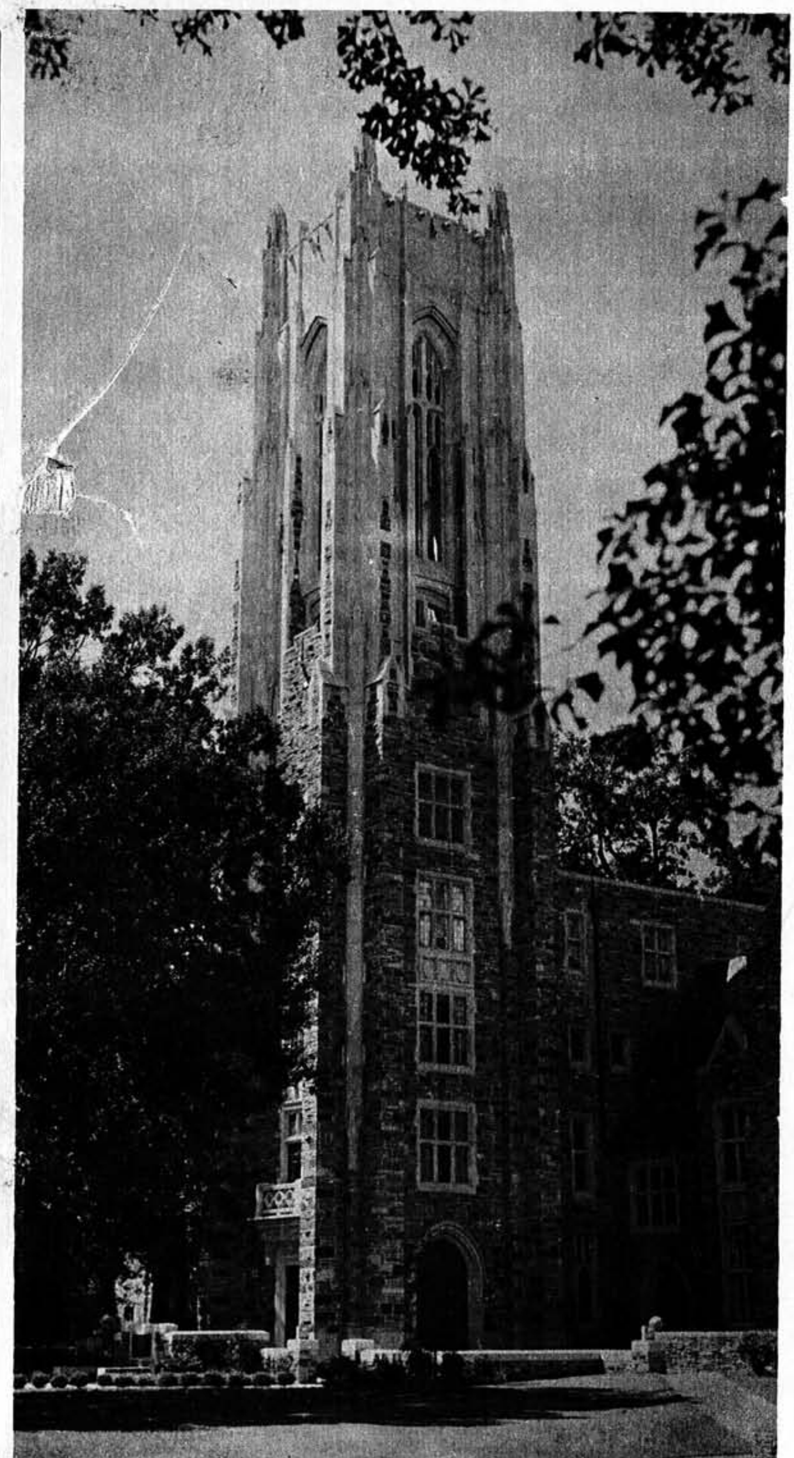

A REVIEW OF THE HISTORY OF PHYSICS AT SOUTHWESTERN

Departments - Physics

By

J.H. TAYLOR

DEPARTMENT OF PHYSICS
SOUTHWESTERN AT MEMPHIS
JANUARY 29, 1972

PHILOSOPHIÆ NATURALIS PRINCIPIA MATHEMATICA.

AUCTORE

ISAACO NEWTONO, EQ. AURATO.

