

SECTION II

ABSTRACTS OF TALKS AT  
AMERICAN PHYSICAL SOCIETY MEETINGS  
AND  
OTHER MEETINGS AND CONFERENCES

(JULY 1977-JUNE 1978)

Performance of 500 MeV Superconducting Cyclotron Magnet\*. H.G. BLOSSER, Michigan State U.-- Previous talks<sup>1</sup> have described the superconducting magnet which utilizes a large NbTi coil to obtain fields in the vicinity of 50 kilogauss. The magnet has 56" diameter poles which give a 65 cm orbit radius, and the cyclotron energy parameter, K, is then 500 MeV.<sup>2</sup> The magnet also has strongly-spiralled three-fold sectors: these provide focusing adequate for isochronous operation up to energies given by  $E/A(\text{MeV}) = 160(Q/A)$ . First full power tests of the magnet occurred in May 1977 and were extremely successful. Sensing instruments gave no evidence of any mechanical or magnetic instability; also results from initial field measurements are in excellent agreement with results of design calculations (differences less than 1%). These results imply: 1) that there will be no need for any re-machining or other corrections to the magnet pole tips; 2) that it is a reasonable and safe procedure to undertake construction of high field magnets, even magnets with extremely complicated pole tip geometries, without expensive and laborious cycles of model magnet studies (reflecting the basic simplification of the magnetic boundary value problem at high fields due to the fully aligned state of the magnetic materials). Both the cost of the superconducting magnet and the schedule are also in excellent agreement with forecasts (roughly 10% less costly, and roughly 10% longer to build, than estimated). Overall, the superconducting magnet has a large cost advantage in comparison with room temperature magnets of comparable capability. This advantage makes the superconducting cyclotron a likely component in a number of heavy-ion nuclear physics applications, which will be reviewed in the talk. Results from the field mapping program on the magnet will also be reviewed.

\*Work supported by the National Science Foundation.

<sup>1</sup>H.G. Blosser, Bull. APS 21, 611 and 989(1976); Blosser, Johnson, Burleigh, Niemann and Purcell, Cyclotrons and Their Applications, Birkhauser (1975)584.

<sup>2</sup>The parameter K is a convenient way of expression the bending power (B) of the magnet. In terms of K, the energy E of an ion with charge Qe and mass AE<sub>0</sub> is given by  $E = (KQ^2/A) (1 - (1/2)(K/E_0)(Q/A)^2 + \dots)$ .

The Spin-Flip Effective Interactions for the 1<sup>+</sup> States in <sup>12</sup>C from the <sup>12</sup>C(p,p')<sup>12</sup>C Reaction at 122 MeV.\* J.R. COMFORT, U. Pitt., P. DEBEVEC and G. MOAKE, Indiana U., S.M. AUSTIN, Mich. St. U., R.W. FINDLAY, Ohio U., and W.G. LOVE, U. Georgia.--The <sup>12</sup>C(p,p')<sup>12</sup>C reaction has been investigated at 122 MeV with protons obtained from the Indiana University cyclotron and detected with a helix detector in a magnetic spectrometer. The data span the angular range 10-58° in steps of 2-4°. Particular attention was given to the 1<sup>+</sup> states with T = 0 at 12.71 MeV and T = 1 at 15.11 MeV. The angular distributions have pronounced differences at θ < 30°, the T = 1 state being more-strongly forward peaked. Both states have similar shapes for θ > 30°. The differences cannot be ascribed to multistep processes. Interpretation in terms of microscopic effective interactions will be presented. The tensor interaction can be constrained by additional data for the <sup>14</sup>N(p,p')<sup>14</sup>N reaction to the T = 1 state at 2.31 MeV.

\*Supported by the National Science Foundation.

Recent Developments in the Analysis of the (p,n) Quasielastic Reaction in Terms of Matter Distribution Models.\* S.D. SCHERY, Moody College, Texas A&M Univ. and A. GALONSKY, Michigan State Univ.--Schery et al.<sup>1</sup> have analyzed quasielastic data on the tin isotopes at 22.8 MeV proton energy and on <sup>208</sup>Pb at 25.8 MeV in terms of matter distribution models. This work is being expanded to include more nuclides, a wider range of proton energies, and refinements in the reaction models. In analogy to the procedure reviewed by Sinha<sup>2</sup> for the imaginary term of the full optical potential, we have added an imaginary component, formulated in terms of neutron and proton matter distributions, to the isospin component of the optical potential. The resulting complex isospin potential is used through the Lane model for analysis of the (p,n) reaction. We give preliminary results of the analysis of existing <sup>208</sup>Pb(p,n) data at proton energies of 25.8, 35, and 45 MeV, and present new quasielastic data on the tin isotopes taken at Michigan State University's neutron time-of-flight facility.

\*Work supported in part by NSF.

<sup>1</sup>S.D. Schery, D.A. Lind, H. Wieman, Phys. Rev. C 14, 1800 (1976)

<sup>2</sup>B. Sinha, Physics Reports 20, 1(1975)

Heavy Ion Cyclotron Vacuum Calculations.\* M.L. MALLORY, Mich State Univ.--A vacuum model for cyclotrons has been developed to establish vacuum requirements for the Michigan State University superconducting heavy ion cyclotron. This model includes a charge pick-up cross section term, which is added to the conventional charge stripping cross section term. The beam transmission is calculated as a function of energy for various particles and charge states. These beam transmission results are compared with present heavy ion cyclotron beam attenuation curves and leads to the conclusion that present beam attenuation curves and leads to the conclusion that present beam attenuation seen by these cyclotrons can in part be explained by vacuum losses, where previously these losses had been ascribed to other causes. A vacuum requirement of  $1 \times 10^{-7}$  Torr gives greater than 50% transmission for all ions (C to U) that have been calculated for the superconducting cyclotron and the beam transmission is greater than 90% for the majority of the particles. Cryopumping is planned for the superconducting cyclotron that will meet these vacuum requirements.

\*Work supported by the National Science Foundation.

Neutron Production from 710-MeV Alphas in Thick Targets. R. CECIL, B. ANDERSON, A. BALDWIN, R. MADEY, Kent State U.\*; A. GALONSKY, P. MILLER, L. YOUNG, Mich. State U.†; F. WATERMAN, U. of Chicago.--We measured the spectra and yields of neutrons produced at nine angles from 0° to 150° by 710-MeV alphas stopping in targets of C, Pb, H<sub>2</sub>O, and steel. A telescope counted each alpha particle in the beam at the Space Radiation Effects Laboratory and provided a timing signal to measure the neutron flight-time to one of six organic scintillation counters operated in a multiplexing mode with a PDP-11/15 computer. Neutron yields above about 8 MeV were measured with five NE-102 plastic scintillators with flight paths of 5 m at forward angles, 3 m at 60°, and 2 m for angles greater than 60°; neutron yields from about 3 to 10 MeV were measured with a small (2 in. diam x 2 in. long) NE-213 liquid scintillator (with n-γ pulse-shape discrimination) at a distance of 1 m. The energy resolution varied from 8% at 3 MeV to about 18% at 300 MeV. At 0° and 6°, we observed neutron yield above the 178 MeV kinetic energy per nucleon of the incident alpha up to about 300 MeV, and a peak at about 115 MeV which is more pronounced in the light targets.

