February 28, 1961

GRADUATE RESEARCH IN PHYSICS

GEORGETOWN UNIVERSITY
WASHINGTON 7, D. C.

PHYSICS DEPARTMENT

TOTAL COST: $ 114,707.00

AMOUNT REQUESTED: $ 57,353.00

Signatures: Principal Investigator: _____ Tel. Ju 7 7395
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M. P. Thekaekara, S. J.

Authorized Official _____
Joseph F. Cohalan, S.J.

SUMMARY

The project proposed herein will support graduate research at the doctoral and post-doctoral level at Georgetown University. The University Development Fund is bearing the total cost of 4.2 million dollars for the construction of the shell of a seven story Basic Research and Science Building. The Physics Department will occupy the following space (excluding corridors, lavatories, etc.)

1) Fifth floor: 13,400 square feet
2) First floor: 4,612 square feet
3) Third floor 8,800 square feet

Gross total 26,812 square feet.

In addition, there are rooms totalling 7,000 square feet for classes and seminars, which will be shared among different departments. These rooms are all on the second floor.

The following space will be devoted exclusively to basic research and research training:

1) Fifth floor: 4,242 square feet
2) First floor 1,960 square feet
3) Third floor 1,300 square feet

Net total for research 7,502 square feet

The present space devoted to research comprises four rooms in the basement of the Healy Building, totalling 3,000 square feet. The additional research space gained by this new construction will be 4,502 square feet. It will house seven faculty members and thirty-three graduate students. This will provide approximately 200 square feet of research area per man.

The total cost of the proposed project is 114,707.00. The amount requested is $57,353.00. It should be noted that every dollar granted in support of this request is really being matched many times over by the University which is bearing the total cost of the building.

1. DESCRIPTION OF THE FACILITY

Facilities now available for research are four rooms comprising approximately 3000 square feet of space in the basement of the Healy Building. The University recognizing the inadequacy of the facilities, has begun construction of a new Basic Research and Science Building. The Physics Department will occupy the following areas:

1. The entire fifth floor with a total available floor space (less corridors, lavatories, etc.) of 13,400 square feet. Of this total area, 4,242 square feet will be devoted exclusively to basic research at the graduate (doctoral and post-doctoral) level. The balance of the space will house the undergraduate and graduate laboratories.
2. On the first floor, a total of 4,612 square feet will be occupied. Of this total, one room comprising 1,780 square feet will be devoted exclusively to research and 180 square feet of the instrument shop (total area 700 sq. ft.) will be devoted to research support. The total area devoted to research on the first floor is 1,960 square feet. The balance of the space will house lecture rooms and storage area.
3. On the third floor, a total of 8,800 square feet comprise the Science Library. Of this total, 1,300 square feet will house a Research Reading Room for physics.

The gross total space available for the Physics Department is 26,812 square feet, about 30 percent of the area of the building. The net total space devoted exclusively to physics research is 7,502 square feet.

Presently occupied research space comprising 3,000 square feet will be vacated by the Physics Department and turned over to the University Library for its expansion.

The geographical relationships are indicated in the accompanying sketches of the Physics Department area (Appendix A). The fifth floor is shown in architecht's drawings in great detail and the basic research areas are shaded in red.

The new facility will provide approximately 4,502 square feet of additional research area over that presently available. This will all be new construction. Details of research space are as follows:

LIST I

DETAILS OF RESEARCH SPACE

Fifth Floor

Room Number	Research Field	Area in Square ft.
536	Low energy n. p.	503.0
528	Biophysics	195.8
532	Infrared	194.4
24	Microwaves	196.8
507	Molecular Spec.	214.8
542	Molecular Structure	217.0
546	Th. Solid State	199.4
552	Molecular Structure	197.5
55 -556	High energy Nuclear Physics	205.0 525.8
527 525 523	Biophysics Ultrasonics Spectroscopy	124.8, 107.0 114.3, 118.1 130.3, 151.8
545 547	Microwave	147.4, 98.8 134.3, 89.8
553-59	Nuclear Physics	Combined area 375.4

First Floor

1-1	High energy nuclear physics	1,780
1-2	Instrument shop, 30% of total area	180

Fourth Floor

3-1	Physics Research reading room, 15% of Library space	1,300
		7,502 sq. ft.

Comparison of the items listed above should be made according to room number on the accompanying sketch (Appendix A). Room partitions and basic furnishings including storage cabinets, work benches, sinks, hood, etc. are indicated in the sketch.

