

SECTION II

ABSTRACTS AND/OR TITLES OF TALKS AT  
AMERICAN PHYSICAL SOCIETY MEETINGS  
AND  
OTHER MEETINGS AND CONFERENCES

(JULY 1979-JUNE 1980)

Coulomb Effects in Pion Production Above and Below the Nucleon-Nucleon Threshold.\* WALTER BENENSON, Cyclotron Laboratory and Physics Department, Mich. State Univ., E. Lansing, MI.--Positive and negative pion production at  $0^\circ$  has been measured with the LBL Bevalac at five beam energies per nucleon from 125 MeV/u to 400 MeV/u.<sup>1</sup> This range includes both the free nucleon-nucleon and nucleon-nucleus thresholds and was expected to be a favorable one for the observation of collective effects. The cross section rises more than four orders of magnitude over this range but is quite well represented as a sum of thermal plus first-collision, Fermi-motion production. Hence, there is no evidence of collective effects in the data. A very large enhancement of  $\pi^+$  to  $\pi^0$  ( $\approx 10$ ) is observed when the pions have a velocity close to the beam velocity. This unambiguous Coulomb effect may indicate that some fraction of the pions comes from a projectile-like source and not an intermediate velocity participant.

\* National Science Foundation Grant No. Phy-7822696, the Department of Energy, Contract W-7405-ENG-48, the Japan Society for the Promotion of Science, and the Yamada Foundation.  
<sup>1</sup>W. Benenson, G. Bertsch, G.M. Crawley, E. Kashy, J.A. Nolen, Jr., H. Bowman, J.G. Ingersoll, J.O. Rasmussen, J. Sullivan, M. Koike, M. Sasao, J. Peter, and T.E. Ward, submitted to Phys. Rev. Letters.

On the Influence of Two-Quasiparticle Structure in the Negative-Parity Yrast States:  $i_{13/2}$  Couplings in  $^{170}\text{Yb}$  and  $^{172}\text{Yb}$ .\* P.M. WALKER, S.R. FABER, W.H. BENTLEY, R.M. RONNINGEN, and R.B. FIRESTONE, Mich. State Univ.--Using the  $(\alpha, 2n)$  reaction we have observed rotational bands to high spin in  $^{170}\text{Yb}$  and  $^{172}\text{Yb}$ . Of special interest are  $K=1^-, 4^-,$  and  $6^-$  bands, based on couplings of a  $7/2^+[633]_2$ ,  $i_{13/2}$  neutron with either a  $1/2^-[521]$  or a  $5/2^-[512]$  neutron. The odd-even staggering is markedly different in each band, yet the moments of inertia are similar, and very large compared with the ground-state band. The large moments of inertia are interpreted as resulting from the alignment of a considerable fraction of the  $i_{13/2}$  angular momentum with the rotation, essentially independently of the second neutron involved in the two-quasiparticle configuration. However, the odd-even staggering depends on the degree of mixing with  $K=0^-$  bands, and is sensitive to the K-projection of each quasiparticle.

\* National Science Foundation Grant No. Phy-7822696.

Detection of a Charge State Loss Process in a Heavy Ion Penning Source.\* M.L. MALLORY, Michigan State University--The charge state distributions of heavy ion sources are peaked at charge states greater than  $1^+$  and a large effort has been made to enhance this peaking, since the energy from cyclotrons and hence usefulness to nuclear physics is proportional to  $q^2$ . A penning source was constructed that allowed a voltage to be applied to the center section of the ion source chimney. Upon the application of -10 volts on the chimney, thereby creating a potential well for the plasma, the charge state distribution extracted from the source changed dramatically for a nitrogen arc, with the low charge states increasing. The charge state distribution is now quite similar to expectations of single impact ion source calculations. Secondly, this differential charge state loss to the cathodes can probably be enhanced by ion source geometry and may explain differences in charge state distribution as seen by various sources. A biased chimney would be useful in source applications, where low charge states are emphasized.