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PP. THOMÆ LE SEUR & FRANCISCI JACQUIER

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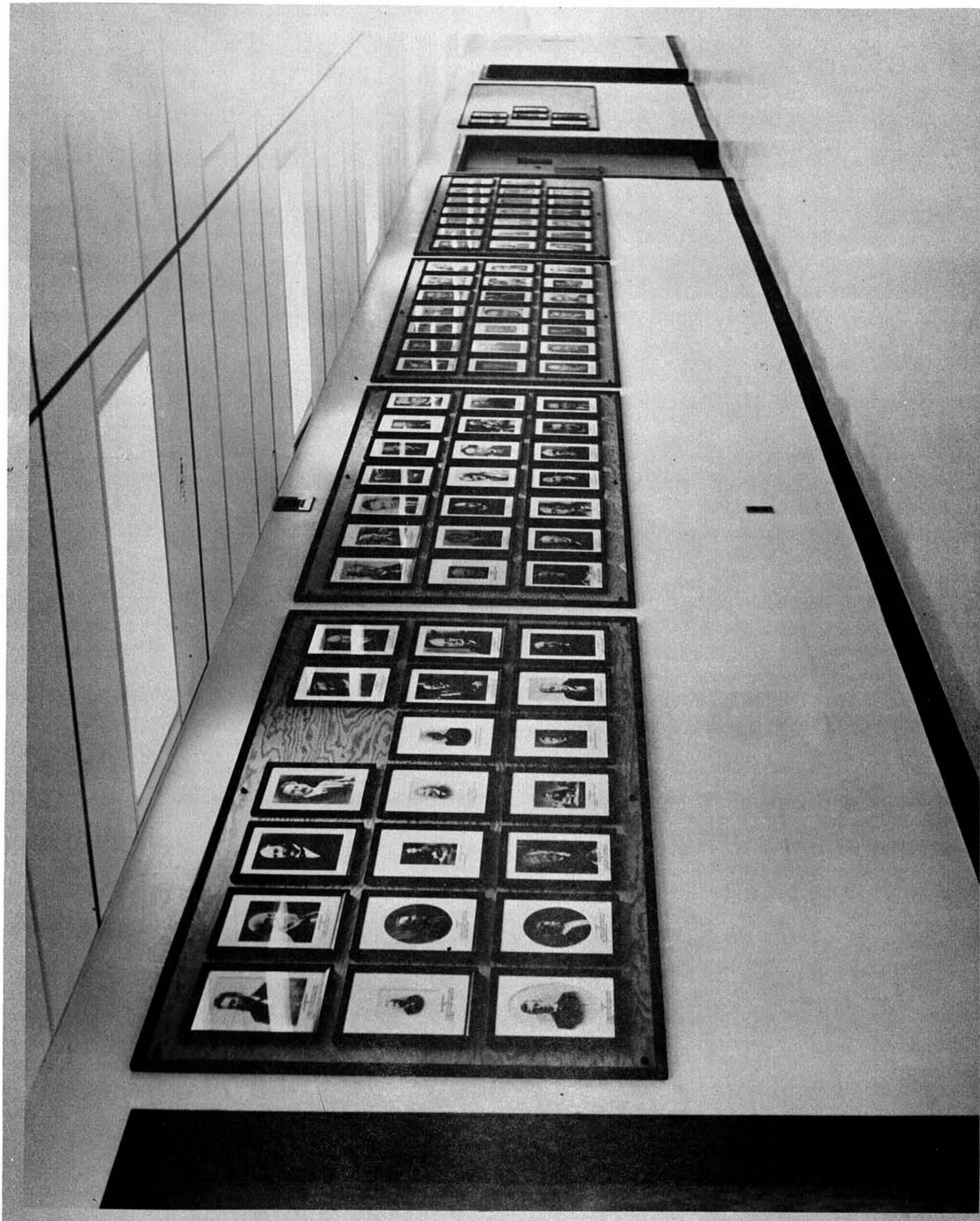


NOBEL LAUREATES IN PHYSICS

IN MEMORY OF

MR. AND MRS. HENRY CLAY NALL, JR.

AND

MR. AND MRS. THOMAS WATT GREGORY

TABLE OF CONTENTS

LIST OF ENCLOSURES

LIST OF ENCLOSURES (continued)

LIST OF PHOTOGRAPHS

LIST OF PHOTOGRAPHS (continued)

LIST OF PHOTOGRAPHS (continued)

LIST OF PHOTOGRAPHS (continued)

Foreword

Beginning in 1848 Southwestern (known variously through the years as the Montgomery Masonic College, Stewart College, Southwestern Presbyterian University and Southwestern at Memphis) offered courses in "Natural Philosophy" and proclaimed to the world and to all that the college had facilities with the latest "philosophical apparatus." These rather quaint phrases described the offerings and equipment that were the precursors to the program and the laboratories of the present-day Department of Physics.

The building of a modern department of physics depends upon the organization of human activity, knowledge, facilities, instruments and good students. But none of these elements is more important than the teaching manpower that spans the years of developmental achievement. In this useful and timely history of Southwestern's Department of Physics will be found the names of nearly two dozen professors who devoted many years of their lives to the evolution of a distinguished science program.