\*Supported in part by US ERDA Cont. EY-76-S-02-2231.

†Supported in part by the National Science Foundation.

Backbending Behavior and Decay of a High-Spin Isomer in  $^{178}\text{W}$ .\* F.M. BERNTHAL,† B. B. BACK, O. BAKANDER, J. BORGGREEN, J. PEDERSEN, and G. SLETTEN, Niels Bohr Institute, Denmark, and H. BEUSCHER, D. HAENNI, R. LIEDER, and C. MAYER-BORICKE, KFA-Jülich, Germany.--The ( $^{13}\text{C}, 4n$ ) and ( $\alpha, 5n$ ) reactions have been used to populate high spin states in  $^{178}\text{W}$ . A previously identified<sup>1</sup> 710 ns,  $I > 37/2$  isomer is found to decay directly into the backbending region of the  $7/2^- [514]$  g.r.b. The  $i_{13/2}$  band has been tentatively identified to spin  $41/2$ ; no backbending behavior is observed, supporting the view<sup>2</sup> that  $i_{13/2}$  neutron decoupling is the dominant influence on backbending in  $^{180}\text{W}$ . The unexpected short half-life of the isomer suggests new evidence for the higher-seniority (3-q.p.) configurations postulated to influence the nuclear wavefunction in the backbending region.<sup>3</sup>

\* Work supported by the Danish Natural Science Research Council.

† On leave from Michigan State University; supported in part by MSU, USNSF, and NATO.

<sup>1</sup> O. Bakander, J. Borggreen, J. Pedersen, and G. Sletten, to be published.

<sup>2</sup> F.M. Bernthal *et al.*, Phys. Lett. **64B**(1976)147.

<sup>3</sup> F.S. Stephens & R.S. Simon, Nucl. Phys. **A183** (1972)257.

Coulomb Displacement Energies in the  $1f_{7/2}$  Shell.\* B.A. BROWN, Cyclotron Laboratory, Mich. State U. and R. SHERR, Princeton U.--Recently<sup>1</sup> experimental data for  $\Delta E_C$  in the  $1f_{7/2}$  shell were analyzed in terms of a shell model description which incorporated charge dependent effects.<sup>2</sup> Generalized seniority wave functions were used and only states of lowest seniority (33 cases) were considered. An excellent fit was obtained (r.m.s. deviation  $\sigma=12.5$  keV). In the present work more realistic  $f_{7/2}$  wave functions<sup>3</sup> based on empirical residual interactions are used. For the lowest seniority states the results are nearly identical to the generalized seniority calculation. We are now able to extend the fits to easily include higher-spin (higher-seniority) states (for a total of about 60 states). The fits are again very good; the worst discrepancies occur for  $A=42$ . The effective two-body matrix elements for  $V_{pp}^{pp}$ ,  $V_{nn}^{nn}$  and  $V_{pn}^{pn}$  will be presented and discussed.<sup>3</sup>

\* Supported in part by the National Science Foundation.

<sup>1</sup> R. Sherr, Phys. Rev. **C**, Oct. 1977

<sup>2</sup> R. Sherr and I. Talmi, Phys. Lett. **56B**, 212(1975)

<sup>3</sup> W. Kutschera, B.A. Brown, and K. Ogawa, to be published.

The Origin of the Rare Light Elements and Whether the Universe Will Expand Forever.\* SAM M. AUSTIN, Michigan State University--Most of the elements were apparently created in stars, but the rare light nuclides:  $^2\text{H}$ ,  $^3\text{He}$ ,  $^6\text{Li}$ ,  $^9\text{Be}$  and  $^{10,11}\text{B}$ , are too fragile to withstand stellar temperatures and must have been made elsewhere. Evaluations of possible creation sites lead to the tentative conclusion that only two processes need be invoked. Collisions of galactic cosmic rays with the interstellar medium can produce the observed abundances of  $^6\text{Li}$ ,  $^9\text{Be}$  and  $^{10,11}\text{B}$  while  $^2\text{H}$ ,  $^3\text{He}$  and  $^7\text{Li}$  (as well as the abundant  $^4\text{He}$ ) are produced in the primeval Big Bang. This conclusion rests eventually on cross sections for the many nuclear reactions involved. Spallation cross sections for the galactic cosmic ray process have been measured recently at Orsay, Michigan State, Maryland and Berkeley. I will briefly discuss these measurements and then review calculations leading to the conclusion that  $^7\text{Li}$  and  $^2\text{H}$  were probably not created by the cosmic ray process, but rather by the Big Bang. Important consequences follow. If the Big Bang is the only significant source of  $^2\text{H}$ , then the abundance of  $^2\text{H}$  yields an estimate<sup>(1)</sup> of the density of the Universe. Recently it has been pointed out<sup>(2)</sup> that  $^7\text{Li}$  can also be used to place an upper limit on the density which is consistent with that obtained from  $^2\text{H}$ . Since both these estimates are much less than the critical density necessary to close the Universe, they lend strong support to the idea that the present expansion of the Universe will continue forever.

\* Research supported by the U.S. National Science Foundation.

(1) J.R. Gott, *et al.*, Ap. J. **194**, 543(1974).

(2) S.M. Austin and C.H. King, Nature **269**, 782(1977).

High-Spin Level Structure of  $^{188}\text{Pt}$ \* C.L. DORS, H. HELPPI, S.K. SAHA, M. PIIPARINEN, P.J. DALY, Purdue Univ., F.M. BERNTHAL, T.L. KHOO, Mich. St. Univ.--We have previously reported<sup>1</sup> on the high-spin level systematics of A=186-194 Pt nuclei. For the even-even nuclides, pronounced backbending anomalies occur which have been ascribed<sup>1,2</sup> to the intersection of the ground band by decoupled structures of  $\nu i_{13/2}$  and/or  $\nu h_{11/2}$  character. Further investigation of  $^{188}\text{Pt}$  by detailed ( $\alpha,4n$ ) and ( $^{12}\text{C},4n$ ) studies has revealed some features which differ from those in the neighboring nuclides. Whereas in these other nuclides the  $10^+$ ,  $12^+$  two quasiparticle states decay to the ground band, the corresponding states in  $^{188}\text{Pt}$  are found to de-excite predominantly through members of the  $\gamma$ -band, and the ground band population is very weak above  $10^+$ . The significance of this result will be discussed and a detailed level scheme for  $^{188}\text{Pt}$  will be presented. Substantial support for this scheme and some important B(E2) determinations have resulted from independent delayed conversion electron studies<sup>3</sup>.

