Bull. Am. Phys. Soc. 12, 915(1967).

TO BE SUBMITTED TO THE SEATTLE APS MEETING, AUGUST 1967

Proton Radiation Damage of Ge(Li) Detectors*. C. R. Gruhn, C. J. Maggiore, and Jagdish Chander**, Michigan State Univ.

The proton radiation damage of Ge(Li) detectors has been studied using a 42 MeV proton beam scattered from a 0.015 inch Ta target. The relative pulse height and resolution response of the detectors to the protons and gamma rays of ^{137}Cs and ^{60}Co was measured as a function of total proton flux incident upon the detector. The relative pulse heights, ε, vs total proton flux, Φ are described by the equation: $\varepsilon = 1 - K\Phi$ and where $K = 3.2 \times 10^{-12} \pm 0.8 \times 10^{-12}$ cm^2/proton. The constant, K, is observed to be the same within the quoted error for both protons and gamma rays. The resolution is observed to be more strongly dependent upon O than one would expect on the basis of statistical fluctuations in the number of collected ion pairs. A discussion of these results and of the relationship of K to both geometry and the bulk properties of the semiconductor detector will be given.

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* This work supported by the National Science Foundation.

** NSF College Research Participant.

Am. Chem. Soc. (1968).

Submitted to the Division of Nuclear Chemistry & Technology
ACS Meeting Chicago - September 1967

The Level Structure of Pb^{204} as Determined by the Decay of Bi^{204} and the $Pb^{206}(p,t)Pb^{204}$ Reaction. Wm. C. McHarris and C. R. Gruhn, Department of Chemistry, Michigan State University, East Lansing, Michigan 48823*. Bi^{204} was prepared by bombarding Pb^{206} with 28 MeV protons from the MSU Sector-Focused Cyclotron. Its decay to levels in Pb^{204} was observed with Ge(Li) gamma-ray detectors used singly and in coincidence experiments with NaI detectors and with electron detectors. States in Pb^{204} as high as 4319 keV above ground were found to be populated, and these results in more than 170 gamma transitions, the highest gamma-ray energy being 2836 keV. Gamma-ray spectroscopy, even including coincidence data, could not be relied on to yield unambiguous results for level positions in Pb^{204}, so we performed (p,t) experiments on Pb^{206}, using the raw beam of the MSU cyclotron and obtained a resolution of 70 keV. This yielded a skeleton level scheme to which we then added the high resolution spectroscopic data. We now have located some 25 levels in Pb^{204}, and more than 100 gamma-rays are placed in deexciting these levels. Comparisons are also made with shell-model calculations.

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*Supported by the National Science Foundation.

Bull. Am. Phys. Soc. 12, 1199(1967).

SUBMITTED TO THE MADISON MEETING OF THE APS, OCTOBER 1967

The $^{14}N(p,p')$ Reaction at 24.8 MeV*. S. M. Austin, W. Benenson, and G. M. Crawley**, Michigan State Univ.
The inelastic scattering of protons from ^{14}N has been studied with emphasis on transitions to the T = 1, 0^+ first excited state at 2.3 MeV. In first order only the spin-flip, isospin-flip part (V_{11}) of the effective interaction contributes to this transition. Protons from the Michigan State University Cyclotron were scattered from an N_2 gas target and detected in a solid state detector telescope. Data were taken at 10° intervals from 20° to 160°. The cross section for excitation of the 2.3 MeV state is about five times smaller than that for the corresponding transition: $^{6}Li(p,p')^{6}Li$ (3.56 MeV, $J^\pi = 0^+$, T = 1)[1]. Presumably, this effect is related to the approximate cancellation of the matrix element for the β decay of ^{14}C to the ground state of ^{14}N. This cancellation does not occur in the β decay of ^{6}He to ^{6}Li. Thus it seems unlikely this reaction will give unambiguous information about V_{11} but it may provide a sensitive test for tensor forces in the effective interaction or for admixtures of 2s-1d shell configurations in the low lying states of ^{14}N.

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* Research supported by the National Science Foundation.
** Present Address: The Australian National University, Canberra, ACT
1) S. M. Austin and G. M. Crawley, to be published.

Bull. Am. Phys. Soc. 12, 1178(1967).