\* National Science Foundation Grant No. Phy-7822696.

Proton Scattering at 35 MeV to Ground Band States in  $^{232}\text{Th}$  and  $^{234, 236, 238}\text{U}$ .\* R.C. MELIN, R.M. RONNINGEN, J.A. NOLEN, JR., G.M. CRAWLEY, and J.E. FINCK, Mich. State Univ., and C.E. BEMIS, JR., ORNL--Angular distributions of elastically and inelastically scattered protons have been measured in the angular range of  $20^\circ$  to  $144.5^\circ$  in steps of  $2.5^\circ$  and  $5^\circ$ . A 35.3 MeV dispersion-matched proton beam from the MSU cyclotron was used. The scattered protons were detected in the focal plane of an Enge split-pole spectrograph with the 25 cm inclined cathode, delay-line detector. The angular distributions for states in the ground band with  $J^\pi=0^+$  through  $6^+$  are being analyzed within a coupled channels framework. Quadrupole, hexadecapole, and possibly higher order mass moments will be presented. The results will be compared to moments from  $(e, e')$ <sup>1</sup>,  $(\alpha, \alpha')$ <sup>2,3</sup>, and Coulomb excitation<sup>4</sup> studies.

\* National Science Foundation Grant No. Phy-7822696.  
<sup>1</sup>T. Cooper et al., Phys. Rev. C13, 1083 (1976).  
<sup>2</sup>P. David et al., Z. Physik A278, 281 (1976).  
<sup>3</sup>D.L. Hendrie, Phys. Rev. Lett. 30, 571 (1973).  
<sup>4</sup>C.E. Bemis, Jr., et al., Phys. Rev. C8, 1466 (1973).

The Isovector Strength of the Nucleon-Nucleus Optical Potential From Elastic Nucleon Scattering at 30.3 and 40 MeV.\* R.P. DEVITO, SAM M. AUSTIN, U.E.P. BERG, W.A. STERRENBURG, and L.E. YOUNG, Mich. State Univ.--Neutron elastic scattering angular distributions at 30.3 and 40 MeV are analysed in terms of a local optical model potential. Comparison of deduced neutron potentials with existing proton potentials at the same incident energy for  $N=Z$  nuclei yields directly the Coulomb correction term. The extracted value is in agreement with that reported by Rapaport<sup>1</sup> for lower energies. The magnitude and energy dependence of the isovector strength of the nucleon-nucleus interaction is deduced by comparison of neutron and proton potentials for  $N \neq Z$  nuclei. Comparisons are done both in terms of volume integrals and fixed potential geometry.

\* National Science Foundation Grant No. Phy-7822696.  
<sup>1</sup>J. Rapaport et al., Nucl. Phys. A286, 232 (1977).

Neutron Elastic Scattering on  $^{12}\text{C}$ ,  $^{28}\text{Si}$ ,  $^{32}\text{S}$ ,  $^{40}\text{Ca}$ ,  $^{208}\text{Pb}$ , and  $^{209}\text{Bi}$  at 30.3 and 40 MeV.\* R.P. DEVITO, S.M. AUSTIN, U.E.P. BERG, W.A. STERRENBURG, and L.E. YOUNG, Mich. State Univ.  
 --Elastic scattering angular distributions ( $15^\circ < \theta_{\text{Lab}} < 130^\circ$ ) of 30.3 and 40 MeV neutrons have been measured using the MSU beam swinger TOF system. The  $^7\text{Li}(p,n)^7\text{Be}$  reaction served as a neutron source. Overall energy resolution was typically 500-1000 keV FWHM. Relative uncertainties are typically <3% while normalization errors are typically 5%. Optical model potentials were deduced by comparing the observed cross sections with optical model predictions smeared to account for the effects of multiple scattering, attenuation, and finite angular resolution.

\* National Science Foundation Grant No. Phy-7822696.