\*Work supported by the USERDA and the NSF.

<sup>1</sup>M. Piiparinen et al., Phys. Rev. Lett. 34 (1975) 1110.

<sup>2</sup>L. Funke et al., Phys. Lett. 55B (1975) 436.

<sup>3</sup>H. Backe, L. Richter et al., T.H. Darmstadt, priv. com.

A Method for Finding Small Leaks in Large Cryogenic Vessels\* M.L. MALLORY and H.G. BLOSSER, Mich. State U.--A large super-conducting magnet for a heavy ion cyclotron is now operating at MSU. The vessel containing the superconducting windings and liquid helium (surface area  $\sim 25\text{ m}^2$ ) had a small leak into its vacuum jacket. The gaseous helium leak rate was measured to be  $\sim 10^{-6}$  torr  $\ell/\text{sec}$ , producing a significant heat load on the refrigeration system. The leak rate as observed by the pressure in the vacuum jacket is dependent upon the temperature variation of the viscosity of helium and the temperature and density in the area of the leak can be varied by the choice of the boil-off gas return line (six options). The leak was thereby localized to an area of  $\sim .06\text{ m}^2$ , leading to rapid isolation of the problem.

\*Work supported by the National Science Foundation.

The  $^{10}\text{Be}(d,p)^{11}\text{Be}$  reaction at  $E_x=25.0\text{ MeV}$ \* B. ZWIEGLINSKI, W. BENENSON, and R.G.H. ROBERTSON, Mich. State Univ., and W.R. COKER,†--The  $^{11}\text{Be}$  nucleus has been recently studied up to  $E_x=9.0\text{ MeV}$  with  $^9\text{Be}(t,p)^{11}\text{Be}$ . Six new states in the excitation energy range from 4.0 to 9.0 MeV have been found, and the existence of those previously known has been confirmed. A high-resolution study of  $^{11}\text{Be}$  through  $^{10}\text{Be}(d,p)^{11}\text{Be}$  at 25 MeV and over a similar excitation energy range has been undertaken using a target fabricated by D.R. Goosman to measure the spectroscopic factors of the states. Protons have been detected with a delay-line proportional counter at the focal plane of the Enge split-pole spectrograph. Only the ground state, 0.320, 1.785 and 3.410 MeV states are strongly excited, which corroborates the suggestion made in ref. 1 that the transition of both neutrons to the sd shell is probably involved in the excitation of the higher states in  $^{11}\text{Be}$ . DWBA analysis of the angular distributions using continuum wave functions will be presented.

\*Work supported by the U.S. National Sci. Fdn.

†Univ. of Texas, Austin.

<sup>1</sup>F. Ajzenberg-Selove and T. Lauritsen, N.P. A114 (1968)1.

Extensive  $i_{13/2}$  Level Families in  $^{187}\text{Pt}$  and  $^{189}\text{Pt}$ \* S.K. SAHA, C.L. DORS, M. PIIPARINEN, H. HELPPI, P.J. DALY, Purdue Univ., T.L. KHOO, F.M. BERNTHAL, Mich. St. Univ.--The level structures of  $^{187,189}\text{Pt}$  have been investigated by  $^{186,188}\text{Os}(\alpha,xn\gamma)$  reactions. Measurements included  $\gamma$ -ray angular distributions,  $\gamma$ - $\gamma$ -t coincidences and excitation functions. The level schemes established include extensive  $\nu i_{13/2}$  level families with both favored and unfavored  $\Delta I=2$  decoupled bands, similar to those observed previously<sup>1</sup> in  $^{191}\text{Pt}$  and  $^{193}\text{Pt}$ . The systematics of the  $\nu i_{13/2}$  families in odd-A Pt nuclei show that with decreasing mass number the unfavored levels are gradually lowered in energy with respect to the favored levels until in  $^{189}\text{Pt}$  the  $11/2^+$  unfavored level lies only 11 keV above the  $13/2^+$  level. Finally, in  $^{187}\text{Pt}$  the  $11/2^+$  level is found below the  $13/2^+$  level. An explanation of this result using the triaxial rotor plus particle description will be discussed. In both nuclei several negative parity cascades have also been observed. One of these "bands" in  $^{189}\text{Pt}$  may be ascribed to the  $\nu h_{9/2}$  orbital.

\*Work supported by the USERDA and the NSF.

<sup>1</sup>S.K. Saha et al., Phys. Rev. C15 (1977) 94.

Status Report on 500 MeV Superconducting Cyclotron\* H.G. BLOSSER, Mich. State U.--As reported previously<sup>1</sup>, the magnet for the 500 MeV cyclotron is now in operation and the field has been mapped and found to be in accurate agreement with design requirements. Funding of a project to make the magnet into an operating cyclotron was received in the summer of 1977, and detailed design and construction of major parts is now in progress. It appears possible to have the cyclotron ready for initial beam testing in the summer of 1979 with phasing into full time use in heavy ion research in early 1980. Major design effort is now directed toward details of ion source, rf system, extraction system and vacuum system. Testing of ion sources in the 50 kilogauss field is expected in the spring of this year, and the first of three dee and amplifier assemblies is expected to be ready for high power tests in the summer. The extraction system consists of three electrostatic deflectors plus a series of inert focusing bars. A major disassembly of the magnet for installation of extraction system components is scheduled for the fall.

\*Work supported by the National Science Foundation.

<sup>1</sup>H.G. Blosser, B.A.P.S. 22, 991 (1977).

Recoil Mass Identification Via Time-of-Flight.\* M. DISTASIO, R.B. FIRESTONE, and WM. C. MCHARRIS, Michigan State Univ.--A time-of-flight spectrometer (SIEGFRIED) has been utilized at the MSU Cyclotron Laboratory as a means of mass identification of short-lived species. Radioactive species are deposited on a collecting plate by a He-JRT system and undergo  $\beta$ - or  $\gamma$ -decay. The decay, which is detected by a plastic scintillator, results in a recoil ion that is electrostatically accelerated to  $\sim 6$  keV. After drifting down a flight path the ion is counted by a CEMA detector. The two signals start and stop a TAC which yields the time-of-flight. This, together with the energy, fix the mass of the recoil. Evidence indicates that a significant portion of the widths of the observed mass peaks is due to the intrinsic recoil spectrum. A parameterization of the widths indicates that  $\beta$ -decay energies may be measured to an accuracy of  $\sim 100$  keV. Presently, we are working on particle trajectory calculations and the inclusion of relevant recoil distributions, with the aim of improved interpretation of our measurements.