SUBMITTED TO THE MADISON MEETING OF THE APS, OCTOBER 1967

Energy Dependence of Inelastic Proton Scattering to the First T = 1 State of ^{6}Li*. P. J. Locard** (introduced by S. M. Austin), S. M. Austin, W. Benenson, and G. M. Crawley, Michigan State Univ. The Michigan State University cyclotron was used to measure the energy dependence of the total cross section of $^{6}Li(p,p')^{6}Li$ to the T = 1, 3.56 MeV state. Because the gamma decay of this state is isotropic and because the state is not fed appreciably by de-excitation gamma rays, a measurement of the intensity of the gamma ray at a single angle is a measurement of the total cross section for the reaction. A 20 cc germanium detector was used at an angle of 160° with respect to the proton beam. The data were normalized to the absolute cross section at 24.4 MeV[1]. The total cross section is found to be nearly independent of energy. Only the spin-flip isospin-flip term (V_{11}) of the effective interaction enters the microscopic theory of this process. Using a V_{11} of Yukawan shape with a range of 1.0F and L-S coupling wave functions, a DWBA calculation shows that the strength required for V_{11} to fit the data varies from 11 MeV at Ep = 25 MeV to 13 MeV at Ep = 45 MeV.

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* Work supported by the National Science Foundation.

** On leave from the Centr d'Etudes Nucleaires de Grenoble, France.

1) G. M. Crawley and S. M. Austin, International Conference on Nuclear Physics, Gatlinburg, September, 1966.

Bull. Am. Phys. Soc. 12, 1047(1967).

PERFORMANCE OF A MODERN MEDIUM ENERGY CYCLOTRON

Invited Paper Presented to the
Fall Meeting of the American Physical Society
New York, New York
by

H. G. Blosser*
Michigan State University

November 19, 1967

* Supported by the National Science Foundation.

Bull. Am. Phys. Soc. 12, 1125(1967)

SUBMITTED TO PASADENA APS MEETING, DECEMBER 1967

Energy Levels of Cf^{252}*. Irshad Ahmad, P.R. Fields, Argonne National Laboratory, and Wm. C. McHarris, Michigan State University. Energy levels of Cf^{252} have been investigated by measuring the radiations associated with the electron-capture decay of Es^{252}. By following the growth of Cf^{252} in a purified Es^{252} sample, the electron-capture to alpha decay ratio has been found as 0.2. Gamma-single and gamma-K x-ray coincidence experiments reveal the presence of 102-, 139-, 785-, and 924-keV γ rays, with relative intensities of 0.07, 0.8, 1.0, and 0.2 respectively. The multipolarities of the 102-and 139-keV transitions have been determined as E2 and E1, respectively. The 785-keV γ ray is in coincidence with the 102-as well as 139-keV transition. On the basis of these results, 2 levels at 931 and 1070 keV are postulated, the upper level receiving almost all the electron-capture population. The 931-keV state de-excites to the 4+ member of the ground-state band, which in turn is depopulated by the 102-keV transition. The spin assignment to the 931- and 1070-keV state and their interpretation in terms of 2-quasi-particle states will be presented.

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*Supported by the U.S. Atomic Energy Commission and the National Science Foundation.

Bull. Am. Phys. Soc. 13, 129(1968).

SUBMITTED TO CHICAGO APS MEETING, JANUARY 1968

An N-fold Computer Controlled Coincidence Pulse Height Analysis System*. J. V. Kane, N. Dobeck, E. Dounce, and L. Harms-Ringdahl** Michigan State Univ. In order to be able to perform multiparameter analysis of nuclear reactions which emit more than two particles it is desirable to measure the number of particles simultaneously observed as a function of two or more variable parameters which are usually referred to as pulse heights. Such a system is being built at Michigan State University. The primary emphasis is upon simplicity of operation. An event detecting unit is being built which recognizes all 16 pulse coincidences which can occur for 4 detectors. A four bit register selects the coincidence event conditions; if this coincidence event occurs an interrupt signal will be sent to the MSU Sigma 7 computer. Simultaneously the appropriate pulse height information is stored in pulse stretcher circuits. The computer program can then select via a two bit code which pulse stretchers are to be read by a single analog to digital converter. The system should have a resolving time of 20 ns. and can be expanded to do N-fold coincidence experiments.

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* Work supported in part by National Science Foundation.

** Institute for Nuclear Research Stockholm, Sweden.

Instructions: This paper is the second of two papers in the same session.