Each Professor will have a minimum of two rooms. One room will serve as an office and data reduction and analysis center. The other room or rooms will house the research equipment in the area or areas under investigation and will be used by the professor and those graduate students under his direction to conduct basic research. The facilities requested in this proposal will be exclusively devoted to research.

2. SCIENTIFIC JUSTIFICATION

Experimental facilities to conduct basic research at the graduate level are an essential part of the program leading to the Ph.D. degree in Physics. The basic research effort will be conducted in the following areas:

I Molecular Structure.

An existing contract under the Office of Scientific Research, Department of the Air Force in Theoretical Molecular Structure is under way. This theoretical effort will be aided and supplemented by experimental research in Atomic and Molecular Spectroscopy and Microwave Spectroscopy.

II Infrared Spectroscopy

Work is already underway to conduct an experimental study of the infrared spectrum of the planets.

III Ultrasonics

The study of relaxation phenomena in corrosive gases; velocity and absorption in liquids and solids; and selected areas in biophysics will be the subjects of research in this area.

IV Nuclear Physics

Low energy nuclear physics and selected areas in the effects of nuclear radiation on biological systems will be the subjects of research in this area.

DETAILED PROGRAM DESCRIPTIONS

I Molecular Structure

(a) Theoretical Research

This is a continuing program supported by the Office of Scientific Research, Department of the Air Force. Its object is to study the vibrational energy levels of diatomic molecules. Three steps are being taken to help remove ambiguities in the determination of molecular properties. The first step is to determine the vibrational levels of the Heitler-London potential for the hydrogen molecule and increase the understanding of the vibrational properties of covalent molecules. The second step is to find the vibrational levels of Rittner's potential and apply these data to reveal the vibrational characteristics of ionic molecules. The third step is to find a new type of equation for the accurately known, experimental, vibrational levels of the ground state of the hydrogen molecule. This research should be of considerable value in understanding processes which involve molecules at high temperature, such as an unambiguous determination of molecular properties near the equilibrium separation of the nuclei; determination of unknown vibrational levels from known experimental data; dissociation limit values; and information on the relative importance of various nuclear binding forces.

(b) Atomic and Molecular Spectroscopy

The program in Atomic and Molecular Spectroscopy is an extension of the work we have been doing during the past five years. We have already developed several semi-automatic techniques for the rapid reduction of spectroscopic data. These include in particular the

use of the telecordex and a small computer. Electrodeless discharge tubes provide efficient laboratory sources. The relative advantages of these sources as compared to conventional arc and spark discharges, have been demonstrated by our work as by that of several other workers. The technique of making these tubes has to be perfected. Several spectra of astrophysical interest need to be studied. A great deal of work still needs to be done in connection with the accurate determination of energy levels. Two Master's dissertations, "Ultraviolet Spectrum of Ti I 2000-3000A," by C. Wilson, "Interferometric Measurements of Ti I Lines" by J. Giuliani have already been presented. Work on two Ph.D. dissertations on the Spectra of Y I and Ti I is about to be completed. There are about fifteen graduate students currently working in spectroscopy.

(c) Microwave Spectroscopy.

Experimental research in this area is already under way. A study of the hyperfine structure in the rotational spectra of polyatomic molecules, principally those like NO_2, which possess resultant electron spin angular momentum and those like CH_3OH in which hindered torsional motion occurs is being conducted. The dependence of the various dipole and quadrupole coupling energies of these molecules on their rotational quantum numbers will be of particular concern.

II Infrared Spectroscopy.

Almost no data exists on the infrared spectra of the planets. Sinton and his co-workers and a group at Air Force Cambridge Research Laboratory have carried out a few measurements in the 4 to 8 micron region. Until recently, the astronomers had the major interest in planetary studies and their experience appears to have limited them to the visible region of the spectrum where classical photographic techniques are

applicable. Light received from the moon or a planet is reflected sunlight that passes twice through the planetary atmosphere and once through the earth's atmosphere. Comparison of the absorption spectrum seen on earth from the moon and the planet can indicate the presence of certain gaseous molecules in the planetary atmosphere. It should also be possible to observe light from the planet at a time when a large component of velocity exists between the planet and the earth (about five or six weeks before and after opposition). Absorption lines or bands should show a doppler shift with respect to lines produced in the earth's atmosphere. Calculations indicate that reflected infrared radiation from the planets provides sufficient energy as far out as 30μ for accurate spectroscopic measurements to be made. Furthermore, strong vibration-rotation bands of many polyatomic molecules occur in the infrared. Much information, including accurate estimates of the abundances of such gases in planetary atmospheres should be obtainable. An experimental program will be conducted using a one foot diameter heliostat and an infrared spectrometer to obtain data on Mars and the other planets with the highest obtainable resolution throughout the infrared region.

