ANNUAL REPORT

on the

RESEARCH AND GRADUATE TRAINING

at the

Michigan State University Cyclotron Laboratory

for the period

July 1, 1967

to

June 30, 1968

Work supported jointly by
Michigan State University
and the
National Science Foundation

FOREWORD

The major portion of this annual report consists of the published papers and abstracts resulting from the research activities of this laboratory during the period July 1, 1967 to June 30, 1968. Abstracts of papers submitted to journals but not yet published by June 30, 1968 are also included. Authors and titles of PhD theses completed during the year are given. The report concludes with a list and a photograph of the cyclotron staff. A brief survey of the progress made during the past year in the improvement and development of various laboratory facilities is given below.

1. The Cyclotron

The performance of the cyclotron has continued to improve and its capabilities have further expanded. The installation of a new electrostatic deflector has enabled the cyclotron to operate routinely at proton energies up to 45 MeV with nearly 100% extraction efficiency. Improved circuitry in the rf system has reduced the energy spread of the raw beam to 0.1%. Another operation that has become routine is second harmonic rf acceleration. This has made available beams of deuterons and alpha particles with energies up to 23 MeV and 46 MeV, respectively. With completion of a helium purification and recovery system, there have begun experiments with helium-3 beams having energies up to 70 MeV.

Aided by specially located internal phase selection slits, proton beams having less than 1 nanosecond pulse length and 1 microampere time average intensity have been used in experiments employing the time of flight technique. We expect this capability of the MSU cyclotron to be further exploited.

2. Beam Transport

The beam transport and analyzing system has been refined and extended so that beam can now be placed on target at any of five different experimental set ups. A recently installed NMR system in the analyzing magnets should allow stability and reproducibility of the beam energy to a few parts in 10^5.

3. Experimental Apparatus

A goniometer-type scattering chamber with an angular precision of $\pm 0.2^{\circ}$ has been designed and constructed in this laboratory. Although not limited to this use, the chamber has been specially designed to accommodate the germanium detector packages developed here. The chamber plus germanium detector has been used in (p,p') experiments at 40 MeV with the resolution from all sources being less than 0.1%.

A broad-range, double-focusing, reaction-product spectrograph has been purchased from Scanditronix. The scattering chamber, camera box and plate holder have been designed and are under construction in our shop.

4. Computer

During the past year our use of the Sigma 7 Computer has advanced from computations to data analysis to data

acquisition. The versatility of the laboratory has been greatly increased by the use of the computer in the data-acquisiton mode.

In parallel with the development of sophisticated on-line uses of the computer there has been an extensive conversion of both our cyclotron and our nuclear physics computer programs from the CDC 3600 to the SDS Sigma 7. Work is underway to convert the distorted wave code "JULIE" for use on the Sigma 7. With the cooperation of R.M. Drisko at ORNL "JULIE" has already been reduced to Fortran and put to use at MSU on the CDC 3600 computer.

In order to perform frequent and extensive computations and at the same time perform the real time tasks of data acquisition, a time sharing system called "JANUS" is being developed at MSU. A limited amount of time sharing has already been achieved. In order to permit efficient time sharing a second 16K bank of memory is being added to the system.

5. Building Addition

After a three month delay caused by a strike the cyclotron laboratory addition is now scheduled for completion and occupancy in September, 1968. In addition to alleviating overcrowding of the nuclear experimental group, the addition will allow the nuclear theory group, presently in the Physics Building across the campus, to be housed under the same roof with us. The theory group now includes Drs. H. McManus, J. Borysowicz, K. Kolltveit and R. Muthukrishnan and their students and staff.

The year ahead should prove to be the most productive one for nuclear physics at MSU.