Bull. Am. Phys. Soc. 13, 52(1968).

SUBMITTED TO CHICAGO APS MEETING, JANUARY 1968

A Pulse Stretcher for Nuclear Physics Pulse Height Analysis using a Computer*. J. V. Kane, N. Dobeck, and E. Dounce (introduced by J. V. Kane), Michigan State Univ. A Pulse stretcher has been designed to record and store pulse height information for analog to digital conversion by a computer system. The main goal of the design is to achieve a pulse charging time constant which is short compared with 1 microsecond and a voltage holding time constant appreciably better than 1 second. Thus pulse height information should be degraded by less than one part in 10^4 if the analog to digital conversion is performed within a time less than 100 microseconds after pulse storage. The circuit employed is based upon the diode capacitor charging circuit. A first improvement is made by including the diode capacitor circuit in the feedback loop of an integrated circuit operational amplifier. A high impedance unity gain FET operational amplifier is used to read out the voltage across the capacitor. These modifications improve the linearity and zero offset errors of the diode capactior but result in a ratio of charging to discharging time constant ratio of about 10^{-5} which is not sufficient for our purposes. A second improvement is obtained by including the FET amplifier in the feedback loop and bootstrapping the FET amplifier to the charging diode so as to reduce the back leakage across this diode. Charging times less than 1M microsecond and holding times greater than 5 seconds have been obtained.

*Work supported in part by National Science Foundation.

Instructions: This paper sould be given as the first of two papers submitted by J.V. Kane, et al., in the same session.

Bull. Am. Phys. Soc. 13, 115(1968).

SUBMITTED FOR THE CHICAGO APS MEETING, JANUARY 1968

Elastic Scattering of Protons by ^{16}O.* James L. Snelgrove (introduced by Edwin Kashy) and Edwin Kashy, Michigan State Univ. Differential cross sections for the elastic scattering of protons by ^{16}O have been measured at incident proton energies of 25.5, 32.1, 35.1, and 38.4 MeV over an angular range of 10-170° in the center of mass. Measurements are in progress at 45.2 MeV and planned for 51.7 MeV. The proton beam from the Michigan State University cyclotron was analyzed to give an energy spread of 0.08%, and focused on a natural oxygen gas target, maintained at a pressure of 30 cm. Hg. in a 5-inch gas cell. Scattered particles were detected with a CsI(Tl) scintillation counter. The bombarding energies were chosen as convenient for studying the extraction of spectroscopic factors for the $^{16}O(p,d)^{15}O$ reaction. The differential cross section at the second maximum (50-60°) was measured over an energy range of $\pm$300 keV around the bombarding energy, and no significant fluctuations were found. The data has been compared to that of Cameron[1] and has been found to be in good agreement. Optical model fits are being made and will be shown with the data.

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*Supported in part by the National Science Foundation.

[1]J. M. Cameron, UCLA Technical Report No. P-80 (1967).

Bull. Am. Phys. Soc. 13, 85(1968).

TO BE SUBMITTED TO THE CHICAGO APS MEETING, JANUARY 1968

M2 Isomerism in ^{83}Rb and High Resolution Spectroscopic Investigations of the Decay of ^{83}Sr.* R. C. Etherton** (Introduced by W. H. Kelly), L. M. Beyer** and W. H. Kelly, Michigan State University, and D. J. Horen, U.S. Naval Radiological Defence Laboratory. The photon spectrum accompanying the electron capture decay of ^{83}Sr has been studied with high resolution Ge(Li) spectrometers in singles and coincidence configurations. The positron and internal conversion electron spectra were investigated with the MSU "orange" and $\pi\sqrt{2}$ iron free electron spectrometers. Sixty transitions were identified. Excited states have been placed in ^{83}Rb at 5.0, 42.3, 295.2, 389.2, 423.5, 736.8, 804.8, 994.2, 1043.7, 1053.7, 1103.0, 1202.0, 1242.6, 1273.1, 1324.6, 1653.1, 1756.9, 1783.5, 1916.7, 1952.2, 2014.8, 2090.0, 2147.8, and 2179.3 keV. Internal conversion coefficients, log ft, and gamma ray branching have been used to place limits upon the spins and parities of the excited states. An isomeric M2 transisition of 42.3 keV has been identified. The ground state spin and parity of ^{83}Sr have been shown to be $7/2^+$ which are the same as for all other known 45 neutron nuclei.

