Section II
Abstracts of Talks at Meetings
July 1970–June 1971
Neutron Yields from Proton Bombardment of Thick Targets—W. Atwood, A. Galonsky, and K. Jolly, M.I.T. State Univ.—Stopping targets of natural C, Al, Cu, Ta, and Pb were bombarded by 18 and 20 MeV protons. The resultant neutron spectra were measured at laboratory angles of 0, 30, 60, 90, 120, and 150 degrees by a 7 naus/meter neutron time-of-flight spectrometer for neutron energies above 2 MeV. Preliminary analysis of the data indicates the following results for the energy- and angle-integrated yields:

Neutrons/Proton
Target 30 MeV 40 MeV
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C \(0.04\) \(0.02\)
Al \(0.02\) \(0.04\)
Cu \(0.03\) \(0.07\)
Fe \(0.02\) \(0.07\)
Pb \(0.05\) \(0.07\)

Neutron time-of-flight spectra, energy spectra, angular distributions, and total yields will be presented and discussed.

Work supported by the National Science Foundation.

Ultra-High Resolution Spectrometer System for Charged Particle Studies of Nuclei—H. L. Bloch, C. H. Grimes, R. G. Morris, E. Kashey, and B. H. Wilkenthal, M.I.T. State Univ.—This paper describes an arrangement for introducing feedback into a charged particle magnetic analysis system for nuclear reaction studies. In initial tests of the system, it was found that the system has been obtained in (p,p') studies at 30 MeV with the cyclotron internal beam on target. This corresponds to a resolving power p/d of 12,000. Essential features of the system, in addition to the feedback, are a careful design of the cyclotron source by means of internal slits and the use of dispersion matching to cancel the effect of coherent on-target energy spread.

Work supported by the National Science Foundation.

Proton Spin-Flip in C(p,p') Reaction on \(^{139}\)Sn and \(^{140}\)Sn—W. H. Howell, R. H. Kehl, and A. Galonsky, M.I.T. State Univ.—The angular distributions for proton spin-flip in the excitation of the first 2p state in \(^{140}\)Sn and \(^{139}\)Sn are being studied at 30 MeV. The technique requires measuring the \(g-p\) angular correlation function at 90 degrees from the scattering plane. Coincidence particle-particle spectra were recorded in a live time, two parameter array with the single-particle spectrum stored separately by a computer. Measurements have been made from 90 degrees to 150 degrees. The angular distribution showed a typical shape with small forward-angle values and a peak at back angles. Values ranged from 0.0011 ± 0.0013 at 30 degrees to 2.0 ± 0.1 at 120 degrees for \(^{139}\)Sn and from 0.0011 ± 0.0013 at 30 degrees to 2.0 ± 0.1 at 150 degrees for \(^{140}\)Sn. These values do not include corrections ranging between -0.1 and -0.2 for finite solid angles. The integrated spin-flip probability is \(4.31 \pm 0.04\) for \(^{139}\)Sn and \(6.61 \pm 0.04\) for \(^{140}\)Sn.

Supported by the National Science Foundation.
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The decay of 11.7-h Bi$^{214}$ has been investigated with high-resolution Ge(Li) detector systems. The Bi$^{214}$ sources were prepared by the Penning trap reaction, using a 40 MeV proton beam from the Michigan State Isochronous Cyclotron and the 2-dimensional n-p pulse shape discrimination will be achieved. The TOF spectrum was stabilized by a zero level ADC stabilizer locked on the target gamma-ray peak.

Supported by the National Science Foundation.

Electron Capture Decay Scheme of Bi$^{214}$ ...

The °(p, n) Reaction on 23Na§ and 23Mg§ at 1.0 MeV

J.B. REH[ ] and G.M. SAVIN, Oak Ridge Nat. Lab. We have studied the °(p, n) reaction on 23Na§ and 23Mg§ at 1.0 MeV. Angular distributions were taken between 0° and 150° using a 20° at 1.0 MeV and 0° at 1.0 MeV. The angular distributions are quite different. A comparison of the experimental angular distributions with microscopic DWBA calculations will be made.

Supported by the National Science Foundation.


Shell-Model Calculations for Nuclei with A=24-29. H.R. WILDE[ ] and H.R. WILDE[ ], Mich. State Univ. and F.E. MCMH[ ], Oak Ridge Nat. Lab. We have extended our previous calculations for A=18-22, made in the complete sd-shell configuration space, to °, °, and °. The approach has been to limit the population of the d5/2 orbit to no more than two particles and to limit the number of d5/2 holes to no more than four. The Hamiltonian we have used in these calculations was obtained by diagonalizing the one-body matrix elements so as to improve the agreement between model and observed energy levels for A=18-22. The predictions obtained for A=23 and 24 with this approach are very encouraging. Spectra and transition strengths will be presented. Analogous treatments of ° and ° are less successful. Further calculations for the A=25-29 region will also be discussed.

