

ENGINEERING RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
ANN ARBOR

FINAL REPORT

INVESTIGATION OF NUCLEAR-ENERGY LEVELS

mes
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Professor of Physics

Project 1670-2

OFFICE OF NAVAL RESEARCH, U. S. NAVY DEPARTMENT
CONTRACT N5ori 116, PROJECT ORDER III, ONR PROJECT NRO24-01

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This contract dealing with the Investigation of Nuclear-Energy Levels was terminated on April 1, 1955. It has been superseded by another contract continuing the same investigation.

During the life of the contract, from June, 1946, until its termination, some 64 publications dealing with new data on the structure of various nuclei have appeared, mainly in The Physical Review. A list of these titles follows:

1947

- Internally Converted Gamma Radiation from Tantalum. Phys. Rev., 71, 487 (1947).
- Magnetic Field Measurement in Beta Spectroscopy. Rev. Sci. Inst., 18 315 (1947).
- The Double Focusing Beta-ray Spectrometer. Phys. Rev., 71, 681 (1947).
- Internally Converted Gamma Rays from the Heavy Elements. Phys. Rev., 72, 186 (1947) (Abstract).
- Gamma Radiation from Tantalum, Iridium, and Gold. Phys. Rev., 72, 581 (1947).
- Internally Converted Radiation from Europium, Hafnium, and Osmium. Phys. Rev., 72, 1209 (1947).

1948

- Note on Gamma Radiation from Europium. Phys. Rev., 73, 78 (1948).
- Neutron Induced Radioactivity in Certain Rare-earth Elements. Phys. Rev., 74, 240-43 (1948).
- Gamma Radiation from Tellurium and Samarium. Phys. Rev., 74, 1249 (1948).
- Beta Ray Spectra of Europium and Tungsten (with F. B. Shull). Phys. Rev., 74, 917 (1948).
- Converted Gamma Radiation from Silver, Cadmium, Indium, Praseodymium, and Rhenium. Phys. Rev., 74, 1657 (1948).

1949

- Radioactivity Induced in Ytterbium by Neutron Bombardment. Phys. Rev., 75, 1133 (1949).
- Radiation from Ytterbium. Phys. Rev., 75, 1287 (1949) (Abstract).
- Gamma Rays from Iodine. Phys. Rev., 75, 1621 (1949).
- Gamma Rays from Tantalum 182. Phys. Rev., 75, 1778 (1949).
- Neutron Induced Radioactivities in V^{52} , Mo^{99} , and W^{185} . Phys. Rev., 76, 575 (1949).
- Radioactivity in Holmium 166, Thulium 170, and Lutetium 177. Phys. Rev., 76, 986-87 (1949).
- Gamma Rays and Internal Conversion. Nucleonics, 4, 24-34 (1949).
- Radioactive Lanthanum 140. Amer. Journ. Phys., 17, 1886 (1949).
- Graphical Computation of Line Shapes in Beta Spectroscopy (with C. M. Fowler and R. G. Shreffler). Rev. Sci. Instr., 20, 966 (1949).

1950

- Radioactivity in Platinum by Neutron Capture. Phys. Rev., 77, 843 (1950).
- Additional Electron Lines from Radioactive Europium. Phys. Rev., 77, 848-49 (1950).
- Re-interpretation of the Electron Lines of Radioactive Ytterbium and Tantalum. Phys. Rev., 78, 95 (1950).
- Radioactivity in Hafnium. Phys. Rev., 78, 299 (1950).
- Gamma Rays from Terbium 160. Phys. Rev., 78, 304 (1950).
- The 282 Day Radioactivity in Silver 110. Phys. Rev., 79, 237 (1950) (Abstract).
- Energy Levels Associated with Selenium (with W. C. Rutledge and others). Phys. Rev., 79, 889 (1950).
- Radioactivity from Enriched Isotopes of Cadmium. Paper, Wash. Meet. Amer. Phys. Soc. Phys. Rev., 79, 938 (1950).
- Gamma Rays from Radioactive Silver. Paper, Wash. Meet. Amer. Phys. Soc., (1950).
- Gamma Rays from Silver 110 (with W. C. Rutledge and others). Phys. Rev., 80, 286-87 (1950).
- Nuclear Energy Levels for Several Long-lived Isotopes. Nucleonics, 7, 24-33 (1950).

1951

- The Radioactive Decay of Iodine 131 (with W. C. Rutledge and others). Phys. Rev., 81, 482-83 (1951).
- High Energy Gamma Radiation from Tantalum 181 (with W. J. Childs and others). Phys. Rev., 81, 642-43 (1951).
- Radioactivity Induced in Iridium by Neutron Capture (with J. M. LeBlanc and others). Phys. Rev., 82, 258-59 (1951).
- Gamma-Radiation Associated with Radium and Daughter Products (with C. E. Branyan and others). Phys. Rev., 83, 681-82 (1951).
- The Radioactivity of Barium 140 . Phys. Rev., 83, 856 (1951).
- Gamma-Radiation from Lanthanum 140 (with A. E. Stoddard and others). Phys. Rev., 83, 856-57 (1951).
- Additional Data on the Radioactive Isotopes of Tin and Tellurium. Phys. Rev., 84, 596-97 (1951).
- Gamma-Rays and Nuclear Levels Associated with Radioisotopes of Europium, Erbium, and Cerium (with H. B. Keller). Phys. Rev., 84, 1079-83 (1951).