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

** Present Address: Department of Physics and Astronomy, Murray State University, Murray, Kentucky.

Bull. Am. Phys. Soc. 13, 85(1968).

TO BE SUBMITTED FOR THE CHICAGO APS MEETING, JANUARY 1968

Direct (p,α) Reactions on Several Nuclei in the 2s-1d Shell.* G. H. Mackenzie (introduced by R. A. Atneosen) and R. A. Atneosen, Michigan State Univ. The direct (p,α) reaction has been investigated for the target nuclei ^{23}Na, ^{31}P, ^{32}S, and ^{40}Ar. In each case the proton bombarding energy was selected to yield outgoing alpha particles of 36 MeV(c.m.) for the ground-state transition. Differential cross sections were measured for transitions leading to the ground states and several excited states over an angular range from 7.5° or less to more than 80°. The distributions were taken with a two-counter array of 1000-μ surface-barrier detectors, except at forward angles where a counter telescope was used to reduce background. The overall energy resolution varied from 90 to 200 keV depending upon the experimental arrangement. Examples of pure $\ell = 0$ and $\ell = 2$ orbital angular momentum transfers have been observed for several nuclei. Definite j-dependence has been observed for the $\ell = 2$ ($j^\pi = 3/2^+, 5/2^+$) transfer in ^{32}S and, less directly, in ^{31}P. In addition, new levels have been seen in Cl^{37} at 4.02, 4.24, 4.77 and 5.92 MeV with errors of $\pm$0.02 MeV and some prominent peaks occur higher in the spectrum at about 10.2, 11.5, and 12.3 MeV. The level at 4.77 MeV is the strongest one observed in Cl^{37} and has an angular distribution similar to other $\ell = 2$, $j^\pi = 3/2^+, 5/2^+$ transfers.

*Work supported in part by the National Science Foundation.

ANZASS Congress, Christchurch, New Zealand, 24-31 January, 1968

"ANALYSIS OF 25 MeV INELASTIC PROTON SCATTERING ON 1 p SHELL NUCLEI"*

G. M. Crawley**, S. M. Austin and W. Benenson
Michigan State University, East Lansing, Michigan

Inelastic scattering from a number of 1 p shell nuclei has been studied using 25 MeV protons from the Michigan State Sector focussed cyclotron. The scattered protons were detected using solid state counters and the overall resolution obtained was about 100 keV. The data has been analysed using a microscopic model of both the interaction and the nuclear wave functions. A comparison of the ^{6}Li, ^{14}N data is presented since these nuclei can be treated as either 2 particles or 2 holes in the 1p shell. Particular reference is made to the excitation of the 0^+ T = 1 states which results from the $(\sigma_1 \cdot \sigma_2)(\tau_1 \cdot \tau_2)$ term in the interaction. The coefficient of this interaction has also been studied as a function of energy using the (pp'γ) reaction up to 52 MeV.

* Supported in part by the National Science Foundation
** Present Address - Australian National University
Canberra, Australia

TO BE SUBMITTED AS A COMTRIBUTED PAPER TO THE ELEVENTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM

Lithium-Drifted Germanium for Charged Particle Spectroscopy*. C. R. Gruhn, T. Kuo, C. Maggiore, B. Preedom, L. Samuelson, and J. Chander**, Michigan State Univ. The Michigan State University Cyclotron Laboratory has undertaken a program of developing lithium-drifted germanium for high-resolution charged particle spectroscopy. The charged particle spectroscopy has been concerned with reactions leading to protons, deuterons, and tritons in the energy range of 25 to 90 MeV. The emphasis of this program has been two-fold in that both the response of the detector and the packaging of the detector are considered. The response of the Ge(Li) detector includes the resolution capabilities of both side entry and normal entry detectors, radiation damage of the detector by protons, effects of internally induced reactions on the response of the detector, and multiple scattering within the detector. Also, the particle identification capabilities of a single-crystal Ge(Li) detector have been studied in lieu of applications to 76 MeV He^3 induced reactions. The packaging of the Ge(Li) detector has been studied with emphasis being placed on the problem of convenience for application in nuclear scattering experiments. A general discussion of the results of this program will be presented.

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* Work supported in part by the National Science Foundation.

** National Science Foundation College Research Participant, visiting from Wisconsin State College at Stevens Point, Wisconsin.