\*Work supported by the U.S. National Science Foundation.

The observation of inner-hole states in ( $^3\text{He}, \alpha$ ) reaction at 70 MeV on  $^{90}\text{Zr}$ ,  $^{144}\text{Sm}$  and  $^{208}\text{Pb}$  nuclei.\* G.M. CRAWLEY, S. GALES, D. WEBER, B. ZWIEGLINSKI<sup>††</sup> and W. BENENSON, Mich. State Univ.--The ( $^3\text{He}, \alpha$ ) reaction at 70 MeV incident was used to populate inner neutron hole states in  $^{89}\text{Zr}$ ,  $^{143}\text{Sm}$  and  $^{207}\text{Pb}$  nuclei. An excitation energy range of 25 MeV was investigated with a split-pole spectrometer and a 50 cm position sensitive proportional counter. In the low energy part of the spectra (0-3 MeV), the high spin neutron hole states are strongly excited. In the case of the  $^{208}\text{Pb}(\text{}^3\text{He}, \alpha)^{207}\text{Pb}$  reaction an enhanced cross section with a large amount of fine structure is clearly seen between 5 and 9 MeV excitation energy. This result agrees with a previous study of this reaction at 217 MeV.<sup>1</sup> The  $T_{\frac{1}{2}}$  components of these inner hole states were populated in  $^{89}\text{Zr}$  and  $^{143}\text{Sm}$  and a search for these isobaric analog states was made in  $^{207}\text{Pb}$ .

\*Work supported by the U.S. National Science Foundation.

<sup>†</sup>On leave from Institute de Physique Nucléaire, Orsay, France.

<sup>††</sup>On leave from the Institute of Nuclear Research, Warsaw, Poland.

<sup>1</sup>E. Gerlic et al., Phys. Lett. 57B, 378 (1975).

The giant M1 resonance in  $^{22}\text{Ne}$ ,  $^{26}\text{Mg}$ ,  $^{30}\text{Si}$ , and  $^{34}\text{S}$ .\* U.E.P. BERG, Mich. State Univ. and K. Wienhard, Strahlencentrum, Justus-Liebig-Universität, D-6300 Giessen, Germany--Nuclear resonance fluorescence experiments with bremsstrahlung and Ge(Li) detectors have been performed at the Giessen 65 MeV electron linac to investigate the influence of two valence neutrons on the giant M1 resonance in selfconjugate sd-shell nuclei. The additional neutrons cause a fragmentation of the M1 strength, and the  $T_{\frac{1}{2}}$  part of the giant M1 resonance is shifted to lower excitation energies. The ( $\gamma, \gamma$ ) results are compared to shell model calculations and sum rule predictions.

\*Supported by the U.S. National Science Foundation.

$^{145}\text{Gd}$  EC/ $\beta^+$  Decay Branching Ratios Revisited.\* R.B. FIRESTONE, R.C. PARDO, and WM. C. MCHARRIS, Michigan State Univ.--Experimental studies of  $^{145}\text{Gd}$  EC/ $\beta^+$  decay branching ratios have indicated several large anomalies with respect to allowed beta decay theory. Recently, this data has come under attack<sup>1</sup> because of the poorly known value of  $Q_{\beta^+}=5.30\pm 0.12$  MeV, and the possibility of unobserved beta decay to high-lying states in  $^{145}\text{Eu}$ . To answer the first assertion we have measured the beta endpoint by  $\beta$ - $\gamma$  coincidence techniques using plastic and Ge(Li) detectors. The spectra were internally calibrated with well known beta decay standards and we have extracted the preliminary value of  $Q_{\beta^+}=5.1\pm 0.1$  MeV. The second question is difficult to address directly because of the high level density above 2.5 MeV in  $^{145}\text{Eu}$ . Nevertheless, an analysis of the  $^{145}\text{Gd}$  high energy  $\gamma$ -ray spectrum reveals insufficient intensity from these transitions to remove the larger anomalies. In conclusion we find that the EC/ $\beta^+$  ratio anomalies are probably smaller than first reported, however several large anomalies still persist.

\*Work supported by the U.S. National Science Foundation.

<sup>1</sup>P. Hornshøj, H.L. Nielson, and N. Rud, Phys. Rev. Lett. 39, 537(1977).

The  $^{206}\text{Pb}(p, \alpha)$  and  $^{206}\text{Pb}(p, \alpha)$  reactions at 35 MeV.\* D. WEBER, G.M. CRAWLEY, R.G. MARKHAM, Mich. State Univ. and P.A. SMITH, Univ. of Colorado--Excitation energies and angular distributions have been obtained for states in  $^{205}\text{Tl}$  and  $^{203}\text{Tl}$  up to 4 MeV excitation by the ( $p, \alpha$ ) reaction on  $^{206}\text{Pb}$  and  $^{206}\text{Pb}$ . A 35 MeV proton beam from the MSU Cyclotron was used and the  $\alpha$ -particles were detected in the focal plane of the Enge split-pole spectrometer using both a position sensitive proportional counter and photographic plates. An energy resolution of about 15 keV was obtained. A number of new states have been observed. Good fits to the angular distributions have been obtained using cluster model DWBA calculations. On the basis of these calculations, many new spin assignments have been made. States with spins as high as ( $19/2^+$ ,  $21/2^+$ ) have been observed. A comparison of the states populated in the ( $p, \alpha$ ) reaction with those seen in other reactions was made. The nature of the observed states will be discussed.

\*Work supported by the U.S. National Science Foundation and the Department of Energy.

Mass Measurements with the ( $^3\text{He}, ^6\text{He}$ ) reaction on nuclei with  $A > 70$ .\* R. PARDO, E. KASHY, W. BENENSON, and L.W. ROBINSON, Mich. State Univ.--We have used the ( $^3\text{He}, ^6\text{He}$ ) reaction at 70 MeV bombarding energy to measure the mass excess of several proton-rich nuclei. The  $^6\text{He}$  ions were detected and identified in the focal plane of an Enge split-pole spectrograph using a double charge division proportional counter backed by a plastic scintillator. The  $^{60,62}\text{Ni}(\text{}^3\text{He}, ^6\text{He})^{57,59}\text{Ni}$  reactions, with Q-values of  $-11.039\pm 0.008$  MeV and  $-8.255\pm 0.005$  MeV, were used as calibration reactions. Preliminary results of the mass excesses (Q-values) for the nuclei  $^{87}\text{Zr}$ ,  $^{103}\text{Cd}$ ,  $^{109}\text{Sn}$ , and  $^{141}\text{Sm}$  are  $-79.344\pm 0.011$  ( $-12.083$ ) MeV,  $-80.621\pm 0.020$  ( $-9.172$ ) MeV,  $-82.630\pm 0.025$  ( $-8.676$ ) MeV, and  $-75.767\pm 0.014$  ( $-8.859$ ) MeV, respectively. In addition to these measurements, the results of experiments reaching the nuclei  $^{67}\text{Ge}$  and  $^{89}\text{Mo}$  will be presented. These measurements are the first determinations of the mass of  $^{109}\text{Sn}$  and  $^{89}\text{Mo}$ . The other nuclei have uncertainties of 60-140 keV from previous measurements except for  $^{67}\text{Ge}$ . Typical cross sections for these reactions were 100nb/sr at far forward angles ( $5^\circ$ - $13^\circ$ ) and show more variation between individual targets than global variation with A.