III Ultrasonics

Research in this field will be concentrated in three areas:

a) Relaxation phenomena in corrosive gases. A systematic study of the velocity and absorption in corrosive gases (Bromine, Chlorine, Iodine, Fluorine, etc.) will be conducted. Practically no data exists in this area due to experimental difficulties in handling these gases since, in general, their low vapor pressure at STP requires working at elevated temperatures.

b) Study of velocity and absorption of ultrasonics in liquids and solids. Measurements on selected classes of liquids should lead to additional insight into the nature of the liquid and solid state.

c) Biophysics. The application of ultrasonic techniques to the study of biological systems is well known. Much is to be gained by such interdisciplinary research with a long term aim to improve our quantitative understanding of biological systems and their reaction to a controlled environment.

IV Nuclear Physics.

The Department has concentrated in the period 1956-1960, on outfitting a complete nuclear physics research laboratory for low energy studies. The program was under the direction of Dr. K. J. Watters (Ph.D. MIT, 1956) who was Visiting Associate Professor. Georgetown now has a formal licensing from the Atomic Energy Commission as a user of by-products material.

One graduate student (R. Dowling) is presently conducting research on the techniques for detection of internal exposure to radioactivity resulting from inhalation or injection in the human body.

Another graduate student (T.A. Henrickson) is conducting research on a high sensitivity method of radiocarbon dating using liquid scientillation counting. A dense liquid counting medium allows the introduction of large amounts of carbon into the counter thus increasing the level of radioactivity per unit volume of sample and reducing the background problem.

3. USE IN RESEARCH TRAINING

The Physics Department presently has thirty-three graduate students enrolled for the Ph.D. program. These students will use the research

facilities for their thesis to satisfy the requirements for the Ph.D. Two candidates are expected to obtain the Ph.D. this year. They will be the first produced by the newly developed program. The thesis titles are:

1. An investigation of the vibrational properties of some diatomic molecules - E. J. Finn
2. Molecular orbital study of Be_2^+ - J. T. Dehn.

4. ADMINISTRATIVE PLANS

The facility will be under the direct control and administration of the Chairman of the Department of Physics. The Department is under the administrative control of the President and Directors of Georgetown University. The facility will be for the sole use of the Department of Physics.

5. BUDGET

Total Cost: $114,707.00

Breakdown: See List 2

These cost estimates were made on the basis of quotations given by Kewaunee and Co. Contractors.

The Institution proposes to contribute 50% of the cost, a total of $57,354.00 from the University development fund. Funds are presently available in this amount.

The multi-story building is presently under construction. Plans have been drawn for the facility described herein but construction has not begun and contracts have not yet been let. Present plans call for requesting bids by July, 1961 and letting contracts by September, 1961.

LIST 2

I - ITEMIZED BUDGET

Type A	31 Built-in storage cases, topped with work bench	$ 350.00 each	$ 10,850.00
Type B	20 " " "	400.00	8,000.00
Type C	49 " " "	375.00	18,375.00
Type E	19 Sinks	150.00	2,850.00
5	L Shaped wall assembly, stainless steel, top and curb, sink	1,800.00 each	9,000.00
2	Fume hoods, rooms 536 and 556	2,000.00 each	4,000.00
1	Type F sink, (Dished No. 316, Stainless steel, top and curb, sink 24" x 20" x 8" I.D.		1,200.00
Compressed air system			22,000.00
Vacuum system			25,000.00
Partitions as shown in II - below			7,023.00
Sliding doors: Rooms 527,525, 523, 545, 547, between 545 and 547 -- total of 7 at $60.00 each			420.00
Tables similar to Kewanee No. 8390, cat. no. 57, p. 105			1,080.00
Stools, Ajusto model, no. RSS -- 1826 ..			624.00
Chairs			910.00
Desks			1,500.00
Files, 4 drawers, letter size			1,275.00
Total			$ 114,707.00

II - Budget details, partitions for research areas

Room No.	Running feet
536, 528, 532, 524 507., 542, 546, 552, 527, 554-56, Ten rooms	195
at 19 1/2 ft. each	24
545-57	12
553-59	
	231 ft. at $33.00 per foot, $7623.00