Bull. Am. Phys. Soc. 13, 631(1968).

SUBMITTED FOR THE WASHINGTON APS MEETING, APRIL 1968

Proton Spin Flip in the Reaction $^{12}C(p,p')^{12}C^*$ (4.44 MeV).** J. J. Kolata and A. Galonsky, Michigan State University. Spin-flip Probability in the reaction $^{12}C(p,p')^{12}C^*$ (4.44 MeV) has been measured at 24.5 and 42.0 MeV incident proton energy, using the method of Schmidt et.al.[1]. Elastic cross section and polarization, and inelastic cross section and asymmetry data are available at these two energies. The elastic data have been analyzed to yield optical model parameters, which were then used to calculate the inelastic scattering in the DWBA. Fits obtained to these and other spin-flip data will be presented. Preliminary results indicate that DWBA calculations with optical model parameters so obtained can give qualitative fits to spin flip. The predictions display a marked sensitivity to the parameters of the L·S term in the optical potential, while the interaction which produces the excited state contributes little. It would seem, then, that proton spin-flip could be an effective probe for the spin-orbit parameters of the optical model.

** Work supported in part by the National Science Foundation.

1) F. H. Schmidt, R. E. Brown, J. B. Gerhart and W. A. Kolasinski. Nucl. Phys. 52, 353 (1964).

Bull. Am. Phys. Soc. 13, 625(1968).

SUBMITTED FOR THE APS WASHINGTON MEETING 1968

High Resolution Gamma-Ray Spectroscopic Studies of the Decays of 2.6-Hour Nd^{141g} and 60-Second Nd^{141m}.* D. B. Beery (introduced by Wm. C. McHarris), Wm. C. McHarris, and W. H. Kelly,** Michigan State University. Gamma-rays emitted in the decays of Nd^{141m} have been investiaged with Ge(Li) and NaI(Tl) detectors. Gamma-rays accompanying the decay of Nd^{141g} having energies (and relative intensities) 145.4 (30.3), 981.3 (3.0), 1126.8 (≡100), 1147.1 (38.2), 1292.8 (61.2), 1298.7 (16.3), 1434.6 (3.0), 1579.9 (0.74), 1607.9 (2.3), and 1657.2 (0.12) keV have been observed. On the basis of coincidence and anti-coincidence experiments, energy sums, and relative intensities, states were placed in Pr^{141} at 0 (5/2+), 145.43 (7/2+), 1126.8 (3/2+), 1292.5 (5/2+), 1298.4 (3/2+ or 1/2+), 1580.0 (5/2+), 1607.9 (3/2+ or 1/2+), and 1657.2 (3/2+ or 1/2+) keV, the spin and parity assignments for the upper six being tentative. The limits on these spin assingments are based on the log ft values and relative photon intensities. An upper limit of 0.1% of the intensity of the 756.5-keV isomeric γ-ray was placed on the intensity of any other γ-ray of energy between 130 and 2600 keV following direct transitions from the $11/2^-$ Nd^{141m} to high spin states of Pr^{141} or lower-energy states in Nd^{141}.

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

** At present on leave to Lawrence Rad. Lab., Berkeley, California

Bull. Am. Phys. Soc. 13, 700(1968).

(This should immediately precede "A Progress Report on System JANUS" by P. J. Plauger and J. O. Kopf.)

SUBMITTED FOR THE APS WASHINGTON MEETING, APRIL 1968

JANUS - A Computer Operating System for Time Sharing and Nuclear Data Acquisition.* J. O. Kopf (introduced by A. Galonsky) and P. J. Plauger, Michigan State University. JANUS has been designed to take maximum advantage of the resources available in the SDS Sigma 7 computer at the MSU Cyclotron Laboratory. A 3072 word resident cycles around a ring of "tasks" which may be batch processing monitors, on-line data analysis routines, or control programs for data taking real-time routines. During its 0.1 second time slice, a task might obtain permission from the resident to use an external interrupt, dedicate a real-time routine in memory and connect it to the interrupt. The real-time process is thus promoted to a hard-wired priority that is higher than all supervisory functions, including input-output. Eight external interrupts and a direct I/O interface are available for on-line data acquisition and control. Mapping and access-protect hardware permit time-shared tasks: 1) to use all non-dedicated memory, 2) to minimize swapping between memory and the 1.47 M byte RAD, and 3) to use up to 131,072 words of virtual memory in a 16,384 word (or smaller) machine. We believe that JANUS is unique in its extreme decentralization and extraordinary lack of constraints.

