

HIGH SPIN STATES IN THE (p,t) REACTION

D.N. Mihailidis, N.M. Hintz, and A. Sethi

University of Minnesota, Minneapolis, Minnesota 55455

E.J. Stephenson, A. Bacher, J. Liu, X.L. Zhang, and S. Wells

Indiana University Cyclotron Facility, Bloomington, Indiana 47408

During the run from March 13 to March 19, 1992 we used split beam to take data for the experiment E352, a study of the (p,t) reaction on targets of ^{208}Pb and ^{60}Ni at 120 MeV proton energy.

The main objective of E352 was to use the (p,t) reaction to search for low-lying high spin ($J = 6-12$) neutron pair-hole states in ^{208}Pb and ^{60}Ni . For example, in ^{208}Pb states such as $J^\pi = 10^+$, 12^+ , and $J^\pi = 9^-$, 11^- are expected to be pure $(i_{13/2}^{-2})$ and $(i_{13/2}^{-1} h_{9/2}^{-1})$ neutron pair-hole configurations, respectively, and so can be used to test the residual shell model interaction. A secondary goal of the experiment was to study the high angular momentum structure of deep pair-hole states corresponding to pickup from inner shells. These data, together with those on the low spin states at lower proton energy,¹ can be used to test current ideas on modifications of the residual interaction due to meson and nucleon mass decreases in the nuclear medium. The consequence of this mass reduction for the central, spin-orbit and tensor parts of the effective interaction has been discussed extensively.²⁻³ In particular (although the effects are range or momentum dependent), an enhancement of the central and spin-orbit interactions (by a greater amount), and a reduction of the tensor interaction (at moderate range) is predicted by the mass reduction in the medium. At present, only about half of the high spin states ($J = 7-12$), below $E_{ex} = 8$ MeV, expected in ^{206}Pb are known and only few of these have reliable determined spectroscopic factors. It is very important to measure energies and spectroscopic factors for as many as possible of these states predicted in a given configuration space, as it is only in this way that the separate contributions of the central, spin-orbit and tensor residual interaction can be sorted out.⁴

The measurements were performed with the K600 magnetic spectrometer. Two ^{208}Pb targets (3.6 and 7.8 mg/cm²) and one ^{60}Ni (3.25 mg/cm²) were used. Particle identification was established via pulse height correlations between the S1 and S2 scintillators of the focal plane. Proton drift tables were obtained from (p,p) continuum spectra. The fact that we were split beam users created the frequent need for dispersion matching between the K600 and the beam line to maintain reasonable energy resolution. Under these conditions, variations in the tune and the target thickness caused the on-line energy resolution to vary between 33 and 55 keV. This situation forced us to eliminate data for the ^{60}Ni target, reduce the running time at each angle and increase the angle step to 4° using the 2" × 1" (2.52 msr) rectangular aperture. Data on ^{60}Ni were taken only at 6° and 12°, and on ^{208}Pb from 7.5° to 34° (steps of 4°). Failure of the internal Faraday Cup (FC) and replacement with a larger external one prevented us from going to angles smaller than 7.5°. Several runs at various angles were repeated with the external FC to take care of any beam current normalization problems coming from the internal FC failure. Beam polarization data were