III - Budget details, Furnishings for research areas

Room No.	Tables	Stools, Chairs	Desks	Files
536	1	4	2	1	2
528	1	2	2	1	1
532	1	2	2	-	-
524	1	2	2	1	1
507	1	2	2	1	1
523	-	4	-	-	-
568	1	2	2	1	1
546	1	2	2	1	1
552	1	2	2	1	1
554	1	2	2	1	1
556	1	4	2	1	2
527	1	2	-	-	-
525	1	2	-	-	-
545	1	2	-	-	-
547	1	2	-	-	-
553	1	2	-	-	-
559	-	2	-	-	-
1-1	3	12	6	3	6
Totals for all rooms	18	52	26	12	17

Tables similar to Kewannee, no. 8390, Cat. 57, p. 105	18 at $ 60.00 ea	$1,080.00
Stools Ajusto model no. RSS - 1926	52 at $ 12.00	624.00
Chairs	.. 26 at $ 35.00	310.00
Desks	.. 12 at $125.00	1,500.00
Files, four drawers, letter size	.. 17 at $ 75.00	1,275.00

IV - Budget details, Laboratory benches, etc.

Room no. First Floor 1-1 536 and 556, Nuclear phys.

Storage case and work bench

CBR Lab. 2C351-28R, L-shaped wall assembly, Stainless steel top, curb and sink at $ 1800.00 each
Three for 1-1 and one each for 536 and 556

	Type A	Type B	Type C	Type E	
528 Biophysics	3	1	3	1	
532 Infrared	3	1	3	1	
524 Microwaves	3	1	3	1	
507 Spectroscopy	3	1	3	1	
542 Mol. Struct.	3	1	3	1	
546 Th. Solid State	3	1	3	1	
554 Nuclear phys.	1	1	4	2	
527 Biophys.	1	1	4	2	
525 Ultrasonics	2	1	4	2	
523 Spectroscopy	2	1	5	2	
545 Microwaves	1	2	3	2	
547 Microwaves	1	2	2	2	
553 Nuclear phys.	-	-	4	1	
559 Nuclear phys.	-	2	3	1	(F type, Dished no. 316)
548 Mol. Structure	3	1	3	1	
1-1 Nuclear Phys.	-	3	-	-	
Totals	31	20	49	19	

Cost			
Type A storage case and work bench at	$350	$	10,850.00
Type B " " "	$400	$	8,000.00
Type C " " "	$375	$	18,375.00
Type E sinks at	$150	$	2,850.00
Type F sinks and bench for room 559		$	1,200.00
CBR Lab 2C 351-28R L-shaped wall assembly, 5 at $1800.00 each.....			9,000.00

APPENDICES

APPENDIX A.

List of Sketches and Drawings

1. Sketch of floor plan of First Floor

2. Sketch of floor plan of Third Floor

3. Detailed floor plan, (architect's drawing) of Fifth Floor

   Inset: Typical storage case and work bench.

   Note: Designations of rooms according to fields of research are as given on pages 4 and 13 of this proposal, and are slightly different from those given in the architect's drawing of the fifth floor.

APPENDIX B.

Biographies of Researchers; Listing of Publications and Current Research Support

1. Molecular Structure

a) Theoretical Research - Principal investigator: CHARLES L. BECKEL Associate Professor of Physics, B.S. degree, University of Scranton, 1948, Ph.D. degree, Johns Hopkins University, 1954. Dr. Beckel has been with the Department since 1953. He spent summers of 1954 and 1955 with the Detonation Physics Branch, Ballistics Research Lab, Aberdeen Proving Grounds, Md., Consultant to this Branch from 1955 to 1957. Fullbright Lectureship in Physics at Peshawar University, Pakistan in 1957-1958.

Publications:

1. Evaluation of a Certain Finite Sum, Amer. Math. Monthly 62, 211 (1955)
2. A case of Superiority of Numerical Integration over Integration in Closed Form, Amer. Math. Month. 62, 211 (1955)
3. A study of Detonation and Shaped Charge Jets by Means of Optical Filters, Memorandum Report No. 969, Jan. 1956, B.R.L., Aberdeen P. G., Md.
4. Improved Vibrational Potential for Diatomic Molecules, J. Chem. Phys. 24, 553 (1956) Doctoral Thesis.
5. Linear Extrapolation of the Vibrational Energy Levels of Ionic Molecules, J. Chem. Phys. 24, 923 (1956).
6. Superiority of the Poeschl-Teller Potential to that of Morse for Diatomic Molecules, J. Chem. Phys. 27, 998 (1957).
7. Teaching Experiences in Pakistan, AAPT, Chesapeake Section, October, 1958.