Supported by the National Science Foundation.


The ^17Ne(p, n)^17F Reaction

P.E. HALL[ ], M. MAB[ ], and J.A. STEIGLITZ, Brookhaven Nat. Lab. The 17Ne(p, n)^17F reaction has been studied over the energy range 2-15 MeV. Angular distributions were taken over the range 0° to 120°. The angular distributions are quite different. A comparison of the experimental angular distributions with microscopic DWBA calculations will be made.

Supported by the U.S. National Atomic Energy Commission.


The °(p, t) Spectra of °, °, and °. H.R. WILDE[ ], Mich. State Univ. and F.E. MCMH[ ], Oak Ridge Nat. Lab. The °(p, t) reaction on °, °, and ° were measured at incident proton energy of 60 MeV and lab observation angle of 20° using a wide range of magnetic spectrometer. The proton beam, accelerated from the MSU Sector Focused Cyclotron, was analyzed to give an energy spread of ±0.06% and focused on 400 µcm2 metallic foils of the above target material. The scattered tritons were detected using both a 3 cm Si position sensitive detector and photographic plates. The resulting spectra are all characterized by strong collective excitations of the residual nuclei. In particular, it is found that members of the ground state rotational band up to 6 spin units above the band head are strongly excited by this reaction.

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


The °(p, t) Reaction on ° and °. H.R. WILDE[ ] and H.R. WILDE[ ], Mich. State Univ. and F.E. MCMH[ ], Oak Ridge Nat. Lab. The °(p, t) reaction on ° and ° was measured at incident proton energy of 60 MeV and lab observation angle of 20° using a wide range of magnetic spectrometer. The proton beam, accelerated from the MSU Sector Focused Cyclotron, was analyzed to give an energy spread of ±0.06% and focused on 400 µcm2 metallic foils of the above target material. The scattered tritons were detected using both a 3 cm Si position sensitive detector and photographic plates. The resulting spectra are all characterized by strong collective excitations of the residual nuclei. In particular, it is found that members of the ground state rotational band up to 6 spin units above the band head are strongly excited by this reaction.

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


The °(p, t) Reaction on ° and °. H.R. WILDE[ ] and H.R. WILDE[ ], Mich. State Univ. and F.E. MCMH[ ], Oak Ridge Nat. Lab. The °(p, t) reaction on ° and ° was measured at incident proton energy of 60 MeV and lab observation angle of 20° using a wide range of magnetic spectrometer. The proton beam, accelerated from the MSU Sector Focused Cyclotron, was analyzed to give an energy spread of ±0.06% and focused on 400 µcm2 metallic foils of the above target material. The scattered tritons were detected using both a 3 cm Si position sensitive detector and photographic plates. The resulting spectra are all characterized by strong collective excitations of the residual nuclei. In particular, it is found that members of the ground state rotational band up to 6 spin units above the band head are strongly excited by this reaction.

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

Isotropic Yields of Masses 6 to 11 from Proton Spallation of $^{13}N$ in the Energy Range 7 to 27 MeV. J. H. LAMBEH, H. H. HANSS, and E. M. AUTHEN, Mich. State Univ.—Time-of-flight methods were used to measure masses of reaction products stopped in a silicon surface-barrier detector. A gas cell with total exit area density 50-150 g/cm$^2$ contained the $^{13}N$. Total cross-sections were obtained by integrating angular distributions. The ratio mass 7/8, 7/8, 8/7, and 8/8, to 10 at 21.7 MeV. Mass 10/11 is 1.5 at 24 MeV, 3.2 at 26 MeV, and 0.25 at 17 MeV. The importance of the light elements Li, Be, and B will be discussed.

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

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Internal Conversion Studies of the 2.3 keV Transition from the Electron Capture Decay of $^{151}$Tb. W. E. JOHNSON, W. C. MOORES, W. C. MARSHALL, and W. H. KELLY, Mich. State Univ. The internal conversion electron spectrum for the 2.3 keV transition in Pb has been measured using the MgK$_x$ x-ray spectrometer. This transition had never been directly observed before. The work was generally accepted to be an E2 transition from the $^{151}$Tb$^+$ to the ground state. It was observed in the internal conversion to the first excited state of $^{151}$Tb. The total cross-sections were obtained by integrating angular distributions. The ratio mass 7/8, 7/8, 8/7, and 8/8, to 10 at 21.7 MeV. Mass 10/11 is 1.5 at 24 MeV, 3.2 at 26 MeV, and 0.25 at 17 MeV. The importance of the light elements Li, Be, and B will be discussed.