*Supported in part by the Nationsl Science Foundation.

Bull. Am. Phys. Soc. 13, 701(1968).

(This should immediately follow "JANUS - a Computer Operating System for Time Sharing and Nuclear Data Acquisition" by J. O. Kopf and P. J. Plauger.)

SUBMITTED FOR THE WASHINGTON APS MEETING, APRIL 1968

A Progress Report on System JANUS.* P. J. Plauger and J. O. Kopf, Michigan State University. The current status of JANUS as it is being used at the MSU Cyclotron Laboraotry is discussed. Total data taking capability is 30,000 events per second on the SDS Sigma 7 Computer, without any special-purpose hardware. One CRT display is available at present. A number of data acquisition codes operating within these constraints is described. The advantages of not relying on a special-purpose, centralized acquisition scheme are also investigated. Routines for concurrent data acquisition and analysis and particular configurations presently used in nuclear physics experiments will be described.

*Supported in part by the National Science Foundation.

Bull. Am. Phys. Soc. 13, 674(1968).

SUBMITTED FOR THE APS WASHINGTON MEETING, APRIL 1968

Inelastic Scattering of Protons from ^{28}Si at 24.9 MeV.*

P. J. Locard** (introduced by Sam. M. Austin), Walter Benenson and Sam M. Austin, Michigan State University. In this experiment, protons from the Michigan State University Cyclotron bombarded a 840 $\mu g/cm^2$ ^{28}Si target enriched to about 99%. The scattered protons were detected with a dE/dx-E silicon counter telescope. The overall energy resolution ranged from 45 to 70 keV. Data were taken every 5 degrees between 7.5 and 160 degrees. Angular distributions were obtained for the strongly excited states at 1.77 MeV (2+), 4.61 MeV (4+), 4.97 MeV (0+) and 6.27 MeV (3+). The states at 6.69 MeV (0+), 7.80 MeV (3+) and 7.93 MeV (2+) are weakly excited. The unresolved doublets at 6.88 and 7.40 MeV are also strongly excited. A DWBA analysis using a collective form factor is now being performed for the three first excited states. Comparison of our results with a Hartree-Fock calculation[1] on ^{28}Si shows that the first four states which are strongly excited correspond to oblate configuration (the same as that of the ground state), whereas the 0+ state at 6.69 MeV which is weakly excited corresponds to a prolate configuration.

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* Reserach supported in part by the National Science Foundation

** On leave from the Centre d'Etudes Nucleaires de Grenoble, France.

1) S. Das Gupta and M. Harvey Nucl. Phy. A96 (1967) 602.

Bull. Am. Phys. Soc. 13, 630(1968).

SUBMITTED FOR THE WASHINGTON APS MEETING, APRIL 1968

A Study of the $^{16}O(p,d)^{15}O$ Reaction.* James L. Snelgrove and Edwin Kashy, Michigan State University. Energy spectra and angular distributions of deuterons from the $^{16}O(p,d)^{15}O$ reaction have been measured for several incident proton energies between 21 and 46 MeV. The motivation for this work was to obtain a check on the consistency and reliability of the extraction of spectroscopic factors in this reaction. The proton beam from the Michigan State University cyclotron was analyzed to give an energy spread of 0.08%, and focused on a natural oxygen gas target, maintained at a pressure of 30 cm. Hg. in a 5-inch gas cell, with a ΔE-E counter telescope used for particle identification. DWBA calculations are being performed using the Oak Ridge code JULIE, and spectroscoic factors are being extracted for the ground ($1/2^-$) and 6.18 ($3/2^-$) MeV levels of ^{15}O. In addition to the dueteron groups corresponding to states in ^{15}O at 0.0, 5.19-5.24 (unresolved doublet) and 6.18 MeV, twelve other deuteron groups have been observed below 14 MeV excitation.

*Supported in part by the National Science Foundation.

Bull. Am. Phys. Soc. 13, 701(1968).