\*Work supported by the U.S. National Science Foundation.

A Study of the  $^{194,196,198}\text{Pt}(p,p')$  Reactions and the  $0^+(5)$  Limit of the Interacting Boson Model.  
 F.T. DEASON, C.H. KING,† T.L. KHOO,† F.M. BERNTHAL, and J.A. NOLEN, JR., Michigan State University--  
 The low-lying levels of the even platinum nuclides  $^{194,196,198}\text{Pt}$ , were investigated by inelastic scattering of 35 MeV protons. Angular distributions were obtained for most levels below 2 MeV; results will be compared with the predictions of current theories for inelastic scattering. In addition the energy levels of five Pt nuclides and the B(E2) values for  $^{194}\text{Pt}$  and  $^{196}\text{Pt}$  will be described in terms of the  $0^+(5)$  vibrational limit of the Interacting Boson Model.<sup>1</sup> Good agreement is obtained with theory for most of the even parity levels, with the exception that no experimental candidate for the 2-boson  $0^+$  level ( $n_B=2, v=0, L=0$  in the IBM) is found. The agreement throughout the Pt region is comparable to that obtained for  $^{198}\text{Pt}$  using the  $0^+(6)$  limit<sup>2</sup> of the IBM.

\*Supported by the U.S. National Science Foundation.  
 †Present address: Lawrence Berkeley Laboratory.  
 †Present address: Argonne National Laboratory.  
<sup>1</sup>A. Arima and F. Iachello, Ann. Phys. 99(1976)253.  
<sup>2</sup>J.A. Cizewski et al., Phys. Rev. Lett. 40(1978)167.

Highly Excited States in  $^{24,25,26}\text{Al}$  from the  $(p,n)$  Reaction.  
 \* U.E.P. BERG, L.E. YOUNG, A.I. GALONSKY, SAM M. AUSTIN, Y. IWASAKI, and R. DEVITO, Michigan State Univ.--Excited states in  $^{24,25,26}\text{Al}$  have been studied via the  $^{24,25,26}\text{Mg}(p,n)$  reaction at  $E_p=35$  MeV. Because of the similarity of the operators involved, this reaction is expected to strongly excite analogs of the  $1^+, M1$  states in the Mg isotopes. Although the level density in most of the excitation region investigated (up to  $E_x=15$  MeV in  $^{25,26}\text{Al}$ ) is very high, well separated peaks appear throughout the  $(p,n)$  time-of-flight spectra. Strong transitions are concentrated in the energy region where the analog and antianalog states of the giant M1 resonance in  $^{25}\text{Mg}$  and  $^{26}\text{Mg}$  are expected to occur.

\*Work supported by the U.S. National Science Foundation.

Cross Sections for A=6 and A=7 Isotopes in the  $\alpha+\alpha$  Reaction.  
 \* V.E. VOILA, JR., B.G. GLAGOLA, G.J. MATHEWS†, P.G. ROOS and A. NADASEN, University of Maryland and SAM M. AUSTIN, Michigan State University--Cross sections for the production of A=6 and 7 isotopes in the  $\alpha+\alpha$  reaction have been measured from 120 to 160 MeV at the University of Maryland Cyclotron in order to investigate mechanisms of  $^6\text{Li}$  and  $^7\text{Li}$  nucleosynthesis. Particle identification was to detect  $^7\text{Li}$ ,  $^7\text{Be}$ ,  $^6\text{Li}$  and  $^6\text{He}$  isotopes at angles from  $3.5^\circ$  in the laboratory system to angles beyond the maximum permitted by kinematics. The  $^7\text{Li}$  and  $^7\text{Be}$  cross sections are found to be essentially equal and decrease exponentially with energy. For  $^6\text{Li}$  (really all of the A=6 cross section) it is observed that the contribution from three-body final states is several times larger than that from two-body states. Furthermore, the yields decrease much more slowly with energy than is the case for A=7. These results support arguments which preclude significant synthesis of  $^7\text{Li}$  are proposed, among the most probable is the big bang.

\*Work supported by the NSF and DOE  
 †Present address: Lawrence Berkeley Laboratory, Berkeley, CA.

Fast resolution optimization in a magnetic spectrograph.  
 \* E.KASHY, P.S. MILLER, AND J.A. NOLEN, JR., Mich. State Univ.--A variation on the tuning method of Blosser et al.<sup>1</sup> to achieve high resolution using a Cyclotron-Spectrograph combination has been developed. In this new method the direct beam is transmitted through the spectrograph at  $0^\circ$  and the resulting image width and shape on a scintillator are viewed directly via TV. The TV magnification is such that a 100  $\mu\text{m}$  wide line in the focal plane is 5 mm wide on the TV monitor. While beam images corresponding to  $\Delta P/P=1/20,000$  have been seen, this is still not quite as good as has previously been achieved.<sup>2</sup> However, tuning time has been reduced from hours to minutes. At the same time, a rapid evaluation of target thickness and homogeneity is obtained.

\*Work supported by the U.S. National Science Foundation.  
<sup>1</sup>H.G. Blosser, G.M. Crawley, R. DeForest, E. Kashy and B.H. Wildenthal, Nucl. Inst. and Methods 91, 61(1971).  
<sup>2</sup>J.A. Nolen, Jr. and P.S. Miller, Proc. 7th Int. Conf. on Cyclotrons (Birkhouser, Basel, 1975) p. 249-253.

Observation of the Radiative Capture Process  $^2\text{H}(\alpha,\gamma)^6\text{Li}$ .  
 \* R.G.H. ROBERTSON, R.A. WARNER, P.DYER and R.C. MELIN, Mich. State Univ. and T.J. BOWLES, Argonne National Lab.--The capture of  $^4\text{He}$  by deuterium is of interest in big-bang nucleosynthesis, in tests of cluster model descriptions of  $^6\text{Li}$ , and in searches for the parity- and isospin-forbidden  $\alpha$  decay of the  $0^+ T=1$  state of  $^6\text{Li}$ . Successful observation of this reaction at incident alpha energies of 5.4, 5.8, 6.2, 8.1, 10.1, 12.5 and 25 MeV has been achieved by direct detection of the recoiling  $^6\text{Li}$  ion in a two-section proportional counter in the focal plane of an Enge split-pole spectrograph. The technique also provides a complete  $\gamma$ -ray angular distribution from the  $^6\text{Li}$  momentum distribution, from which the capture at  $E_\alpha=8.1$  MeV is deduced to be mainly quadrupole.