Work supported in part by the U.S. National Science Foundation, and the U.S. Atomic Energy Commission.

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Decay of $^{114}$Sm. R. R. TOWN, E. C. TUPPLEY, W. H. KELLY, W. C. MARSHALL, and R. A. MARKER, Mich. State Univ.—The decay of $^{114}$Sm (22.1 m half-life) has been studied with Ge(Li) spectrometers using sources primarily prepared by the $^{114}$Ba$(n, 4n)^{114}$Sm reaction. The energies and relative intensities of all 31 y-rays in the decay have been determined. The level scheme has been established by means of y-y coincidence experiments, resulting in the placement of 15 levels and the determination of a 62.6 keV delayed isomeric transition in the daughter Pb. We have identified 6, possibly 7 states belonging to a three quasi-particle multiplet of high spin states with low log ft values between 5.7 and 6.9. Some data will also be presented concerning the decay of $^{114}$E.

Work supported in part by the U.S. National Science Foundation and the U.S. Atomic Energy Commission.

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Inelastic Proton Scattering on Nu$^2$ nuclei. D. LABORO, P. E. EDWARDS, B. A. WISEMAN, and R. N. FOX, Mich. State Univ.—High resolution spectra and angular distributions from $^{16}$O to $^{82}$Sr have been measured for $^{16}$O and $^{18}$O, as part of a study of proton inelastic scattering from nuclei with $^2$ neutrons, 30 MeV on nuclei from the $^4$He$^2$+$^4$He sector. The Sektor-focused Cyclotron in conjunction with the Inge spin pole spectrometer and associated equipment enable us to obtain resolutions of better than 10 keV. The results will be compared with existing data and gamma-ray data and also with each other, the latter comparison in order to delineate the effects produced by the addition of six protons between $^8$O and $^{36}$Sr. Comments will be made as to the nature of the states excited via x-ray predictions of shell-model calculations.

Supported by the National Science Foundation.

H.G. Blosser, et al. (to be published).

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Meson Modes of Lithium and Boron in Silicon. P. S. MIZRAHY, C. S. KAPAL, and C. M. GRON, Mich. State Univ.—Inelastic studies of local vibrational modes of 8.doped Si samples have been made. The temperature dependence of the exciton centroid and the exciton emission lines have been extended. Uniaxial stress was applied and an attempt to break up the local modes degeneracies, thereby, accentuating a 3-fold degeneracy has been successful. The free interstitial Li local mode has turned out to be unproductive.

Work supported in part by NASA and NSF.

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The Elastic Scattering at 70 MeV on $^{40}$Ca and $^{40}$Ca. M. A. HOFMANN, R. E. DORING, and A. G. CASSIDY, Mich. State Univ.—We have begun a study of the elastic scattering of $^{40}$Ca and $^{40}$Ca on the nuclei at 70 MeV by examining the nuclei $^{40}$Ca and $^{40}$Ca. Angular distributions were taken from 3° to 120° with detector telescopes. One particularly interesting feature of the data is that the ratio at 120° and greater than 100° of smooth lines at angles less than those used in the present paper. Optical model calculations were not able to fit both data and shape of the data. The fast data, provided additional information on possible target spin dependences in $^{40}$Ca elastic scattering.

Supported by the National Science Foundation.


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Inelastic Proton Scattering on Nu$^2$ nuclei. D. LABORO, P. E. EDWARDS, B. A. WISEMAN, and R. N. FOX, Mich. State Univ.—High resolution spectra of 10° to 80° have been measured for $^{16}$O and $^{18}$O, as part of a study of proton inelastic scattering from nuclei with $^2$ neutrons, 30 MeV on nuclei from the $^4$He$^2$+$^4$He sector. The Sektor-focused Cyclotron in conjunction with the Inge spin pole spectrometer and associated equipment enable us to obtain resolutions of better than 10 keV. The results will be compared with existing data and gamma-ray data and also with each other, the latter comparison in order to delineate the effects produced by the addition of six protons between $^8$O and $^{36}$Sr. Comments will be made as to the nature of the states excited via x-ray predictions of shell-model calculations.

Supported by the National Science Foundation.