Out of this roster stand like tall timber the two names of Peyton Nalle Rhodes and Jack Howard Taylor. Dr. Rhodes, for many years a professor of physics, chairman of the department, and president of the college for sixteen years, completed in 1972 forty six consecutive years of service to Southwestern as an administrator, a distinguished teacher and a highly recognized man of physical science. Professor Taylor, recognized throughout the United States for his accomplishments in physics education, for his service on such important national bodies as the National Science Foundation and the Research Corporation of New York, for his dedication and zeal in designing and bringing into fruition the present physics building and its laboratory complexes at Southwestern, has established himself as one of this institution's most productivee and competent teachers.

The reader will find that when he or she looks back at what has happened in physics education at Southwestern many years ago, as well as what has happened recently and at what is about to happen in the future, I feel that there will be general agreement that the record of Southwestern's Department of Physics is remarkable. When the reader examines the performances of all of the players on this particular stage, I think there will be a consensus that this department had "the right agenda." This seems to me to be not only reassuring, but it strikes me that the faculty of this particular department has had a rare insight into the meaning of "quality education." The program that the Department of Physics had chosen and explored in company with its teachers and its students throughout the decades indeed has been "the right agenda."

William L. Bowden
President

I. Historical Background

It is the feeling of the author that it is incumbent upon the chairman of a department to report from time to time on developments in the department. Although I have been chairman for the past sixteen years I have failed to do this. It is my hope that this report will bring you up to date. Perhaps future chairmen will want to supplement this as they see fit.

For some time I have wanted to try to gather in some appropriate document a condensation of developments in physics that have taken place since the beginning of our College in 1848. In gathering this material I have been most fortunate in being able to discuss these matters with President Emeritus, Dr. Peyton Nalle Rhodes.

Regardless of the manner in which one might approach a review of the history of physics at Southwestern he cannot help being impressed by the fact that physics and physicists have certainly played a considerable part in the history of this Institution. For example, two physics professors, William M. Stewart and Peyton N. Rhodes, became presidents of Southwestern. In addition, it is interesting to read in the Masonic literature about the lure of "philosophical apparatus" as an inducement both by the citizens of Columbia, Tennessee and Clarksville, Tennessee, to have the Masons locate Southwestern in their city.

In gathering information for this review I have relied heavily on the following books: "The History of Freemasonry in Tennessee 1789-1943" by Charles Albert Snodgrass (published by Ambrose Printing Company, Nashville, Tennessee, 1944) and "Southwestern at

Memphis 1848 - 1948" by Waller Raymond Cooper (published by John Knox Press, 1949).

The Masons of Tennessee had resolved in 1848 to establish somewhere in the state a college under the control and supervision of the Grand Lodge. There were two sites under consideration, the town of Columbia and the city of Clarksville. Columbia agreed to offer Jackson College, already located in Columbia as an inducement and Clarksville agreed to offer its Academy. In discussing the Academy at Clarksville the Masons made the statement "Its chemical and philosophical apparatus is entirely new...". The Masons supporting Jackson College made a similar statement, "The Chemical and Philosophical Apparatus is of considerable value, and sufficiently large for the ordinary purposes of a Collegiate education". It is interesting to learn that the founders of the early Southwestern were aware of the importance of Natural Philosophy, or Physics, apparatus. One can only guess at what was included in the philosophical apparatus.

"By March 1849 the erection of the Masonic College was well underway. The cornerstone had been laid February 22nd, with appropriate Masonic ceremonies.

The site of the College edifice was a beautiful elevated spot about a half mile from the river and containing about six acres. The structure was 138 feet front by 44 feet deep, the center building containing, on the first floor, a main Hall or Chapel 50 x 20 feet, on each side of which was a large room 40 x 23 feet for recitation rooms and two rooms 40 x 20 feet, intended for recitation rooms and for the library and philosophical apparatus." The building was completed in September 1850.

The name of the College was changed several times before it moved from Clarksville to Memphis in 1925 and it has had two different names since coming to Memphis. Listed below are the various names the College has had.

1848 - Montgomery Masonic College

1855 - Stewart College

1875 - Southwestern Presbyterian University

1924 - Southwestern

February 12, 1945 - Southwestern At Memphis

In order to give some idea of just how much the "ball game" has changed over the years, so-to-speak, there are enclosed herein descriptions of the physics offerings taken from the College catalogue for the years 1855, 1925 and 1972 (see Enclosures 1, 2 and 3).