Study of Cross Section Enhancements Reached by (p,n) Reactions on Zr, Mo, and Sn Isotopes at  $E_p=45$  MeV.\* W.A. STERRENBURG, S.M. AUSTIN, R. DEVITO, and A.I. GALONSKY, Mich. State Univ. --The study of broad structures in Nb isotopes<sup>1,2</sup> reached by Zr(p,n) reactions has been extended to other nuclides ( $^{94,96,97,98,100}\text{Tc}$  and  $^{112,116,120,122,124}\text{Sb}$ , reached by Mo(p,n) and Sn(p,n) reactions, respectively). This survey shows that similar features, although varying in strength with A, exist in all nuclei studied. The angular distribution of the enhancement closest to the ground state analog has a shape similar to that of isolated  $1^+$  states in  $^{90}\text{Nb}$  and can be interpreted as the antianalog of the magnetic dipole excitation in the target nucleus.

\* National Science Foundation Grant No. Phy-7822696.

<sup>1</sup>R.R. Doering et al., Phys. Rev. Lett. **35**, 1691 (1975).

<sup>2</sup>W.A. Sterrenburg et al., B.A.P.S. **24** (1979).

Improvement of  $ge(\text{Li})$  Detector Energy Resolution and Peak-to-Compton by Use of a Pulse Shape Discriminator.\* N. MATSUSHITA, Wm. C. MCHARRIS, and R.B. FIRESTONE, Mich. State Univ.  
 --It has been shown that the resolution can be improved and the peak-to-Compton ratio drastically increased for a Ge(Li) detector by the optimal choice of rise times coincident with energy pulses.

\* National Science Foundation Grant No. Phy-7822696.

Fission Decay of the Giant Quadrupole Resonance in  $^{238}\text{U}$ .\* B.B. BACK, Argonne National Laboratory, A.C. SHOTTER, University of Edinburgh, C.K. GELBKE, and T.C. AWES, Michigan State University, A. BICE, D.K. SCOTT, and T.J.M. SYMONS, Lawrence Berkeley Laboratory. --The fission decay of the giant quadrupole resonance in  $^{238}\text{U}$  has been studied by means of inelastic scattering of 120 MeV  $\alpha$ -particles and 150 MeV  $^6\text{Li}$ -ions. Total kinetic energies of fission fragments were measured as a function of reaction Q-value. A comparison between the two reactions shows that the giant resonance is most strongly excited in  $^6\text{Li}$ -scattering. The dependence of the total kinetic energy release on excitation energy in the two reactions will be discussed.

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

The High-Spin Two-Particle States in the ( $^3\text{He},p$ ) Reaction.\* L.H. HARWOOD and G.M. CRAWLEY, Mich. State Univ. --Studies<sup>1,2</sup> of the ( $\alpha,d$ ) reaction on various targets led to what appears to be a systematic variation with A of the strongly excited states. We have extended the study by using the ( $^3\text{He},p$ ) reaction at a bombarding of 70 MeV on  $^{11}\text{B}$ ,  $^{12}\text{C}$ ,  $^{13}\text{C}$ ,  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{18}\text{O}$ ,  $^{27}\text{Al}$ , and  $^{28}\text{Si}$  targets. Our spectra are quite similar to the ( $\alpha,d$ ) spectra, but we observe two unreported states in  $^{15}\text{N}$  at 18.76 0.01 and 19.91 0.02 MeV excitation. We also observe that the 11.95 MeV "state" in  $^{15}\text{N}$  is in fact a doublet of states at 11.88 and 11.98 MeV. Measured angular distributions for the  $^{12}\text{C}$  and  $^{13}\text{C}$  target unfortunately did not allow spin/parity assignments to be made for the high lying states in  $^{14}\text{N}$  and  $^{15}\text{N}$ . The observed systematics of the high-spin states will be discussed.

