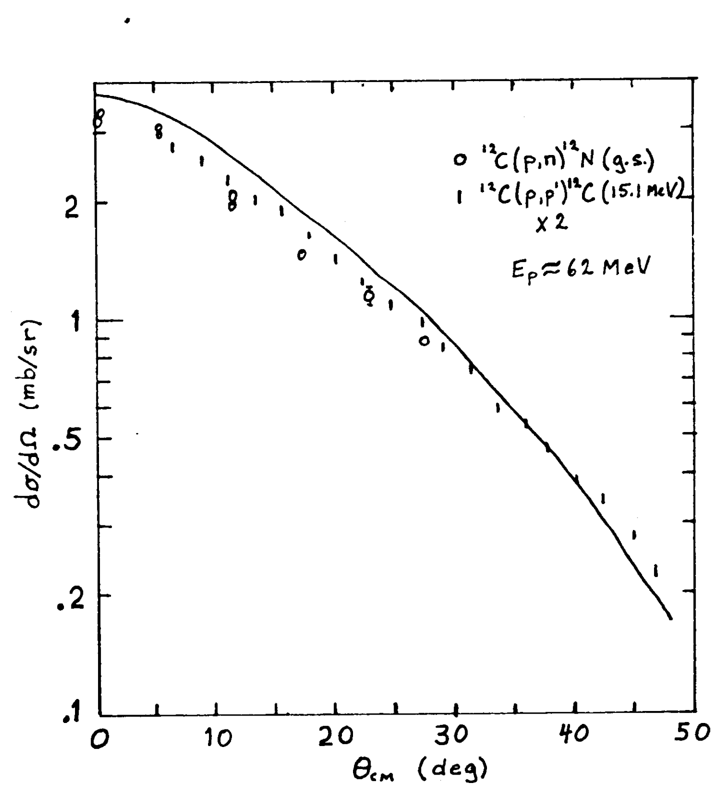

Figure 2.

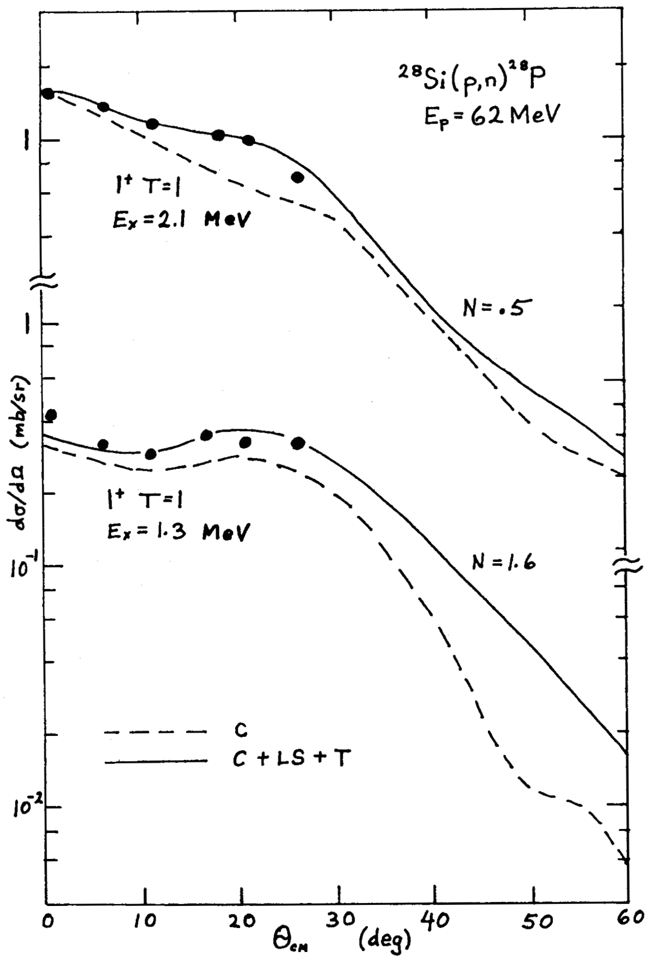

Figure 3.