SUBMITTED FOR THE APS WASHINGTON MEETING, APRIL 1968

A High Precision Goniometer for Charged Particle Spectroscopy.* K. M. Thompson (introduced by C. R. Gruhn) and C. R. Gruhn, Michigan State University. A general purpose four-foot radius goniometer has been constructed and is now being tested. The primary purpose of the apparatus is to provide a precise means of measuring scattering angles and a system compatible with existing packaging techniques for Ge(Li) detectors to be used in charged particle spectroscopy. The core of the goniometer is an 8-inch diameter column which is bolted onto a motor driven rotary table. At the top of the column is a rigidly fastened 4-foot radius counter balanced arm capable of supporting 100 pounds at 4 feet while giving an angular accuracy of $\pm$0.02 degrees. The Ge(Li) detector package views a target in an evacuated 4-inch radius chamber with no windows. This is accomplished by coupling the detector package to the target chamber by means of a sliding seal. The target chamber has a three target ladder and target transfer vacuum lock. The targets can be positioned to within 0.1 degree angular accuracy and 0.001 inch verticle position accuracy. A discussion of the design and results of preliminary tests will be given.

*Supported in part by the National Science Foundation.

Bull. Am. Phys. Soc. 13, 577(1968).

Energy Dependence of Spin-Isospin Interaction

Invited Paper Presented to the
Spring Meeting of the American Physical Society
Washington, D.C.

by
S. M. Austin
Michigan State University

April 1968

*Supported by the National Science Foundation.

Submitted to the Division of Nuclear Chemistry and Technology
ACS Meeting - April 1968

The Electron Capture Decay of Gd^{149}. Richard E. Eppley and Wm. C. McHarris, Michigan State University, East Lansing, Michigan 48823*. Levels in Eu^{149}, which lies in the transition region between well-defined single-particle states and collective states, were studied by observing the electron capture decay of 9.4-day Gd^{149}. The Gd^{149} was prepared by the $Eu^{151}(p,3n)Gd^{149}$ reaction, using 25 MeV protons from the MSU Sector-Focused Cyclotron. Both natural europium and separated isotope Eu^{151} were used as targets; the gadolinium was separated from the target by reducing the europium to Eu^{++} with zinc dust and then precipitating the europium as $EuSO_4$. The gamma rays from the Gd^{149} decay were studied with Ge(Li) detectors used singly and in coincidence and anti-coincidence combinations with NaI(Tl) detectors and with electron detectors. The electrons were studied with a six-sector magnetic spectrometer, with silicon detectors, and with a specially constructed Ge(Li) "conversion-coefficient" spectrometer. Twenty-three gamma transitions were found, having the following energies (and respective intensities): 149.6(≡100), 214.5(0.30), 252.3(0.61), 260.5(2.5), 272.0(6.6), 298.5(54), 346.5(49), 405.5(2.2), 459.9(1.3), 478.7(0.33), 496.4(3.3), 516.4(5.0), 534.2(6.2), 645.2(2.9), 661.7(0.3), 665.7(1.8), 748.2(16), 788.6(16), 812.4(0.33)

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

875.8(0.30), 933.3 and 939.1(5.9), and 947.7 keV (1.7). On the basis of sums, coincidences, and anti-coincidences, some eighteen of these have been placed, involving eleven levels in Eu^{149}. Since the resulting level scheme differs somewhat from previous Eu^{149} level schemes, it is presently being confirmed by more exhaustive coincidence studies.

Bull. Am. Phys. Soc. 13, 882(1968).

SUBMITTED FOR THE LOS ALAMOS APS MEETING, JUNE 1968

Light Elements from Proton Spallation of Carbon at 42 MeV*

Cary N. Davids and Sam M. Austin, Michigan State University.

Spallation fragments have been observed from the bombardment of a thin (~ 75μg/cm^2) carbon target by 42 MeV protons from the Michigan State University Isochronous Cyclotron. Ions with masses between 6 and 12 have been separated, using a thin semiconductor detector to furnish both energy (E) and time-of-flight (t) information. The fragment mass is proportional to the quantity Et^2, which is obtained by on-line digital multiplication. Particles were observed with energies from about 1 MeV to the kinematic limit of 18 MeV. The lower limit is presently imposed by the 53 ns interval between beam pulses. The time resolution was less than 1 ns fwhm, enabling the different mass groups to be separated over the entire energy range. Ions present include ^{12}N, $^{12,11,10}C$, $^{11,10,8}B$, $^{9,7}Be$, $^{7,6}Li$. Mass-yield curves will be presented, as well as energy spectra of the various masses.

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*Research supported in part by the National Science Foundation.