\*Research supported by U.S. National Science Foundation.

The Measurement of the Magnetic Moment of the 19/2 Isomer in  $^{115}\text{Sb}$ .  
 \* S.R. FABER, L.E. YOUNG, and F.M. BERNTHAL, Michigan State University--The magnetic moment of the  $t_{1/2}=156$  ns 19/2<sup>-</sup> isomer in  $^{115}\text{Sb}$  was measured using the TDPAD technique. The reaction used was  $^{115}\text{In}(\alpha,4n\gamma)^{115}\text{Sb}$ , with 49 MeV alphas incident on a thick (110 mg/cm<sup>2</sup>), natural metallic In target (tetragonal lattice). Two Ge(Li) detectors were placed at  $135^\circ$  and  $225^\circ$  to observe the 1217 keV  $15/2^+ \rightarrow 11/2^-$  transition and the 1300 keV  $11/2^- \rightarrow 5/2^-$  transition. The precession frequency obtained for each transition yielded a g-factor of +0.288(4) which is consistent with the g-factor obtained from additivity for the proposed configuration  $\{v d_{5/2} \otimes [v h_{11/2} \otimes v d_{3/2}]\}_{19/2^-}$ . An estimate of the g-factor for the  $t_{1/2}=6.7$  ns 11/2<sup>-</sup> state was obtained by analysis of the phase shift of the 1300 keV  $\gamma$ -ray angular distribution. The effect of core polarization on the measured g-factors will be discussed.

\*Work supported by the National Science Foundation.  
<sup>1</sup>J. Bron et al., Nucl. Phys. A279(1977)365.

On-Line Time-of-Flight Mass Identification.\* Wm. C. McHarris, M.D. Edmiston, R.A. Warner, and W.H. Kelly, Michigan State Univ.--We describe the construction and operation of SIEGFRIED, a He-jet fed time-of-flight mass-identification system based on the MAGGIE system at Texas A&M.<sup>1</sup> It is now used routinely to study exotic nuclei produced by beams from the MSU sector-focused cyclotron. Radioactive recoils are transported by our modular He-jet system<sup>2</sup> through a 10-m long capillary and through a skimmer onto a collection plate held at a high positive potential. Approximately 50% of the  $\beta$ -decaying nuclei recoil forward off the plate, are ionized by electron shake-off, and are accelerated down a 2.2-m flight path by a 90% transmission grid at ground potential. A  $\beta$  or  $\gamma$  detector behind the plate detects  $t=0$ , and a chevron heavy-ion detector at the end of the flight path detects the end-flight time, allowing mass-identification with a TAC. Provision is also made for an additional  $\gamma$  detector for  $\gamma$ -mass coincidence experiments. Thus far we have produced and studied "heavy"  $T=1/2$  nuclei in the  $f7/2$  shell, including  $460.0 \pm 1.5$ -msec  $^{47}\text{Cr}$  and  $\approx 180$ -msec  $^{55}\text{Ni}$ , and also a number of very neutron-deficient nuclei near the  $N=82$  shell.

\* Work supported in part by the U.S. National Science Foundation.

<sup>1</sup>H. Jungclas, R.D. Macfarlane, and Y. Fares, *Radiochim. Acta* **16**, 141 (1971).

<sup>2</sup>K.L. Kosanke, M.D. Edmiston, R.A. Warner, R.B. Firestone, Wm. C. McHarris, and W.H. Kelly, *Nucl. Instr. Meth.* **124**, 365 (1975).

Proton Rich Nuclei Far from Stability.\* Walter Benenson, Michigan State Univ.--High precision mass measurements of the  $T_z=-3/2$  nuclei from  $9\text{C}$  to  $^{37}\text{Ca}$  and the  $T_z=-1/2$  nuclei from  $^{43}\text{Ti}$  to  $^{55}\text{Ni}$  have now been completed. The most recent measurements include  $^{15}\text{F}$ ,  $^{27}\text{P}$  and  $^{31}\text{Cl}$ . The  $T_z=-3/2$  nuclei and their excited states now represent 21 complete mass quartets, which can be compared to the predictions of the isobaric multiplet mass equation. This equation is shown to work extremely well over the whole range of complete quartets. The  $T_z=-1/2$  nuclear masses permit a determination of mirror nucleus Coulomb energies up to  $A=55$  and, when used as input in the Garvey-Kelson charge symmetric mass relation, permit accurate predictions of  $Z>N$  masses up to Ni. Techniques for measuring masses accurately with multi-nucleon transfer reactions will also be discussed.

\* Work supported in part by the U.S. National Science Foundation.

INTERNATIONAL SEAWEED SYMPOSIUM, Santa Barbara, CA, July 1977

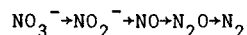
NITROGEN METABOLISM, GENETICS AND DEVELOPMENT OF HETEROCYST-FORMING BLUE-GREEN ALGAE. C.P. Wolk, J.C. Meeks, W. Lockau, T.C. Currier, J.F. Haury, and J. Thomas, MSU/ERDA Plant Research Laboratory, and S.M. Austin and W.-S. Chien, Cyclotron Laboratory and Dept. of Physics, Michigan State University, E. Lansing, MI 48824, U.S.A.

The kinetics of labeling of metabolites during assimilation of  $^{13}\text{N}[\text{NH}_4^+]$  by *Anabaena cylindrica*, and other results, show that the glutamine synthetase/glutamate synthase pathway mediates most of the initial metabolism of ammonium. Differences in detail from the kinetics of labeling during assimilation of  $^{13}\text{N}[\text{N}_2]$  are most simply interpreted as indicating that different pools of glutamine are predominantly labeled from the two nitrogen sources. Auxotrophic mutants of *A. variabilis*, mutants impaired in photosynthesis, and mutants incapable of aerobic assimilation of  $\text{N}_2$ , some of which are modified in the frequency of occurrence, or structure, of heterocysts, have been isolated. The last-named mutants are being used to test the hypothesis that the substance produced by heterocysts which prevents nearby vegetative cells from differentiating into heterocysts is glutamine or a derivative of glutamine.

SYMPOSIUM ON NUCLEAR APPLICATIONS TO RESEARCH IN CHEMISTRY, Anaheim, CA, March 12-17, 1978

DENITRIFICATION STUDIES USING  $^{13}\text{N}$  TRACERS.\* R.B. Firestone and Wm. C. McHarris, Department of Chemistry and Cyclotron Laboratory; M.K. Firestone and J.M. Tiedje, Department of Crop and Soil Sciences, Michigan State University, East Lansing, Michigan 48824.