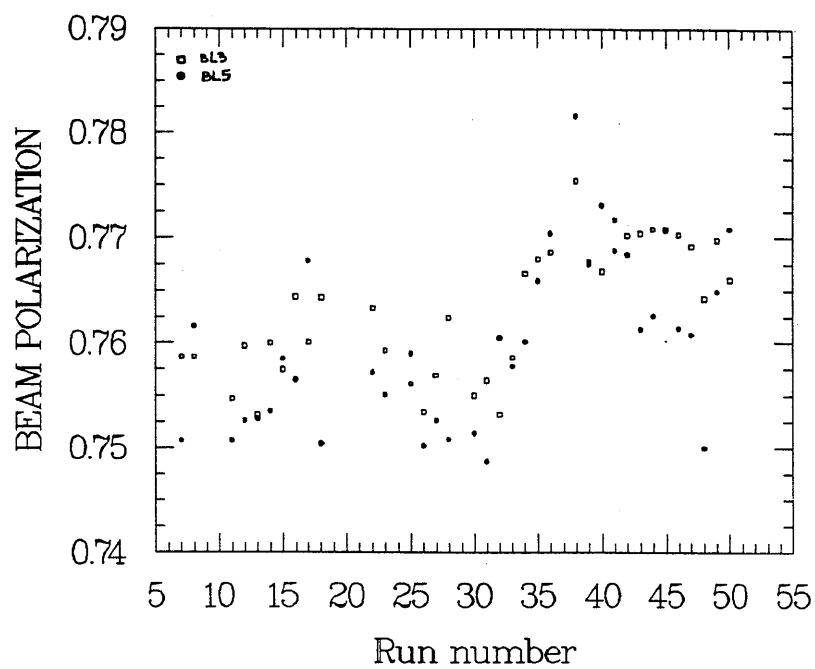


Figure 1. Beam polarization during E352 assuming $A_y = 0.6$.

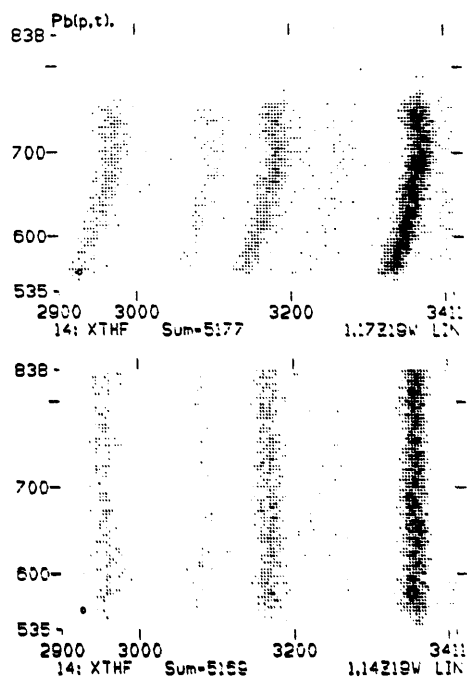


Figure 2. TOP: Focal plane position (horizontal) and angle (vertical) correlations without x and θ polynomials. BOTTOM: the same with polynomials.

collected at the end of each run using both the BL3 and BL5 beam line polarimeters. The magnitude of the beam polarization was between 0.76 and 0.77. This is shown in Fig. 1.

These data have been replayed and final histograms have been obtained. During the replay triton drift tables were calculated using the high excitation energy part of the (p,t) spectrum. The energy resolution was very much improved by using θ and x polynomials to correct for magnetic aberrations. The effect of the polynomials is shown in Fig. 2. After replay the energy resolution was between 25 and 40 keV depending on the degree of dispersion mismatch during the data taking because of the split beam instability. A typical energy spectrum is shown in Fig. 3.

At the present time we are in the process of extracting yields for the majority of the states. Angular distributions of cross sections and analyzing powers will be calculated. Most existing (p,t) calculations have been made in a zero-range approximation which assumes $\Delta S = 0$ and thus gives non-vanishing cross sections only for natural parity states.