I was certainly impressed at reading on page 10 of the 1855 catalogue by the name of the professor teaching Astronomy, i.e., Herschell. This would have been a famous name in astronomy if he had omitted the last "l" in his spelling. At least all students were taught what the College had to offer in the old days. Today, a considerable number of students pass through Southwestern and never study physics.

II. Physics Professors At Southwestern

MONTGOMERY MASONIC COLLEGE

Name	Period of Service	Comments
William A. Forbes, A.M.	1850	Professor of Mathematics, Natural Philosophy, Astronomy and Civil Engineering. His salary was $1,000.
William A. Forbes	1851	
William M. Stewart, A.M.		Professor of Natural Sciences He later became President of the College. Before leaving Philadelphia to come to Montgomery Masonic College, Stewart had, in connection with other associates, organized in that city the Academy of Science, which soon became one of the most noted institutions of its kind in America. He was also one of the early meteorologists.
Forbes and Stewart	1852 - 1854	

STEWART COLLEGE

Name	Period of Service	Comments
Forbes	1855 - 1860	Colonel Forbes was killed at the Second Battle of Manassas.
Stewart		
Stewart	1860 - 1870	"The fact that this grand old man had been able to accumulate a fortune and might have spent his latter years in any way he chose, but that he actually preferred scientific research and the unremunerative life of a teacher, must have had a tremendous influence on every student of Stewart College".

Name	Period of Service	Comments
		The College reopened after the Civil War in 1870. In 1862 it was occupied by Federal troops. The library was used as fuel, and the astronomical, chemical and physical apparatus were destroyed. The College later collected $25,000 for damages sustained.
William M. Stewart	1870 - 1871	Professor (Emeritus) of Geology and Mineralogy.
		Natural Science was distributed among the Faculty.
Judge W. W. Legare, A.B.	1871 - 1872	Professor of Greek, Natural Philosophy and Astronomy
Stewart		
Same as above	1872 - 1873	
Same as above	1873 - 1874	
John W. Caldwell,A.M.,M.D.	1874 - 1875	Professor of Natural Sciences, etc.
Stewart		

The provisional form of the
SOUTHWESTERN PRESBYTERIAN UNIVERSITY

Same as above	1875 - 1876	
Same as above	1876 - 1877	
Same as above	1877 - 1878	Mr. Stewart died September 26, 1877.

SOUTHWESTERN PRESBYTERIAN UNIVERSITY

John W. Caldwell	1879 - 1880	Stewart Professor of Natural Sciences.
John W. Caldwell	1880 - 1884	

Name	Period of Service	Comments
James Adair Lyon, A.M., Ph.D.	1884 - 1900	Stewart Professor of Natural Sciences. A.B., Princeton Univ.,1872 A.M., ibid., 1875; LL.B., Univ. of Miss.; Ph.D., Princeton, 1882; Mathematical Fellowship, Princeton Univ., 1872; Instructor in the York Collegiate Institute, Pa., 1874-6; Prof. of Math. and Natural Sciences, Highland Univ., Kansas, 1876-8; Prof. of Physics and Chemistry, Washington and Jefferson College, Pa. 1878-85.
James Adair Lyon	1900 - 1915	Stewart Professor of Physics and Astronomy
Henry LeRoy Moore, A.M.	1915 - 1916	Stewart Professor of Physics and Geology
Campbell Creighton Edmondson		Instructor in Physics
Isaac Pierce Mason, A.B.	1916 - 1918	Stewart Professor of Physics and Geology
David Levi Snader, A.E., C.E.	1918 - 1920	Professor of Physics and Engineering
Vivian Leroy Chrisler, A.M.	1920 - 1921	Professor of Physics and Associate in Engineering
George A. Scott, B.S., A.M.	1921 - 1924	Professor of Physics and Associate in Mathematics
John Calvin Pomeroy, A.B.,A.M.	1924 - 1925	Professor of Physics and Associate Professor of Chemistry

<u>SOUTHWESTERN</u> (now located in Memphis)

John Calvin Pomeroy	1925 - 1926	Professor of Physics

Name	Period of Service	Comments
Peyton Nalle Rhodes A.B., A.M., Ph.D.	1926 - 1943	Professor of Physics. Dr. Rhodes holds all of his degrees from The University of Virginia. During part of this period the course in analytical mechanics was taught by Dr. R. W. Hartley, Professor of Mathematics. Dr. Hartley was a Rhodes Scholar. His brother was a physicist with Bell Laboratories and developed the Hartley Oscillator.
P. N. Rhodes	1943 - 1944	
William A. Mueller, B.S., Ph.D.		Assistant Professor of Chemistry and Physics. Dr. Mueller's degrees are in chemistry.
Raymond T. Vaughn, A.B., A.M.		Assistant Professor of Chemistry and Physics. At the time of his death in 1970 he was Chairman of the Department of Chemistry at Southwestern. One of his two sons, Thomas, received his B.S. in physics at Southwestern.
Oliver C. Yonts, B.S.		Assistant Professor of Electronics