The effect of increasing use of nitrogen fertilizer on the atmosphere's ozone layer and its long-term implications for agriculture and human nutritional needs are two questions of intense current interest. The process of biological denitrification, by which large quantities of nitrogen are lost from the soil, proceeds simply as



where  $\text{N}_2\text{O}$ , in particular, is thought to be partially destroying the atmosphere's ozone layer. Procedures have been developed at the Michigan State University Cyclotron Laboratory to label all five nitrogen species (and also  $\text{NH}_4^+$ ) with  $^{13}\text{N}$  produced by the  $^{16}\text{O}(\rho, \alpha)^{13}\text{N}$  reaction on water targets. Sources containing  $\approx 85\%$   $\text{NO}_3^-$  are produced directly by bombardment, and a high performance liquid chromatography system with a NaI detector is used to both separate and monitor the ionic species. A gas chromatograph with a proportional counter detector is also used to monitor the gaseous species. Finally a constant flow, differential trapping system has been constructed utilizing NaI detectors to continuously monitor the production of  $\text{N}_2\text{O}$  and  $\text{N}_2$ . These techniques have provided sensitive probes of the denitrification process, and have allowed us to perform numerous experiments that were impossible by traditional techniques.

\* Supported in part by the U.S. National Science Foundation.

N-13 Methodology for the Short-Term Assay of Rates and Products of Denitrification, J.M. Tiedje\*, M.K. Firestone, M.R. Betlach, M.S. Smith, and R.B. Firestone, Michigan State Univ.--N-13 has been found to be a useful isotope for study of denitrification in unamended soils because of the extreme sensitivity its short half-life provides. We generate  $^{13}\text{N}$  via the  $^{16}\text{O}(p,\alpha)^{13}\text{N}$  reaction at the MSU Cyclotron. We use water as the target a 12 to 15 MeV proton beam of 0.7 to 4  $\mu\text{A}$  and a bombardment time of 10 to 20 min.  $^{13}\text{N-NH}_4^+$ ,  $\text{NO}_2^-$ , and  $\text{NO}_3^-$  are produced. The relative proportions among ions vary with bombardment conditions but  $\text{NO}_3^-$  is the major product. We use three methods for assay of denitrification and  $^{13}\text{N}$  compounds. For continuous measurement of denitrification rates we constantly strip  $^{13}\text{N}_2\text{O}$  and  $^{13}\text{N}_2$  from soil slurries and separate each by differential trapping. The production of each gas is monitored by NaI detectors. In the second system  $^{13}\text{N-N}_2$ ,  $\text{N}_2\text{O}$  and  $\text{NO}$  produced in sealed flasks of  $^{13}\text{NO}_3^-$  amended soil is monitored by gas chromatography coupled to a proportional counter. The third analytical system is a high pressure liquid chromatograph in which the effluent is monitored by coincidence counting with NaI detectors.  $^{13}\text{N-NH}_4^+$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$  can be separated within 6 min. by this method. All detectors are on-line to a computer which performs the half-life corrections and prepares plots of the data.

Rapid Changes in Soil Denitrification Rates Subsequent to the Onset of Anaerobiosis: Measurement Using Acetylene Inhibition and  $^{13}\text{N}$  Methods, M. Scott Smith, M.K. Firestone, and J.M. Tiedje, Michigan State University.--Denitrification rates of soil slurries were measured by  $\text{C}_2\text{H}_2$  inhibition of  $\text{N}_2\text{O}$  reduction and with  $^{13}\text{NO}_3^-$ . Rates determined by the two methods correlated well. During short term incubations, the ratio of  $\text{N}_2\text{O}$  produced by soils without  $\text{C}_2\text{H}_2$  to soils with  $\text{C}_2\text{H}_2$  correlated with  $^{13}\text{N}_2\text{O}/(^{13}\text{N}_2+^{13}\text{N}_2\text{O})$ . Therefore, the  $\text{C}_2\text{H}_2$  inhibition method may be useful in determining the ratio of soil denitrification products. Denitrification products of  $^{13}\text{NO}_3^-$  with and without carrier  $\text{NO}_3^-$  were determined in the presence of various  $\text{C}_2\text{H}_2$  concentrations. The  $\text{C}_2\text{H}_2$  concentration necessary for effective inhibition of  $\text{N}_2\text{O}$  reduction increased in the absence of carrier  $\text{NO}_3^-$ . Subsequent to the onset of anaerobic conditions rapid increases in denitrification rate were observed. These increases are believed to reflect, in sequence: removal of  $\text{O}_2$  inhibition, synthesis of denitrifying enzymes by indigenous microorganisms, and growth of denitrifiers. Under some conditions these effects could be separated as distinct phases. A stimulatory effect of added glucose on denitrification rate was observed predominantly in the growth phase.

Factors Influencing the Biological Release of  $\text{N}_2\text{O}$  During Denitrification as Determined by  $^{13}\text{N}$  Methodology, M.K. Firestone\*, M.S. Smith, R.B. Firestone, and J.M. Tiedje, Michigan State University.--Additions of  $^{13}\text{N}$  labeled  $\text{NO}_3^-$  labeled  $\text{NO}_3^-$  and  $\text{NO}_2^-$  to anaerobic slurries of Brookston (mollisol) and Spinks (alfisol) soils were used to determine the rate of exchange between labeled denitrification intermediates and nonlabeled pools of added  $\text{N}_2\text{O}$  and  $\text{NO}$ . Increasing the concentration of  $^{14}\text{N}_2\text{O}$  in actively denitrifying soils resulted in corresponding increases in  $^{13}\text{N}_2\text{O}$  in the gas phase indicating that  $\text{N}_2\text{O}$  is a freely diffusible, biologically produced intermediate. Significant exchange of  $^{13}\text{NO}$  with  $^{14}\text{NO}$  pools was observed in both sterile and nonsterile soils at acid, neutral and alkaline pH's but the exchange occurred more slowly under alkaline conditions. Apparently the production of  $\text{NO}$  is a chemically catalyzed process. Addition of  $^{14}\text{NO}_3^-$  to soils resulted in higher ratios of  $\text{N}_2\text{O}/\text{N}_2$  indicating that  $\text{NO}_3^-$  concentration is a factor controlling  $\text{N}_2\text{O}$  production. The ratio of the gaseous products changed with time after the onset of anaerobiosis. In the Brookston soil,  $\text{N}_2$  was the major product when anaerobic conditions were imposed; the  $\text{N}_2\text{O}/\text{N}_2$  ratio increased with time until ~24 h when  $\text{N}_2\text{O}$  was the predominating product. After >2 days,  $\text{N}_2$  was again the major product.