Dr. Beckel has two research assistants, Mr. Edward J. Finn and Mr. Mohammad Shafi who are candidates for the Ph.D. at Georgetown University.

Current Research Support

Title: A Theoretical Study of Vibrational Energy Levels of Diatomic Molecules.

Source: DSR, USAF

Amount: $20,400

Duration: January, 1960 to January, 1962.

b) Atomic and Molecular Spectroscopy - Principal Investigator:

MATTHEW P. THEKAEKARA

Associate Prof., Acting Chairman, Department of Physics; A.B. (1937), M.S. (1939) University of Madras, Ph.D. (1956) Johns Hopkins University. Fr. Thekaekara was Assoc. Prof. and Departmental Head, Loyola College, Madras (1948-52); Instructor (52-53), Research Assistant (1953-57) Johns Hopkins University; joined the faculty of Georgetown University 1957. He was associated with Dr. C.C. Kiess in two research projects under N.S.F. Grant, in 1958-59, and in 1959-61 for the investigation of atomic and molecular spectra of astrophysical interest. In the summer of 1960, he directed an N.S.F. Conference for College Professors on Recent Advances in Astro-geophysics. Fr. Thekaekara is the director of the expanded program in spectroscopy for which the Department of Health, Education and Welfare has granted two research fellowships for a three year term starting in September, 1961. Total amounts of research support are about $30,000 under the two N.S.F. grants for spectroscopy, $20,000 for the Summer Conference and about $30,000 for the Defence Fellowships.

Publications 1956-1961:

1. The Spectrum of Xenon I, M. Thekaekara, G.H. Dieke and H.M. Crosswhite, Johns Hopkins, Spectroscopic Report, No. 12, December 1955.

2. Emission lines from the pre-ionized levels in Krypton and Xenon, M. Thekaekara and G.H. Dieke, Phys. Rev. 109, 2029 (1958)

3. Semiautomatic methods in spectroscopy, M. Thekaekara, Jesuit Sc. Bul. 35, 82 (1958).

4. A Revision of the Term Values of Titanium I, M. Thekaekara, Georgetown Observatory Monograph No. 13, July 1959.

5. Revised Term Values of Ti I, C.C. Kiess and M. Thekaekara, Astrophys. J. 130, 1008 (1959)

6. Automatic techniques in spectroscopy using a small computer, J. Opt. Soc. Am. 48, 871 (1958)

7. The Spectrum of Krypton I, M. Thekaekara, G. H. Dieke, H.M. Crosswhite, Spectroscopic Report, in the press.

8. Analysis of the Utraviolet Spectrum of Ti I, M. Thekaekara and C. Wilson, J. Opt. Soc. Am. March 1961.

9. Recent Advances in Astro-geophysics, A Topical Symposium; Edited by M. P. Thekaekara, S.J., Georgetown Observatory Monograph No. 14, July, 1960.

c) Microwave Spectroscopy - Principal investigator: RALPH S. HENDERSON

Associate Professor of Physics, B.A. College of Wooster, 1936, M.A., Harvard University, 1941, Ph.D., Harvard University, 1955, Professor, Robert College, Istanbul, Turkey, Professor, College of William and Mary, Radar Maintenance and Development, Army Signal Corps 1942 to 1954.

Publications:

1. On the fine Structure in the Inversion Spectrum of Ammonia, Phys. Rev. 74, 107(c) 1948

2. Electron Spin Coupling in Polyatomic Molecules, Phys. Rev. 100, 723 (1955)

Current Research Support.

Title: An investigation of hyperfine structure in the microwave spectra of polyatomic molecules.

Source: National Science Foundation

Amount: $15,110

Duration: Continuing - work suspended 1960-61 due to sabbatical leave of Dr. Henderson.

2. Infrared Spectroscopy - Principal investigator: WILLIAM J. THALER

Professor of Physics, B.S. Loyola College, Baltimore Md., 1947, M.S. Catholic University, 1949, Ph.D. Catholic University, 1952, Head, Field Projects Branch, ONR, Technical Director, Project Argus, Technical Director, Project TEPEE.