\* National Science Foundation Grant No. Phy-7822696.

<sup>1</sup>E. Rivet et al., Phys. Rev. **141**, 1021 (1966).

<sup>2</sup>C.C. Lu et al., Phys. Rev. **186**, 1086 (1969).

The Magnetic Form Factor of  $^3\text{He}$ .\* DAN-OLOF W. RISKA, Mich. State U.--In the light of recent experimental data<sup>1</sup> on the magnetic form factor of  $^3\text{He}$  we investigate the sensitivity of the calculated form factor to the D-state fraction of the wavefunction and to meson exchange current effects. With simple but not unrealistic wavefunction models (with inclusion of the pion exchange current effects) we obtain larger exchange corrections and thus a form factor minimum at larger momentum transfer than what was found in an earlier calculation.<sup>2</sup> The importance of rho-meson exchange is pointed out.

- \* Research supported in part by the NSF  
<sup>1</sup>I. Sick, private communication.  
<sup>2</sup>A. Barroso and E. Hadjimichael, Nucl. Phys. A238, 422 (1975).

The Non-Linear Terms in the Chiral Lagrangians and the Pion-Nucleus Optical Potential.\* DAN-OLOF W. RISKA and HUGH MCMANUS, Mich. State U.--We show that the lowest order non-linear terms in the chiral Lagrangians for pion-nucleon systems contribute to the real part of the S-wave pion-nucleus optical potential, but that a strong cancellation occurs between the different components. The cancellation is exact in the zero range limit ( $m_\pi \rightarrow \infty$ ). The cancellation is similar to that found previously<sup>1</sup> for the pion-deuteron scattering length. The lowest order non-linear terms also lead to four-nucleon forces that however affect nuclear binding only insignificantly.

- \* Research supported in part by the NSF.  
<sup>1</sup>M.R. Robilotta and C. Wilkin, J. Nucl. Phys. G4, L115 (1978).

Pion Scattering From Nuclei: Phenomenological Considerations, H. MCMANUS, Michigan State University, --Pion-nucleus scattering is discussed in the framework of simple theoretical models, which include in some approximate way all physical effects including true absorption. Attention is focused on models in which most of the parameters are estimated theoretically and then adjusted or determined phenomenologically by comparison with experiment. Some of the ambiguities involved are discussed.

Coulomb Effects on Pion Production in Heavy Ion Reactions\* J.O. RASMUSSEN, J. BISTIRLICH, H. BOWMAN, K.M. CROWE, K. FRANKEL, O. HASHIMOTO, M. KOIKE, C.J. MARTOFF, J. PETER, J. SULLIVAN, W.A. ZAJC, Lawrence Berkeley Laboratory,\*\* W. BENENSON, G. CRAWLEY, J. NOLEN, E. KASHY, Michigan State U., J. QUEBERT, Bordeaux U. --We have earlier shown with a 180° - focal plane pion spectrometer that there is a very large ratio of  $\pi^-/\pi^+$  produced near the incident beam velocity in heavy ion reactions with beam energies around 400 MeV/nucleon. This large ratio seems to be due to coulomb interactions between the fragments of the incident projectile and the pions. In a new experiment with 1.05 GeV/n  $^{40}\text{Ar}$  we measured the production cross section for  $\pi^-$  and  $\pi^+$  at low pion energies at 90° in the C.M. We discuss the implications toward understanding the charge evolution in heavy ion reactions and the enhancement of  $\pi^+$  production at 90° in the C.M. observed in the reactions of 1.05 GeV/A Ar+KCl<sup>1</sup> and 0.8 GeV/A Ne+NaF.<sup>2</sup>

- \*Submitted by J.O. Rasmussen.  
\*\*Work supported by the Nuclear Physics Division of the U.S. Dept. of Energy under Grant No. W-7405-ENG-48.  
<sup>1</sup>K.L. Wolf, et al., Phys. Rev. Lett. 42, 1448 (1979).  
<sup>2</sup>J. Chiba, et al., Phys. Rev. C20, 1332 (1979).