Contents

I. Papers Which Have Appeared in Journals (July 1967 - June 1968)

	Page
The Effective Interactions and the Reactions $^{7}Li(p,p')^{7}Be$ (478 keV) and the $^{7}Li(p,n)^{7}Be$ (431 keV), P. J. Locard S. M. Austin, and W. Benenson, Phys. Rev. Letters 19, 1141(1967).	1
Study of Reactions $^{10}B(p,d)^{9}B$ and $^{11}B(p,d)^{10}B$, L. Kull and E. Kashy. Phys. Rev. 167, 963(1968).	5
Design Considerations for a Separated Turn Isochronous Cyclotron, M. M. Gordon. Nuclear Instruments and Methods 58, 245(1968).	13
Theoretical and Experimental Beam Studies for the Michigan State University Cyclotron, M. M. Gordon, R. E. Berg, and H. G. Blosser, Nuclear Instruments and Methods 58, 327(1968).	21
Conversion Electron Measurements of Transitions Following the Beta Decay of ^{131m}Te, L. Beyer and W. Kelly. Nuclear Physics A104, 274(1967).	36
A New Kind of Radiation Analyzer. T. H. Close, D. V. Hirst, J. V. Kane, C. Y. Kao, J. Kateley, W. A. Shunk, and M. E. Williams. Arkiv for Fysik 36, 553(1967).	45
The $^{14}N(p,d)^{13}N$ Reaction at 30 MeV. R. L. Kozub, L. A. Kull, and E. Kashy. Nuclear Physics A99, 540(1967).	73
(p,d) Reactions with ^{6}Li, ^{7}Li, and ^{9}Be, L. A. Kull. Phys. Rev. 163, 1066(1967).	80
Excitation Energy of the First Excited State of C^{12}, and Observation of a Coherent Doppler Effect, J. J. Kolata, R. L. Auble, and A. Galonsky. Phys. Rev. 162, 957(1967).	88
Energy Reproducibility in Beam Analyzing Magnets, J. L. Snelgrove, and E. Kashy. Nucl. Inst. and Methods 52, 153(1967).	94
Ge(Li)-NaI(Tl) Studies of the Decay of ^{117}Te, G. Berzins and W. Kelly, G. Graeffee, and W. B. Walters, Nuclear Physics A104, 241(1967).	96
A Single Crystal Ge(Li) Compton Spectrometer, C. R. Gruhn, J. V. Kane, W. H. Kelly, T. Kuo and G. Berzins, Nuclear Instruments and Methods 54, 268(1967).	118

Page

Ge(Li)-NaI(Tl) Angular Correlation Studies of Gamma Casacades in the Decay of ^{119m}Te, G. Berzins and W. H. Kelly. Nuclear Physics A104, 263(1967). 127

A Post-Focusing Accelerator for a $\pi\sqrt{2}$ Spectrometer, R. J. Krisciokaitis and S. K. Haynes. Nuclear Inst. and Methods, 58, 309(1968). 138

A Study of the L- and K-Auger Spectra of $^{113}_{49}$In From $^{113}_{50}$Sn, R. J. Krisciokaitis and S. K. Haynes, Nuclear Physics A104, 466(1967). 144

Lithium-Drifted Germanium for Charged Particle Spectroscopy, C. R. Gruhn, T. Kuo, C. Maggiore, B. Preedom, L. Samuelson, and J. Chander, IEEE Transactions on Nuclear Science NS-15, 337(1968). 159

II. Abstracts of Talks Given at Meetings

Seattle APS Meeting - August 1967

Proton Radiation Damage of Ge(Li) Detectors, C. R. Gruhn, C. J. Maggiore, and J. Chander. Bull. Am. Phys. Soc. 12, 915(1967). 169

Chicago ACS Meeting - 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. Am. Chem. Soc. (1968). 170

Madision APS Meeting - October 1967

The $^{14}N(p,p')$ Reaction at 24.8 MeV, S. M. Austin, W. Benenson, and G. M. Crawley. Bull. Am. Phys. Soc. 12, 1199(1967). 171

Energy Dependence of Inelastic Proton Scattering to the First T = 1 State of ^{6}Li, P. J. Locard, S. M. Austin, W. Benenson, and G. M. Crawley. Bull. Am. Phys. Soc. 12, 1178(1967). 172

New York APS Meeting - November 1967

Performance of a Modern Medium Energy Cyclotron, H. G. Blosser. Bull. Am. Phys. Soc. 12, 1047(1967). 173

Pasadena APS Meeting - December 1967

Energy Levels of Cf^{252}, Irshad Ahmad, P. R. Fields, and Wm. C. McHarris, Bull. Am. Phys. Soc. 12, 1125(1967). 174

Page

Chicago APS Meeting - January 1968

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A Pulse Stretcher for Nuclear Physics Pulse Height Analysis using a Computer, J. V. Kane, N. Dobeck and E. Dounce. Bull. Am. Phys. Soc. 13, 52(1968). 176

Elastic Scattering of Protons by ^{16}O, James L. Snelgrove and E. Kashy. Bull. Am. Phys. Soc. 13, 115(1968). 177

M2 Isomerism in ^{83}Rb and High Resolution Spectroscopic Investigations of the Decay of ^{83}Sr, R. C. Etherton, L. M. Beyer, W. H. Kelly and D. J. Horen. Bull. Am. Phys. Soc. 13, 85(1968). 178

Direct (p,α) Reactions on Several Nuclei in the 2s-1d Shell, G. H. Mackenzie and R. A. Atenosen. Bull. Am. Phys. Soc. 13, 85(1968). 179