1952

- The Radioactive Decay of Hg 197 and Hg 203 (with D. W. Martin and others). Phys. Rev., 85, 386-87 (1952).
- Radioactivity in Neutron Activated Platinum (with J. M. LeBlanc and others). Phys. Rev., 86, 415-16 (1952).
- The Radioactive Decay of Ruthenium 103 (with J. M. LeBlanc and others). Phys. Rev., 86, 575-76 (1952).
- Gamma-Rays Associated with Selected Neutron-Induced Radioactivities (with W. C. Rutledge and S. B. Burson). Phys. Rev., 86, 775-86 (1952).
- Energy Levels Associated with the Radioactive Decay of Gd 153 and Tb 161 (with J. M. LeBlanc and others). Phys. Rev., 88, 685-86 (1952).

1953

- The Radioactive Decay of Tungsten 187 (with M. K. Price and others). Phys. Rev., 89, 1291 (1953).
- The Radioactive Decay of Cs 134 , Os 185 , Os 191 , and Os 193 (with J. M. LeBlanc and others). Phys. Rev., 90, 447 (1953).
- The Decay of Rh 104m (4.3 min) and Rh 104 (44 sec) (with W. C. Jordan and S. B. Burson). Phys. Rev., 90, 862 (1953).

1953 (concluded)

- Nuclear Levels in Cs¹³¹ (with J. M. LeBlanc and others). Phys. Rev., 91, 76 (1953).
- The Radioactive Decay of Tungsten 181 (with W. H. Nester and others). Phys. Rev., 92, 119-20 (1953).
- The Radiations of ⁶⁴Gd¹⁵⁹ (18 hr) and ⁶⁴Gd¹⁶¹ (3.7 min) (with W. C. Jordan and S. B. Burson). Phys. Rev., 92, 315-18 (1953).
- The Radioactive Decay of Calcium 47 (with J. M. LeBlanc and others). Phys. Rev., 92, 367-69 (1953).
- Decay of ⁶⁶Dy^{165m} (1.2 min) and ⁶⁶Dy¹⁶⁵ (2.3 hr) (with W. C. Jordan and S. B. Burson). Phys. Rev., 92, 1218-21 (1953).

1954

- The Gamma Spectra of Cd¹¹⁷ and In¹¹⁷ (with J. M. LeBlanc and S. B. Burson). Phys. Rev., 93, 916 (1954).
- Radiation from Antimony 122. Phys. Rev., 93, 1059-61 (1954).
- Decay of V⁵². Phys. Rev., 93, 1124-25 (1954).
- Neutron Capture in the Separated Isotopes of Platinum (with M. K. Brice and others). Phys. Rev., 94, 1218 (1954).
- The Radioactivity of Zn⁷¹ (with J. M. LeBlanc and S. B. Burson). Phys. Rev., 94, 1436 (1954).
- The Decay of Pt¹⁹⁹ (with J. M. LeBlanc and S. B. Burson). Phys. Rev., 95, 627 (1954).
- Energies of the Radiations from Ce¹⁴⁴ and Pr¹⁴⁴ (with M. K. Brice and L. C. Schmid). Phys. Rev., 96, 1295-98 (1954).

1955

- Radioactivities of Lu⁶⁹ and Lu⁷¹ (with J. M. LeBlanc and S. B. Burson). Phys. Rev., 97, 750 (1955).
- Decay of the 3.5 min Metastable State of Sb¹²² (with J. M. LeBlanc and S. B. Burson). Phys. Rev., 98, 39 (1955).
- Radiations from Ce¹⁴³ (with D. W. Martin and S. B. Burson). Phys. Rev., 99, 670 (1955).
- Energies of the Radiations from Co⁵⁷ and Co⁵⁸ (with M. K. Brice and L. C. Schmid). Phys. Rev., 99, 703 (1955).
- The Radioactive Decay of Ruthenium 97 (with M. K. Brice and others). Phys. Rev., 100, 188 (1955).

This project has very materially aided in the educational development of several graduate students in physics. Some have taken positions on receiving the master's degree, while others have continued through the completion of their work for the doctor's degree.

Students receiving M.S. degree—

John Sazyinski	G. D. Hickman
Charles E. Branyan	Wm. H. Nester
Wm. J. Childs	F. B. Stumpf
H. Nine	

Students continuing Ph.D. work—

David W. Martin	L. K. Schmid
M. K. Brice	

Students receiving the Ph.D. degree—

Robert G. Shreffler	Harry B. Keller
C. M. Fowler	W. C. Rutledge
Ernest Salmi	James M. LeBlanc
A. E. Stoddard	Wm. C. Jordan
Franklin B. Shull	

Through the "Participating University Program" of the Argonne National Laboratory, a portion of this investigation has been carried on continuously near their reactor. This has enabled the study to deal with very short-lived radioactivities. Students taking advantage of this arrangement have been temporary members of the section directed by Dr. S. B. Burson.

The apparatus used in the beginning consisted mainly of photographic magnetic spectrometers and a special double-focusing spectrometer for beta-ray studies. Scintillation crystal apparatus has been added, allowing coincidence and summation observations to be made to supplement spectrometer data. At Argonne a hundred-channel pulse-height analyzer has been available for the students' use.

It is proposed to pursue the same objective under the continuing contract.

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