Two-Nucleon Transfer in the Ni-Zr Region.\* N. ANANTARAMAN, H.W. FULBRIGHT, and H.S. HANS, NSRL, Univ. of Rochester, and B.H. WILDENTHAL, Michigan State Univ.--The reaction  $^{68}\text{Zn}(p,t)^{66}\text{Zn}$  has been studied at Rochester at a bombarding energy of 23 MeV. Angular distributions have been obtained in the range 5° to 60° for the four lowest states in  $^{66}\text{Zn}$ . These and other, published, two-nucleon transfer data [(p,t), (t,p) and ( $^3\text{He}$ ,n)] for the Ni and Zn isotopes will be compared with the predictions of the shell-model calculations of van Hienen et al.<sup>1</sup>

- \*Work supported by the National Science Foundation.  
<sup>1</sup>J.F.A. van Hienen et al., Nucl. Phys. A269, 159 (1976).

Search for Parity Non-Conservation in  $^6\text{Li}$ .\* R.G.H. ROBERTSON, + A.B. McDONALD, G.C. BALL, W.G. DAVIES, E.D. EARLE, AECL, Chalk River Nuclear Labs, P.L. DYER, R.C. MELIN, Michigan State Univ., T.J. BOWLES, Argonne National Lab. --The  $\alpha$ -d breakup of the  $0^+ T=1$  state at 3.56 MeV in  $^6\text{Li}$  is forbidden by both parity and isospin conservation. An experiment is now in progress at Chalk River to search for resonant capture of alpha particles by deuterium through this state. The apparatus includes a deuterium gas jet target and a QDDD spectrometer to detect  $^6\text{Li}$  recoils. From an initial 2 days of data-taking, an upper limit of  $2 \times 10^{-6}$  eV for the alpha width has been obtained, two orders of magnitude below the best previous limit.<sup>1</sup> No detailed theoretical treatment is yet available, but an estimate gives an upper limit of approximately 80 for the corresponding neutral current "enhancement factor".

- \*Supported in part by U.S.N.S.F. Grant Phy. 78-22696.  
+Alfred P. Sloan Fellow.  
<sup>1</sup>E. Bellotti et al., Nuovo Cim. 29A (1975) 106.

Precision Test of the Isobaric Multiplet Mass Equation from  $\delta$ -delayed Proton Decay of  $^{24}\text{Si}$ \*

A.G. JEDEBUHR, L.H. HARWOOD, R.G.H. ROBERTSON and T.J. BOWLES, <sup>++</sup> Mich. State Univ.-- A 70 MeV  $^3\text{He}$  beam was used to produce the proton-rich nucleus  $^{24}\text{Si}$  via the  $^{24}\text{Mg} (^3\text{He}, 3n)$  reaction. A cryogenic (liquid-nitrogen cooled) helium jet coupled to a recoil time-of-flight mass analyzer has been used to observe the decay of this nucleus. The half-life of  $^{24}\text{Si}$  was found to be  $115 \pm 60$  ms, and the energy of the protons de-exciting the T=2 state in the daughter,  $^{24}\text{Al}$ , has been measured to be  $3911.2 \pm 3.7$  keV. These findings are in agreement with previous results.<sup>1</sup> The recently completed A=24 isobaric quintet constitutes a test of the Isobaric Multiplet Mass Equation as precise as the mass 9 quartet and shows no significant departure from the quadratic form of this equation. The value obtained for a possible d-coefficient is  $-1.0 \pm 1.6$  keV which is consistent with zero.

\*National Science Foundation Grant No. Phy 78-22696.

+Alfred P. Sloan Foundation Fellow.

<sup>++</sup>Present Address: Los Alamos Scientific Laboratory, Los Alamos, NM.

<sup>1</sup>J. Åystö et al., Phys. Lett. 82B, 43 (1979).