SOUTHWESTERN AT MEMPHIS

Name	Period of Service	Comments
Same as above	1944 - 1945	
P. N. Rhodes	1945 - 1946	
P. N. Rhodes	1946 - 1947	
Jack H. Taylor, B.S.		Instructor in Physics
P. N. Rhodes	1947 - 1948	
Vincil E. Moore, B.S., A.M.		Assistant Professor of Physics
Benjamin A. Wooten, Jr., A.B., A.M.		Assistant Professor of Mathematics and Physics

Name	Period of Service	Comments
P. N. Rhodes	1948 - 1949	
B. A. Wooten, Jr.		
B. A. Wooten, Jr.	1949 - 1950	Associate Professor of Physics
John S. McCartney B.S., M.S., Ph.D.		Associate Professor of Physics Dr. Rhodes is now President of Southwestern
Same as above	1950 - 1951	
Same as above	1951 - 1952	
B. A. Wooten, Jr.	1952 - 1953	
B. A. Wooten, Jr.	1953 - 1954	
David E. Matthews A.B., M.A., Ph.D.		Associate Professor of Physics Dr. Matthews died during the Christmas recess and J. C. Nall ('43 & M.S. from M.I.T. at the time) finished out the session.
B. A. Wooten, Jr.	1954 - 1955	
Kenneth Pearce, B.A., M.S.	1955 - 1956	Assistant Professor of Physics
J. H. Taylor, B.S., Ph.D.	1956 - 1959	Associate Professor of Physics
J. H. Taylor	1959 - 1960	
J. J. Freymuth, B.S., M.S.		Assistant Professor of Physics
J. H. Taylor	1960 - 1961	Professor of Physics
J. J. Freymuth		
H. M. Hanson, B.S., M.S., Ph.D.		Associate Professor of Physics

Name	Period of Service	Comments
J. H. Taylor	1961 - 1962	
H. M. Hanson		
R. M. MacQueen, B.S., M.S.		Assistant Professor of Physics
Same as above	1962 - 1963	
J. H. Taylor	1963 - 1964	
H. M. Hanson		
W. R. Hackleman, B.S., M.S.		Assistant Professor of Physics
J. H. Taylor	1964 - 1965	Director, Laboratory of Atmospheric and Optical Physics
H. M. Hanson		
W. R. Hackleman		
F. R. Stauffer, B.S., M.S.		Assistant Professor of Physics. Associate Director, Laboratory of Atmospheric and Optical Physics
W. L. Raine, B.S., M.S.		Assistant Professor of Physics. Bill offered the first formal course work in astronomy since I have been associated with the Department. He also designed the German equatorial mount used with our 31 inch diameter telescope.
J. L. Streete, B.S., M.S.		Research Physicist, Laboratory of Atmospheric and Optical Physics

Name	Period of Service	Comments
J. H. Taylor	1965 - 1966	
F. R. Stauffer		
W. R. Hackleman		
W. L. Raine		
E. A. Barnhardt, B.S., M.S.		Assistant Professor of Physics
J. L. Streete		
J. H. Taylor	1966 - 1967	
F. R. Stauffer		
E. A. Barnhardt		
J. L. Streete, B.S., M.S., Ph.D.		Assistant Professor of Physics
J. H. Taylor	1967 - 1968	
F. R. Stauffer		Associate Professor of Physics
E. A. Barnhardt		
J. L. Streete		
E. S. Dorman, B.S., Ph.D.		Assistant Professor of Physics
Same as above	1968 - 1969	
J. H. Taylor	1969 - 1970	
F. R. Stauffer		
E. A. Barnhardt		
J. L. Streete		
J. R. Beacham, B.S., M.S., Ph.D.		Assistant Professor of Physics
J. L. Schmitt, B.S., M.S., Ph.D.		Assistant Professor of Physics

Name	Period of Service	Comments
J. H. Taylor	1970 - 1971	
F. R. Stauffer		
E. A. Barnhardt		
J. L. Streete		Associate Professor of Physics
J. R. Beacham		
J. L. Schmitt		
J. H. Taylor	1971 - 1972	
F. R. Stauffer		
E. A. Barnhardt		Associate Professor of Physics
J. L. Streete		
J. R. Beacham		
J. L. Schmitt		

Note: In addition to academic appointments, each staff member also holds an appointment in the Laboratory of Atmospheric and Optical Physics.