ANZAAS Congress, Christchurch, New Zealand - January 1968

Analysis of 25 MeV Inelastic Proton Scattering on 1p Shell Nuclei, G. M. Crawley, S. M. Austin and W. Benenson, ANZAAS Congress, Christchurch, New Zealand, 24-31 January, 1968. 180

Washington IEEE Meeting - February 1968

Lithium-Drifted Germanium for Charged Particle Spectroscopy, C. R. Gruhn, T. Kuo, C. Maggiore, B. Preedom, L. Samuelson, and J. Chander. IEEE Transactions on Nucl. Sci. NS-15, 337(1968). 181

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. Bull. Am. Phys. Soc. 13 631(1968). 182

High Resolution Gamma-Ray Spectroscopic Studies of the Decay of 2.6-Hour Nd^{141g} and 60-Second Nd^{141m}, D. B. Beery, Wm. C. McHarris, and W. H. Kelly. Bull. Am. Phys. Soc. 13, 625(1968). 183

JANUS - A Computer Operating System for Time Sharing and Nuclear Data Acquisition, J. O. Kopf and P. J. Plauger. Bull. Am. Phys. Soc. 13, 700(1968). 184

A Progress Report on System JANUS, P. J. Plauger and J. O. Kopf, Bull. Am. Phys. Soc. 13, 701(1968). 185

Page

Washington APS Meeting - April 1968 (cont.)

Inelastic Scattering of Protons from ^{28}Si and 24.9 MeV, P. J. Locard, Walter Benenson and S. M. Austin. Bull. Am. Phys. Soc. 13, 674(1968). 186

A Study of the $^{16}O(p,d)^{15}O$ Reaction, James L. Snelgrove and Edwin Kashy. Bull. Am. Phys. Soc. 13, 630 (1968). 187

A High Precision Goniometer for Charged Particle Spectroscopy, K. M. Thompson and C. R. Gruhn. Bull. Am. Phys. Soc. 13, 701(1968). 188

Energy Dependence of Spin-Isospin Interaction, Invited Paper, S. M. Austin. Bull. Am. Phys. Soc. 13, 577(1968). 189

San Francisco ACS Meeting - April 1968

The Electron Capture Decay of Gd^{149}, Richard E. Eppley and Wm. C. McHarris. 190

Los Alamos APS Meeting - June 1968

Light Elements from Proton Spallation of Carbon at 42 MeV, Cary N. Davids and Sam M. Austin. Bull. Am. Phys. Soc. 13, 882(1968). 192

III. Papers Submitted to Journals but not yet Published

Date Submitted and Journal Name	Title and Authors	
January 1968 Phys. Rev.	The (p,d) Reaction on 2s-1d Shell Nuclei, R. L. Kozub	193
June 1968 Annals of Physics	Orbit Properties of the Isochronous Cyclotron Ring with Radial Sectors, M. M. Gordon.	195
March 1968 Nucl. Instr. & Methods	Remote Controlled Slits for the MSU Cyclotron External Beam System, W. Benenson, R. deForest W. P. Johnson, and E. Kashy	196
May 1968 Fall Joint Computer Conference	JANUS: A Flexible Approach to Realtime Timesharing, J. O. Kopf and P. J. Plauger	197

	Date Submitted and Journal Name	Title and Author	Page
	February 1968 Phys. Rev.	High Resoltuion Gamma-Ray Spectroscopy Studies of the Decays of 2.6-Hour Nd^{141g} and 60-Second Nd^{141m}, D. B. Beery W. H. Kelly and Wm. C. McHarris	198
	April 1968 IEEE Transitions	Use of a Sigma-7 Computer in a Nuclear Physics Laboratory, W. Benenson and R. A. deForest	199
	April 1968 IEEE Transitions	Precise Energies of ^{40}Ca Levels, E. Kashy and J. L. Snelgove	200
	May 1968 Phys. Letters	Spectral Averages in Transfer Reactions Involving Targets with Single Active Shell, Ram K. Bansal	201
	June 1968 Phys. Letters	$^{203}Pb^{m}$ Decay and M4 Transition Probabilities in Neutron-Deficient Lead Isotopes, R. E. Doebler, Wm. C. McHarris and C. R. Gruhn	202
	June 1968 Nucl. Phys.	The States of ^{117}Sn, D. B. Beery, G. Berzins, W. B. Chaffee, W. H. Kelly and W. C. McHarris	203
	Jan 1968 Phys. Rev.	M2 Isomerism in ^{83}Rb and High Resolution Spectroscopic Investigations of the Decay of ^{83}Sr, R. C. Etherton, L. M. Bever, W. H. Kelly and D. J. Horen	205
	June 1968 Phys. Letters	The Spin-Isospin Dependent Interaction from Inelastic Proton Scattering on ^{6}Li	207
IV.	PhD Theses		208
V.	List of Personnel		209