Energy Systematics of Enhancements in (p,n) Spectra,\* AARON GALONSKY, WIM STERRENBURG, SAM AUSTIN, and RAY DeVito, Mich. State Univ.-- Neutron spectra resulting from bombardment with 45-MeV protons were measured at a forward angle, typically  $7.5^\circ$ , on 17 targets between  $^{90}\text{Zr}$  and  $^{208}\text{Pb}$ . Three features are common to the spectra: (1) a sharp peak representing the isobaric analog of the target ground state, (2) a broad peak, FWHM=3-4 MeV, at slightly higher, but target-dependent, excitation energy and (3) a similarly broad peak  $\sim 10$  MeV higher than (2). The dependence of these energies on  $(N-Z)/A$  shows that the broad peaks are related to states in the target not as analogs but, more likely, as T<sub>c</sub> or anti-analogs of target states. Proposed parents for (2) and (3) are the giant M1 and giant E1 states. If the E1 assignment is correct, the T, T-1 splitting is experimentally determined for the first time.

\*National Science Foundation Grant No. Phy 78-22696.

Isovector Giant Resonances in  $^{90,92,94}\text{Zr}$

(p,n) at 80, 120, and 160 MeV,\* A. GALONSKY, S. AUSTIN, T. NEES, W. STERRENBURG, Mich. State U.; D. BAINUM, Emporia State U.; J. RAPAPORT, Ohio U.; C. FOSTER, Indiana U.; C. GOODMAN, D. HOREN, ORNL; C. GOULDING, M. GREENFIELD, Florida A&M U.--Spectra for the above reaction were obtained with the beam-swinging, time-of-flight system at Indiana U. Two broad peaks previously observed with 45-MeV protons<sup>1,2</sup> are more prominent at these higher energies. The angular distributions of the peaks are very different from each other. The lower peak has the  $\ell=0$  shape of the IAS, whereas the upper peak has an  $\ell=1$  shape. These peaks may represent the T<sub>c</sub> components (or anti-analogs) of the giant M1 and E1 resonances. There is some evidence for the analog of the M1. If so, we have a direct measurement of the M1 isospin splitting in three Nb isotopes.

\*National Science Foundation Grant No. Phy 78-22696 and D.O.E.

<sup>1</sup>R.R. Doering, A. Galonsky, D.M. Patterson, and G.F. Bertsch, Phys. Rev. Letters 35,1691 (1975).

<sup>2</sup>W.A. Sterrenburg, S.M. Austin, U.E.P. Berg, R. DeVito, and A. Galonsky, Bull. Am. Phys. Soc. 24,649(1979).

Negative-Parity Sideband in  $^{168}\text{Yb}$ ,\* J.L.S.

CARVALHO, P.M. WALKER,<sup>+</sup> W.H. BENTLEY, and S.R. FABER,<sup>†</sup> Mich. State Univ.--Using the  $^{166}\text{Er}(\alpha, 2n)^{168}\text{Yb}$  reaction, with  $\alpha$ -particle beams provided by the MSU Cyclotron, we have identified several sidebands in  $^{168}\text{Yb}$ . The techniques used included  $\gamma$ - $\gamma$  coincidence and  $\gamma$ -ray angular distribution measurements. Of particular interest is the identification of a rotational band based on the known  $I, K^\pi = 5, 5^-$  isomeric level<sup>1</sup> at 1999 keV. We have tentatively assigned band members up to the 11<sup>-</sup> level, with both stretched E2 cross-over and mixed M1/E2 cascade transitions between the levels. The angular distribution results imply the dominance of a two quasi-neutron structure for the band, probably with the  $\{5/2^+(642)_n, 5/2^-(523)_n\}$  assignment. The  $5/2^+(642)$  neutron comes from the  $i_{13/2}$  orbitals, and the strong Coriolis effects on the high  $j=13/2$  for this particle can account for the high moment of inertia of the band ( $2/\hbar^2 \approx 110 \text{ MeV}^{-1}$ ).