III. Support Staff Associated With Physics At Southwestern

Name	Period of Service	Comments
G. P. Ruffin	December 15, 1957-August 15, 1970	Gardner was the first of the Support Staff to be hired by President Rhodes after I joined the Department. He was forced to resign because of ill health. For many years he was in charge of our Machine Shop. His services are being sorely missed.
A. C. Emery	June 2, 1961-to date	His friends call him ACE. He is our Electronics Technician. Probably the best way to describe him is to say that he is of the Leonardi de Vinci type. He is an amateur astronomer and is also in charge of our Optics Shop. In addition, he is a licensed amateur radio operator and is in charge of the Department's ham station (WA4-HTB). I could amplify further but I won't except to say he is a deacon in his church and a master gardener.
John E. McKinley	June 1, 1964-February 1965	Design Engineer for the Laboratory of Atmospheric and Optical Physics. John came to us from the Electro-Optics Group (Cape Kennedy). He already had a degree in engineering but wanted additional training in optical physics. Since we had no money we traded him training for his expertise.
Miss Gail Wheeler	June 18, 1964-July 18, 1964	Secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics

Name	Period of Service	Comments
Mrs. Linda Jernigan	August 2, 1964 - September 1964	Secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics
Mrs. Sally Ross	October 27, 1964- June 30, 1969	Secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics
Ernest L. Goad	November 30, 1964- 1965	Part-time Machinist
Charles W. Brandon III	June 1, 1965 - September 1966	Electronics Engineer with the Laboratory of Atmospheric and Optical Physics
William N. Johnson	July 20, 1965 - June 1, 1971	Machinist. Bill is an extremely able instrument maker. His hobby is rebuilding antique automobiles.
Mrs. Lynda Gayle Deacon	July 1, 1969 - September 15, 1970	Secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics
Mrs. Nancy Helen King	September 8, 1970- to date	Secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics
Ernest L. Goad	September 1970 - to date	Part-time Machinist. Ernie is outstanding in his work with the students. It has been a pleasure to observe him in action.

IV. Alumni Of The Department Of Physics

Alumnus	Degree	Year	Comments
John A. Rollow	B.S.	1926	After a lifetime of service to Southwestern he retired as Engineer of the College in 1968. Mr. Rollow died in 1969. He and J. C. Pomeroy packed the physics apparatus that was shipped from Clarksville. Dr. Rhodes says the kilogram masses were inadvertently packed in the same box as the Wimhurst Static Machine!
William C. Montgomery	B.A.	1929	M.S. in Mathematics and Physics in 1932 from Vanderbilt University Member of engineering staff, Radio Station WSM (Nashville, Tenn.)
Arthur C. Omberg		x1931	Attended Southwestern for 2 years. B.E. (1932), M.E. (1934) and Ph.D. from Vanderbilt University. Member of engineering staff, Radio Station WSM (Nashville, Tenn.) Director of Engineering and Research for the Radio Division of Bendix Aviation Corporation.
John W. Flowers*	B.S.	1931	Ph.D. in 1935 from University of Virginia. Professor of Physics, University of Florida.
Leroy Wilson Raney		x1933	Attended Southwestern for 2 years. Formerly Chief Engineer, Radio and Television Station WREC (Memphis, Tenn.)
C. Scudder Smith*	B.S.	1934	Ph.D. in 1938 from University of Virginia. Inventor, holder of many patents, businessman. His grandfather, Dr. George Summey, was Chancellor of Southwestern Presbyterian University 1892-1903.
J. Richard Drake, Jr.	B.S.	1936	M.S. in 1938 from University of Michigan. Formerly with Willow Run Laboratories (University of Michigan). Now teaching at Paul Smith's College (N.Y.)
Charles A. Barton	B.S.	1937	M.S. in 1939 from New York Univ. The Reverend Charles A. Barton, D.D. is a Methodist minister in Mount Kisco, N.Y.
O. C. Yonts**	B.S.	1937	M.S. from University of Chicago. He has had a long and distinguished career at Oak Ridge National Laboratory.
Craig M. Crenshaw*	B.S.	1937	Ph.D. in 1942 from New York University. Chief Scientist for Signal Corps Research and Development. Prior to this he was Director of the Physical Sciences Division, Evans Signal Laboratory, Fort Monmouth, New Jersey. He received the Army Exceptional Civilian Service Award.