Publications:

1. Distortion of Progressive Ultrasonic Waves, Phys. Rev. 74,107-108 (1948)
2. Study of Turbulence by Light Diffraction, Phys. Rev. 74, 708-709 (1948)
3. Intensity as a Factor in Precision Meassurements in Ultrasonics, Bull. Amer. Phys. Soc. April 29, 1948.
4. A New Method of Measuring Sound Velocity, Am. J. Phys. 6, (1950)
5. A High Intensity Short Duration Spark Light Source, J. Appl. Phys. 21, 1269-1271 (1950)
6. Absorption and Dispersion of Sound in Oxygen as a Function of the Frequency - Pressure Ratio, J. Acoust. Soc. Amer. 24, 15 (1951)
7. Ultrasonics - A Tool for Biological Research, Research Reviews, Jan., 1952.
8. Effects of Ultrasonic Waves on the Refractive Media of the Eye, AMA Archives of Ophthalmology 47:2, 204-219 Feb., 1952.
9. 1952-1960 Numerous publications in connection with nuclear weapons research and ballistic missile research are classified.

Current Research Support.

At present this program is financed entirely by the University. However, the Advanced Research Projects Agency is currently considering support of this work. Two graduate students are presently assisting this research effort; Mr. Franklin Fletcher and A.J. McGonigal, S.J.

3. Ultrasonics - Principal Investigator - WILLIAM J. THALER

Professor of Physics (See above for biograph and publications)

Research Support.

At present this program is financed entirely by the University. Research proposals are in preparation for interested agencies. Three graduate students are presently assisting in this research effort; Mr. E. Gaines, Mr. P. St. Hilaire and Miss M. Zagronic.

6. Nuclear Physics - Principal investigator: EARL R. MOSBURG

Lecturer in Nuclear Physics, B.S., Yale University 1952, Ph.D., Yale University, 1956; Instructor, General Physics, Yale U. 1953-1954; Physicist, National Bureau of Standards 1956- present. (Dr. Mosburg is temporarily in charge of the Nuclear Physics program due to Dr. Watter's resignation in 1960 to enter private industry. A permanent replacement is being sought by the Department).

Publications:

1. Production of Λ^0 Particles in Pb and C by 2.5 Bev Protons, Phys. Rev. 108, 805 (1957).
2. Production of Heavy Mesons and Hyperons by Protons on Deuterium, Phys. Rev. 106, 829 (1957).
3. Scintillation Counter Method of Intercomparing Neutron Source Strength, J. Research Natl. Bur. Standards, May, 1959.

Current Research Support:

The nuclear physics research program is presently supported wholly by the University. Plans have been made for a high energy accelerator (Van de Graaf) in the future and proposals will be forthcoming in this area to interested agencies.

APPENDIX C

Titles of These

The University first offered the Ph.D. degree in physics in 1955. The Ph. D. program is now under way after five years of development. Two candidates will present themselves for the Ph.D. in the fall of 1961 and two in 1962.

The titles of the Ph.D. thesis which are due to be completed in the Summer of 1961, are given earlier in Section 3. "Use in Research Training."

The following are the titles of Master's Theses with the names of the authors and the year in which the degree was given:

THESES TITLES IN PHYSICS

1.	A Study of Ultrasonic Interference and Refraction in the Field of a Circular Piston	James Dehn, S.J.	1960
2.	The Self Absorption of Calcium 45 Beta Rays in Animal Blood as Determined by Four PI Counting	Frank P. Falci, Jr.	1960
3.	The Reduction and Analysis of the Arc Spectrum of Titanium from 2117 to 3072 A	Christopher M. Wilson, S.J.	1959
4.	Neutron Flux Distribution in the AGN Training Reactor	Talib Nahi Al-Khafaji	1958
5.	The Atomic Structure of Zirconium, 6100-6500 A	William E. W. Howe	1957
6.	An Investigation of Normal Shock Waves Impinging upon Metal Membranes	Joseph Guarracini	1954
7.	Arc Spectrum of Titanium	Abdul K. Wardakee	1954
8.	Crystal Diodes	Alvin H. Morgan	1952
9.	An Experimental Investigation of the Sonic Velocimeter	Dwight L. Randall	1952

10.	Electric Wave Filters: Ladder Type	Edward B. Reilly	1951
11.	Principles of the Measurement of Flame Temperatures at Centimeter Wavelength	Harry Harrison	1950
12.	Second Order Effects of Sound Waves	Yacoub Nashed	1950
13.	Techniques of Radiation Measurement	Thomas Jefferson O'Donnell	1950
14.	Study of Rotation and Vibration Rotation Bands in the Infra-Red Spectrum of Hydrogen Chloride	Byford H. Stout	1950