\*National Science Foundation Grant No. Phy 78-01684.

<sup>+</sup>Present address: Daresbury Laboratory, Daresbury, Warrington, England.

<sup>†</sup>Present address: Argonne National Laboratory, Argonne, Illinois.

<sup>1</sup>A. Charvet et al., Nucl. Phys. A197(1972)490.

Light Particle Production in Interactions

of 20 MeV/u  $^{16}\text{O}$  with  $^{197}\text{Au}$  and  $^{238}\text{U}$ ,\* T. AWES, C.K. GELBKE, Mich. State Univ., B. BACK, G. GLAGOLA, K.L. WOLF, Argonne National Laboratory, and H. BREUER, A.C. MIGNEREY, V.E. VIOLA, University of Maryland.--Energy spectra of p,d,t and  $\alpha$ -particles at lab angles from  $15^\circ$  to  $140^\circ$  have been measured in coincidence with fission fragments from the reaction of 20 MeV/u  $^{16}\text{O}$  with  $^{238}\text{U}$ . We are able to divide the cross section into central and peripheral collisions by using recoil information obtained from the angular opening between the two fission fragments. Also measured were inclusive spectra of p,d,t and  $\alpha$ -particles produced in the interaction of  $^{16}\text{O}$  with  $^{197}\text{Au}$  at 20 MeV/u. These spectra were measured at 16 different lab angles from  $20^\circ$  to  $145^\circ$  yielding angular information on the relative production of these light particles. These new results will be presented and discussed.

\*National Science Foundation Grant No. Phy 78-22696.

Beam Energy Calibration System,\* P. DYER

and R.G.H. ROBERTSON<sup>†</sup>, Mich. State Univ.--In the search for the parity-forbidden resonance in the  $d(\alpha, \gamma)^6\text{Li}$  reaction at  $E_\alpha = 6.24$  MeV,<sup>1</sup> we wish to determine the beam energy with an accuracy of 0.01%. A 30 kV Tl<sup>+</sup> surface-ionization source has been built to deliver ions having the same magnetic rigidity as the 6.2-MeV  $\alpha^{++}$  particles. The paths of the alpha and Tl<sup>+</sup> beams through a Q3D magnetic spectrometer are matched, and the alpha beam energy is calculated from the voltage applied to the source electrode, as measured with a precision voltage divider and voltmeter. The absolute calibration of the source has been verified by measuring the energies of alpha particles from a  $^{212}\text{Bi}$  source and by measuring the threshold energy for the  $^{27}\text{Al}(p,n)^{27}\text{Si}$  reaction.

\*National Science Foundation Grant No. Phy 78-22696.

<sup>†</sup>Alfred P. Sloan Fellow.

<sup>1</sup>R.G.H. Robertson et al., contribution to this meeting.

TITLES OF TALKS WHICH HAVE NOT YET APPEARED IN PROCEEDINGS (Section III)