Reduction of Nitrate to Ammonia by a Clostridium spp. Isolated from Soil, W.H. Caskey and J.M. Tiedje, Michigan State Univ.--Reduction of  $\text{NO}_3^-$  to  $\text{NH}_4^+$  has been shown to occur in some soils incubated under denitrifying conditions, and evidence suggested this reduction by sporeforming bacteria is a non-assimilatory process. This study was designed to isolate responsible organisms and to examine the nature of the reduction. Twenty-two sporeforming bacteria were isolated, thirteen of which were Clostridia. The isolate most active in  $\text{NO}_3^-$  reduction to  $\text{NH}_4^+$ , a Clostridium spp., was cultured in basal medium containing glucose. Growth yields in the presence and absence of  $\text{NO}_3^-$  were determined. The isolate reduced 45% of added  $\text{NO}_3^-$  to  $\text{NH}_4^+$ , which resulted in a significant increase in growth yield. The effect of inhibitors of assimilatory  $\text{NO}_3^-$  reduction,  $\text{NH}_4^+$  assimilation, and possible alternate substrates on the reduction of  $\text{NO}_3^-$  to  $\text{NH}_4^+$  was determined in basal medium during extended incubation and, also, during a 20 min incubation using  $^{13}\text{NO}_3^-$ . The reduction was unaffected by  $\text{NH}_4^+$ , glutamate, glutamine, 0.01 mM and 10 mM methionine sulfoximine, and 1 mM azaserine. Sulfite inhibited  $^{13}\text{NH}_4^+$  production. Since the reduction of  $\text{NO}_3^-$  to  $\text{NH}_4^+$  is beneficial to the cell but does not result in an assimilated product, we have termed this process auxiliary  $\text{NO}_3^-$  reduction. Auxiliary  $\text{NO}_3^-$  reduction should be considered as a possible fate of  $\text{NO}_3^-$  in nitrogen balance studies of soil.

INTERNATIONAL SOIL CONGRESS, Edmonton, Canada, June 1978

Acetylene Inhibition and  $^{13}\text{N}$  Methods for Study of Soil Denitrification, M. Scott Smith, Mary K. Firestone, Richard B. Firestone, and James M. Tiedje, Departments of Crop and Soil Sciences and Cyclotron Laboratory, Michigan State Univ.--Acetylene inhibition of  $\text{N}_2\text{O}$  reductase and the radioactive isotope of nitrogen,  $^{13}\text{N}$ , have been used to study soil denitrification. These methods provide the advantages of excellent sensitivity and temporal resolution for the study of denitrification rates and ratios of  $\text{N}_2\text{O}/\text{N}_2$  produced. We have validated the methods by obtaining comparable denitrification rate measurements and product ratios for both. The acetylene inhibition method is sensitive enough to measure the denitrification rate of a fresh unamended aerobic soil. The ability to measure these rates during an incubation of 20 minutes or less has enabled us to observe the dynamic effects of changes in soil aeration on denitrification. Using  $^{13}\text{N}$  we have studied the factors controlling the release of the gaseous denitrification intermediates,  $\text{NO}$  and  $\text{N}_2\text{O}$ , and have shown  $\text{N}_2\text{O}$  to be freely diffusible through denitrifying cell membranes.

Assimilation of  $^{13}\text{N}_2$  and  $^{13}\text{NH}_4^+$  by Cyanobacteria, J.C. Meeks, C.P. Wolk, W. Lockau, and W.-S. Chien, Michigan State Univ.--The principal initial product of metabolism of  $^{13}\text{N}_2$  and  $^{13}\text{NH}_4^+$  by Anabaena cylindrica, Anabaena variabilis, Cylindrospermum licheniforme, Plectonema boryanum, Gloeotheca sp., and Anacystis nidulans is glutamine. Methionine sulfoximine inhibits the formation of  $^{13}\text{N}$ glutamine except in the case of Gloeotheca sp., an organism with a thick sheath through which the inhibitor may not penetrate. Thus, glutamine synthetase appears to catalyze the initial step in the assimilation of  $\text{N}_2$ -derived or exogenous  $\text{NH}_4^+$  by these organisms.  $^{13}\text{N}$ Glutamate is, in all cases, the second major product. In all of the  $\text{N}_2$ -fixing cyanobacteria studied, the fraction of  $^{13}\text{N}$  in glutamine declines and that in glutamate increases with increasing times of assimilation of  $^{13}\text{N}_2$  and  $^{13}\text{NH}_4^+$ , and (Gloeotheca again excepted) methionine sulfoximine also reduces incorporation of  $^{13}\text{N}$  into glutamate. Glutamate synthase therefore appears to catalyze the formation of glutamate in a wide range of  $\text{N}_2$ -fixing cyanobacteria. However, A. nidulans may form  $^{13}\text{N}$ glutamate principally by glutamic acid dehydrogenase. The formation of  $^{13}\text{N}$ alanine from  $^{13}\text{NH}_4^+$  appears to be catalyzed principally either by alanine dehydrogenase (as in C. licheniforme) or by a transaminase (as in A. variabilis).

INTERNATIONAL SYMPOSIUM ON HIGH-SPIN STATES AND NUCLEAR STRUCTURE, Dresden, East Germany September 19-24, 1977

High-Spin Level Structure of  $^{188}\text{Pt}$ , P.J. Daly, C.L. Dors, H. Helppi, M. Piiparinen, S.K. Saha, Purdue University and T.L. Khoo and F.M. Bernthal, Michigan State Univ.--We have previously reported<sup>1</sup> on the high-spin level systematics of Pt nuclei with A between 186 and 194. For the even-even nuclides, pronounced backbending anomalies occur which we interpreted<sup>1</sup> as arising from the intersection of the ground band by both  $(h_{11/2})_{\pi}^{-2}$  and  $(i_{13/2})_{\nu}^{-2}$  decoupled structures. Further investigation of  $^{188}\text{Pt}$  by detailed  $(\alpha,4n)$  studies has revealed some features which differ from those in the neighboring nuclides. Whereas in these other cases the decoupled structures decay to the g.s.b., rather surprisingly in  $^{188}\text{Pt}$  the same structures decay via the  $\gamma$ -band. A detailed level scheme for  $^{188}\text{Pt}$  will be presented. The main features of this scheme include the g.s.b. to spin 10, a negative parity sequence to spin 16, the  $\gamma$ -band to spin 8, an  $I^{\pi}=10^+$   $(h_{11/2})_{\pi}^{-2}$  state, and a decoupled band based on the  $(i_{13/2})_{\nu}^{-2}$  structure. Corroborative evidence for the spin assignments comes from delayed conversion electron studies.<sup>2</sup>

<sup>1</sup>M. Piiparinen, et al., Phys. Rev. Lett. 34(1975) 1110.

<sup>2</sup>H. Backe, L. Richter, S. Zeidler, et al., private communication and abstract submitted to this conference.