Alumnus	Degree and Year		Comments
Robert A. Elder**	B.S.	1940	Friend and benefactor of Southwestern. After a career in the Air Force he retired as a Colonel. He is now Vice-President of Allen and O'Hara, a distinguished construction company. This company has built several buildings on the Campus.
W. O. McMinn*	B.S.	1941	Ph.D. in 1951 from University of Indiana. Owner of McMinn Optical Company. Those of us who know him still remember his unusual abilities in experimental work. For many years Dr. Rhodes kept McMinn's laboratory reports to show other students how experiments should be done. Dr. McMinn is now a skilled optical craftsman and the Department has purchased many mirrors from his company. Sigma Xi
E. N. Adams, Jr.	B.S. (Chemistry)	1943	Ph.D. (Physics) in 1950 from University of Wisconsin. He is associated with International Business Machines (IBM).
J. C. Nall**	B.S.	1943	Ph.D. in 1958 from Vanderbilt University. He has made a career with the Central Intelligence Agency (CIA). Member of Southwestern's basketball team. Omicron Delta Kappa.
Roland W. Jones, Jr.**	B.S.	1943	After serving as an officer in the Navy during World War II he returned to his delta plantation where he continues to farm, using of course, physics to help his yield. Omicron Delta Kappa.
J. H. Taylor**	B.S.	1944	Ph.D. in 1952 from The Johns Hopkins University. Fellow - Optical Society of America and American Association for the Advancement of Science. Member of Southwestern's tennis team. Phi Beta Kappa, Sigma Xi, Omicron Delta Kappa.
Frank P. Elby**	B.S.	1947	M.S. in 1952 from The Johns Hopkins University. He is associated with Statistical Research Incorporated (Westfield, New Jersey)

Alumnus	Degree and Year		Comments
Jack Simonton**	B.S.	194	Colonel Simonton has made a career in the Air Force.
D. D. Aufenkamp**	A.B.	1949	Ph.D. in 1952 from the University of Paris. Dr. Aufenkamp is an authority on computer science. He is a member of the staff of the National Science Foundation.
M. E. Rickey	B.S. (Mathematics)	1949	Ph.D. (Physics) 1958 from Univ. of Washington. Dr. Rickey is an authority on particle accelerators. He has been associated with the Brookhaven National Laboratory and the University of Colorado (where he helped design their cyclotron). He is now on the physics staff at the University of Indiana. Phi Beta Kappa.
R. F. Stratton, Jr.	B.S.	1951	Ph.D. in 1957 from the University of Tennessee. Former member of the staff at the Oak Ridge National Laboratory. Presently he is Chairman of the Science Division at Pikeville College (Pikeville, Kentucky)
D. W. Feldman*	B.S.	1952	M.S. from the Pennsylvania State University. Ph.D. in 1959 from the University of California. Phi Beta Kappa
M. C. Whatley**	B.S.	1956	Ph.D. in 1963 from the University of Wisconsin. He is a member of the physics staff at Washington University. Omicron Delta Kappa.
Ed Smith Dorman*	B.S.	1958	Ph.D. in 1965 from The Johns Hopkins University. He is on the physics staff at Western Kentucky University. Won Woodrow Wilson Fellowship. Phi Beta Kappa.
E. Allen Barnhardt	B.S.	1959	M.S. in 1961 from Vanderbilt University. Won an Atomic Energy Fellowship.
William R. Hackleman*	B.S.	1959	M.S. in 1961 from the University of North Carolina. Won a Southern Regional Fellowship. Phi Beta Kappa
Fred E. Bertrand	B.S.	1960	Ph.D. in 1968 from The Louisiana State University. He is on the physics staff at the Oak Ridge National Laboratory. Member of Southwestern's basketball team.

Alumnus	Degree and Year		Comments
Bryan M. Eagle	B.S.	1960	B.S. in 1961 in Business Administration from Harvard University. He owns his own solid state electronics company. Businessman.
David P. Glenn	B.S.	1960	M.S. in 1961 from the University of Florida. He is associated with Pan American World Airways (Cape Kennedy). See Enclosure 4 for a discussion of David and some of his work that appeared in "Careers In Optics" published by the Optical Society of America.
Robert M. MacQueen*	B.S.	1960	Ph.D. in 1967 from The Johns Hopkins University. He is a member of the staff of the High Altitude Observatory. He is the younger son of Dr. M. L. MacQueen, formerly Chairman of Southwestern's Department of Mathematics. Member of Southwestern's basketball team. Omicron Delta Kappa.
John L. Streete	B.S.	1960	M.S. in 1961 from the University of Florida. Ph.D. in 1967 from the University of Florida. During his senior year at Southwestern he was Vice President of the student body. Omicron Delta Kappa.
Donald O. Tate	B.S.	1960	M.S. in 1963 in Business Administration from the University of Southern California.
Kenneth E. Yancey	B.S.	1960	Ph.D. in 1967 from the Virginia Polytechnic Institute. Chairman of the Department of Physics, Lambuth College (Jackson, Tenn.)
William L. Raine III*	B.S.	1961	M.S. in 1962 from Harvard University. He is working as an astrophysicist in Huntsville, Alabama.