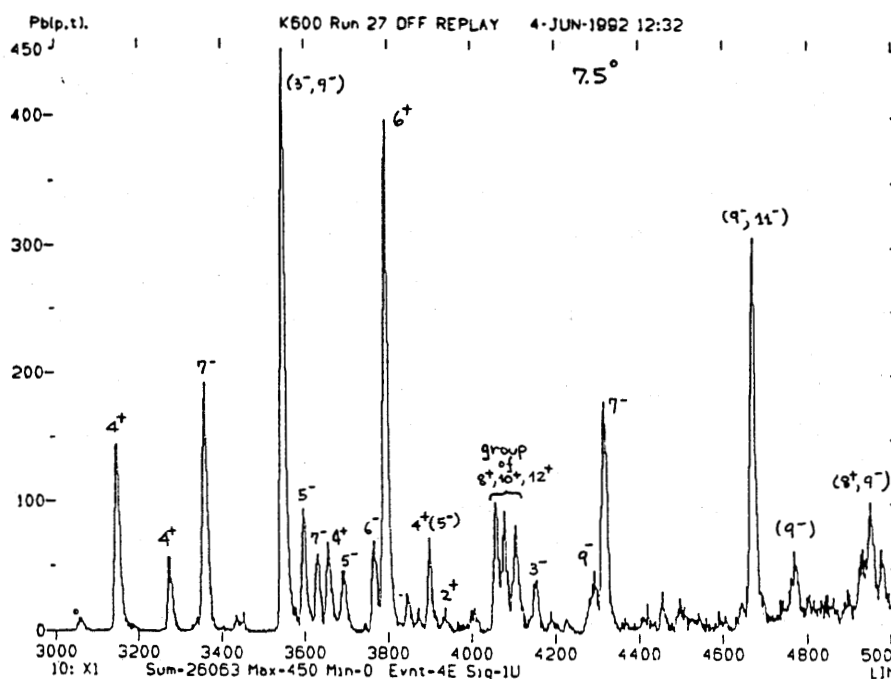


Figure 3. Position spectrum taken at 7.5° , averaged over both spin states, for $^{208}\text{Pb}(p,t)^{206}\text{Pb}$ at 120 MeV. Some of the states of interest are labeled.

In this case, the A_y gives information mainly on the distorting potentials, and seems no more sensitive to the ℓ -transfer than the cross section. However, a full finite range calculation (with a spin dependent interaction) will allow $\Delta S = 1$ transitions and hence the excitation of unnatural parity states.

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3. G.E. Brown and M. Rho, Phys. Lett. **B237**, 3 (1990).
4. D.C. Zheng and L. Zamick, in *The Effects of Spin-orbit and Tensor Interactions in Nuclei*, Rutgers University preprint, October 1990.

SEARCH FOR $3s_{1/2}$ HOLE-STRENGTH FRAGMENTS VIA THE $^{208}\text{Pb}(d, ^3\text{He})^{207}\text{Tl}$ REACTION

P. Grabmayr, A. Mondry, G.J. Wagner, and P. Woldt
Physikalisches Institut de Universität Tübingen, Germany

G.P.A. Berg, J. Lisantti, D.W. Miller, H. Nann, P.P. Singh, and E.J. Stephenson
Indiana University Cyclotron Facility, Bloomington, Indiana 47408

Studies of fractional occupation numbers of shell-model orbitals in doubly-magic nuclei with the proton removal reactions $(d, ^3\text{He})$ and $(e, e'p)$ yield insights into the limitations of the mean-field description of nuclei. Unfortunately, occupation numbers are not directly measurable, but can be derived in a model-dependent way through sum rules from absolute spectroscopic factors.

For the doubly-closed shell nucleus ^{208}Pb , recent mean field calculations by Mahaux *et al.*¹ predict an occupancy of $\sim 85\%$ at the Fermi surface, whereas calculations of Pandharipande *et al.*,² based on nuclear matter results, yield only 64%.

It has been shown that occupancies with less model dependencies can be derived via the CERES approach³ which combines the results of the charge density measurements⁴ with relative spectroscopic factors. Here the uncertainties of DWBA and DWIA calculations are greatly reduced. Thus, occupation numbers derived via the CERES approach depend mostly on the interpretation of the charge density difference in terms of an independent particle model.

Previous $(d, ^3\text{He})$ experiments on ^{208}Pb have focused in general only on the five dominant single-hole states.⁵⁻⁹ Consequently, all recent analyses of proton removal experiments have assumed no $\ell=0$ transition to be present except for the transition to the ground state