- EIGHTH INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS AND NUCLEAR STRUCTURE, VANCOUVER, 1979.  
Emission of Complex Fragments in Argon Induced Reactions at 213 MeV/Nucleon, Y.P. Viyogi, F. Beiser, H. Crawford, P. Doll, D.E. Greiner, C.K. Gelbke, H.H. Heckman, D.L. Hendrie, P. Lindstrom, J. Mahoney, D.K. Scott, T.J.M. Symons, K. Van Bibber, G.D. Westfall and H. Wieman.
- INTERNATIONAL SCHOOL ON NUCLEAR PHYSICS, "ETTORE MAJORANA", ERICE, SICILY, April 1979.  
Invited Lectures on "Towards Relativistic Heavy Ion Collisions", D.K. SCOTT.
- TWELFTH SUMMER SCHOOL ON NUCLEAR PHYSICS, STUDY OF NUCLEAR STRUCTURE BY MEANS OF NUCLEAR REACTIONS, MIKOLAJKI, POLAND, September 1979.  
Invited Lectures on "Transition from Low Energy to Relativistic Heavy Ion Collisions", D.K. SCOTT.
- SUMMER SCHOOL ON HEAVY ION PHYSICS AT A FEW TENS OF MeV/NUCLEON, SERRE-CHEVALLIER, FRANCE, September 1979.  
Invited Lectures on "Direct Reactions with Heavy Ions", D.K. SCOTT.
- WORKSHOP ON NUCLEAR COLLISIONS AT 10 TO 200 MeV/NUCLEON, COPENHAGEN, 1979.  
Invited speaker on Microscopic Aspects of Relativistic Nuclear Collisions, D.K. SCOTT.
- INTERNATIONAL CONFERENCE ON NUCLEAR PHYSICS, BERKELEY, CALIFORNIA, 1980.  
Fragmentation of  $^{40}\text{Ar}$  at 118 MeV/NUCLEON, R. Legrain, T.C. Awes, H.J. Crawford, C.K. Greiner, H.H. Heckman, J.M. Kidd, P.J. Lindstrom, J. Mahoney, D.K. Scott, T.J.M. Symons and G.D. Westfall.
- INTERNATIONAL CONFERENCE ON NUCLEAR PHYSICS, BERKELEY, CALIFORNIA, 1980.  
Giant Resonance Excitation in  $^{208}\text{Pb}$  with 120 MeV/Nucleon Alpha Particles, B. Bonin, N. Alamanos, B. Berthier, G. Bruge, J.L. Escudie, H. Faraggi, L. Farvacque, J. Gastebois, J.C. Lugol and L. Papineau, CEN Scalay, France, J. Arvieux and M. Buenerd, ISN Grenoble, France; P. Doll, K.F.Z. Karlsruhe, W. Germany; M.J. LeVine, BNL, Upton, L.I., N.Y., USA; D.K. Scott, MSU, E. Lansing, USA.
- WORKSHOP ON THE MIMAS PROJECT, SACLAY, PARIS, January, 1980.  
Invited Talk on "Nuclear Physics with Heavy Ions at High Energies", D.K. Scott
- INTERNATIONAL CENTER FOR THEORETICAL PHYSICS, MARMARE, TRESTE, January 1980.  
Invited Lecture on "Giant Resonances at Topical Meeting on Heavy Ion Collisions, D.K. Scott.
- INTERNATIONAL CONFERENCE ON EXTREME STATES IN NUCLEAR SYSTEMS, DRESDEN, GDR, February, 1980.  
"Systematics of Gamow-Teller Strength as Observed in (p,n) Charge Exchange Reactions at  $E_p = 45$  MeV", W. STERRENBURG, S.M. AUSTIN, R.P. DEVITO and A. GALONSKY.  
"Gamow-Teller Resonances Observed in  $^{90,92,94}\text{Zr}(p,n)$  At 120 and 160 MeV", W. STERRENBURG, S.M. AUSTIN, D.E. BAINUM, R.P. DEVITO, C.C. FOSTER, A. GALONSKY, C.D. GOODMAN, C.A. GOULDING, M.B. GREENFIELD, D.J. HOREN, J. RAPAPORT, AND E. SUGARBAKER.  
Invited "Summary" Speaker, D.K. Scott.
- INSTITUTE OF PHYSICS MEETING ON TRENDS IN NUCLEAR STRUCTURE PHYSICS, MANCHESTER, April 1980.  
Invited Speaker on Nuclear Physics at Relativistic Energies, D.K. Scott.
- INTERNATIONAL SCHOOL ON NUCLEAR STRUCTURE, ALUSHTA, CRIMEA, April 1980.  
Invited Lecturer on Heavy Ion Reactions at Intermediate Energies, D.K. Scott.