H.G. Blosser, et al. (to be published).
Asymmetry in the Inelastic Scattering of 86 MeV Protons from ^3He and ^4He. M. GUETTARD and P.J. LOCKAR. IND. Grenoble, France and I-L. ESCORLE and J.H. MOSS. CEM Saclay, France. Polarized protons of 45.5 MeV from the Grenoble Cyclotron were used. The asymmetry in inelastic scattering from ^3He and ^4He is measured using a quadrupole triplate and a cm lithium drifted silicon detector. Resolution of 50 keV permitted observation of the ground plus lowest 2, 3, 4, and 5 states in ^3He and the ground plus lowest 2, 3, 4, and 5 states in ^4He from 5 to 170 MeV. Distorted wave calculations were made for ^3He using UCLA optical model parameters. The small almost isotropic polarization of the unnatural parity 2 state is fairly well given by the microscopic model. For the 1- and 3-state the microscopic model fits poorly. The 2+ states fit is good using a full Thomas form for the distorted spin orbit force.

Present Address: Mich. State Univ.

Inelastic Proton Scattering from ^3He at Bombarding Energies from 28.6 to 46.1 MeV. L. BAYER, L.M. PROCTOR, and F.L. THOMPSON. Mich. State Univ.—Position sensitive detectors on the focal plane of an Enge split pole spectrograph have been used to obtain angular distributions from 10° to 160° for the doublet of states at 6.05 MeV (6.03 and 6.13 MeV) and the doublet of states at 7.12 MeV (7.10 and 7.14 MeV). The cross sections for exciting these states have been analyzed within the framework of the macroscopic collective model and the microscopic model with realistic forces. In the microscopic calculations inelastic electron scattering data was used as a guide in constructing the necessary transition densities.

Supported by the National Science Foundation.

Shapes of (^3He, t) Angular Distributions to Tc States in ^4He. R.A. HIRNICH, Mich. State Univ.—In most (^3He, t) reactions, while the magnitude of the calculated cross-section is dependent upon the form of the radial integral, the shape is primarily dominated by the angular momentum terms. In the case of angular distributions to 0° anti-parallel states there is a non-allowed L1 state. In the case of the 14°(^3He, t) reaction to Tc states in ^4He to look for this effect when more than one L value is allowed. Angular distributions at 33 MeV were taken between 12° and 40° using an Enge split-pole spectrograph. The angular distributions for the 2°/2 state are 0°/2 at 1.740 and 1.806 MeV have predominately non-allowed L=1 shapes. The angular distributions for Tc states with spins other than the spin of the target could not be fitted with allowed L transfers and showed shapes composed of both even and odd L values.

Supported by the National Science Foundation.


Decay of ^5He. J.F. YAPF, R.R. TULL, R.A. WAPCER, W.H. MEYER, and W.C. McKNIGHT, Mich. State Univ. —The decay of ^5He has been studied with Ge(\alpha) detectors using sources prepared by the reaction Md(\alpha, \alpha)Pm. Nearly 50 transitions belonging to the decay of ^5He have been identified on the basis of half-life, and a level scheme has been proposed incorporating more than 30 of these transitions. Various coincidence experiments have so far resulted in the placement of levels at 72.8, 76.7, 77.3, 98, 114, 3, 156.8, 156.6, 156.4, 76, 156.7, 156.4, etc. Spin assignments made from log ft values are compared with results from studies of charged particle reactions populating states in ^4He.

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

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Determination of Trace Elements in Samples by Nuclear Scattering and Reaction Techniques. R.K. Jolly, C.M. Crowe, and W.C. McKnight. Mich. State Univ.—The feasibility of using low energy (13-25 MeV) \alpha-particles scattering for detecting traces of heavy elements in a bulk of light elements is demonstrated. The sensitivity of the method is such that quantities as low as 10 ng of a specific element can be accurately counted. The instrument is economical and the source is easily available. The low energy scattering technique is not only applicable in the field but is extremely useful in the laboratory. The technique can be incorporated into the process of elemental analysis of samples containing light elements and heavy elements of trace concentration.

Supported by the National Science Foundation.

Inelastic Scattering of Protons from ^28Si and the Effective Two-Body Interaction. W.H. Austin, F.J. Locard, Mich. State Univ. D.L. Runker, J.H. Cameron, J. F. Richardson, and J.M. Verba, UCLA, W.H. Van Oers, Univ. of Manitoba. Cross sections for the reaction ^28Si(\alpha,\alpha) ^28Si in its 2°/2 state were determined at 6.05 MeV and 6.14(°) +0.10(°) doublet (dominated by 3°) have been measured at 23°, 24°, 25°, 27°, 30°, 35°, 40°, 45°, 50°, and 55°. Compound nucleus effects are evident below 30 MeV but the cross sections vary monotonically at higher energies. In the direct distorted wave approximation with central forces, the 3°/2 transition can occur only through the term M2 in the effective interaction, while the 2°/2 transition is dominated by the spin-isospin independent term M2. Strengths of M2 and M2 were determined by fitting the cross sections with real interactions of the form M2 e^2 M2 and e^2 M2.

Supported by the National Science Foundation.