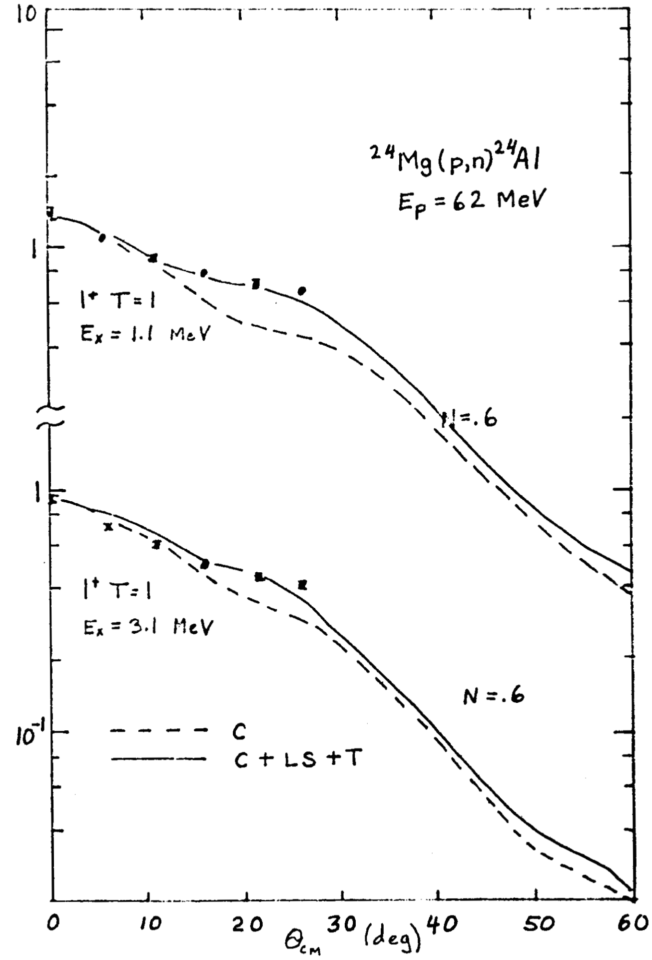

Figure 4.

With respect to the $^{12}C \rightarrow {}^{12}N$ transition its analog, $^{12}C(p,p')^{12}C$(15.1 MeV), is related by simple isospin coupling coefficients, and the nucleon force information can be extracted also from the (p,p') data, assuming isospin conservation. A DWIA calculation, due to W.G. Love, in which the long-range part of the N-N potential is assumed to be the OPEP gives very good agreement with the data (IUCF Technical and Scientific Report, February 1, 1977 to January 31, 1978, p. 93).

Another set of calculations by G.E. Walker and A. Picklesimer, compared with (p,n) and (p,p') data at 120 and 62 MeV, is shown in Figures 1 and 2. Here the N-N interaction is constructed from a global fit to N-N scattering data over a wide energy range. A surprising aspect of the calculations is that the fit is good at 62 MeV where the impulse approximation is not thought to be valid.

Figures 3 and 4 show calculations by F. Petrovich and W.G. Love compared with $^{28}Si(p,n)^{28}P$ and $^{24}Mg(p,n)^{24}Al$ at 62 MeV. In these calculations it was assumed that the impulse approximation is not valid and an effective interaction was generated by the MSU G-matrix approach.[1)] Although this interaction seems to overestimate the cross section, structure differences are well reproduced. Unpublished wave functions obtained from B.H. Wildenthal and W. Chang were used.

The beam swinger has now been installed in the northwest corner of the IUCF building and flight paths are now outside the building, permitting detector locations unobstructed by the building structures.

The use of 50 m and 100 m flight paths is planned for the immediate future. Polarized protons will also be used to measure asymmetries as an additional test of the interactions.

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1) G. Bertsch, J. Borysowicz, H. McManus, and W.G. Love, Nucl. Phys. A284, 399 (1977).