Alumnus	Degree and Year		Comments
Enloe T. Ritter*	B.S.	1961	Ph.D. in 1966 from The Johns Hopkins University. He is associated with the Atomic Energy Commission. First student in the history of the Department to win a National Science Foundation Fellowship. Phi Beta Kappa
Harry L. Swinney*	B.S.	1961	Ph.D. in 1968 from The Johns Hopkins University. He is on the physics staff of New York University. Phi Beta Kappa
Wilber R. Fleming	B.A.	1962	Operations analyst (Technical Operations, Inc. Arlington, Virginia).
Joseph M. Ajello*	B.S.	1962	M.S. in 1963 from Rensselaer Polytechnic Institute. Ph.D. in 1969 from University of Colorado. Phi Beta Kappa. Joe appended the following note on a Christmas card he sent me (1971): "I am working on Mariner Mars representing the Ultraviolet Spectrometer (Group) of the University of Colorado. It is a fascinating job watching the daily data gathering and the decay of the dust storm. We have also gotten nice emission spectra of the upper atmospheric day glow layers."
Paul W. Lawrence*	B.S.	1962	M.S. in 1964 from The Johns Hopkins University. Phi Beta Kappa
William G. Mankin*†	B.S.	1962	Ph.D. in 1969 from The Johns Hopkins University. He is a member of the staff of the High Altitude Observatory. Only student in the history of the Department to win both a Woodrow Wilson and a National Science Foundation Fellowship. Phi Beta Kappa
Jack D. Herbert	B.A.	1962	Ph.D. (Biochemistry) 1970 from the Louisiana State U.
Oliver B. Dickins	B.S.	1963	M.S. in 1966 from the Univ. of Alabama.

Alumnus	Degree and Year		Comments
Philip J. Green *	B.S.	1963	Ph.D. in 1967 from the Louisiana State University. A member of the physics staff at Texas A & M.
John D. McCharen	B.S.	1963	Ph.D. in Mathematics in 1969 from the Louisiana State University.
William Ross McCluney	B.A.	1963	
Laney R. Mills	B.S.	1963	Ph.D. in 1971 from the Louisiana State University. He is a member of the physics staff at the College of Charleston.
James A. Warden	B.S.	1963	Ph.D. in 1968 from the University of South Carolina. He is a member of the physics staff at Wabash College.
Edwin Boyd Ellison	B.S.	1964	Operations Research Analyst (J.P. Stevens & Co., Inc. Charlotte, N.C.)
Jack D. Aldridge	B.S.	1965	He is in charge of the BioMedical Computer Center, University of Tennessee Medical Center (Memphis).
Shannon L. Ball	B.S.	1965	Associated with Ling-Temco-Vaught
William S. Boyd *	B.S.	1965	Ph.D. in Mathematics in 1969 from the University of Tennessee. A member of the mathematics staff at Western Michigan College (Kalamazoo, Michigan).
Charles W. Brandon III *†	B.S.	1965	Consultant in medical electronics and computer software (Memphis, Tenn.). Won Woodrow Wilson Fellowship. Phi Beta Kappa
Charles W. Robertson *	B.S.	1965	Ph.D. in 1969 from Florida State University. Research Associate at Kansas State University.

Alumnus	Degree and Year		Comments
Sara W. Hoffman *	B.S.	1966	M.S. in 1969 from the University of Tennessee. Presently pursuing Ph.D. in Astronomy at the University of Florida.
Paul W. Holmes	B.A.	1966	
Wayne E. Moore	B.S.	1966	M.S. in 1968 from Wake Forest University. Ph.D. in 1971 from Clemson University.
Raymond T. Vaughn, Jr. *	B.S.	1966	M.S. in 1968 from Florida State University. Phi Beta Kappa
Martin F. Wehling	B.S.	1966	M.S. in 1968 from University of Mississippi.
James M. Durham **	B.S.	1967	M.S. in 1968 from the University of Oslo. Won Fulbright Scholarship to Norway. Captain of Southwestern's track team and member of the football team. Omicron Delta Kappa
A. Currie Johnston **	B.S.	1967	M.S. in 1968 from Dartmouth. Presently an officer in the Air Force.
Douglass E. Post *†	B.S.	1967	Ph.D. candidate at Stanford University. Phi Beta Kappa
Martin E. Smithers	B.S.	1967	Ph.D. candidate at Washington University.
Swinton A. Roof**†	B.S.	1968	Phi Beta Kappa
Charles W. Shaw	B.S.	1968	Officer in the Air Force
K. Suzanne Troth	B.A.	1968	Member of Trust Department, First National Bank (Memphis, Tennessee)
John E. Weaver	B.A.	1968	Working as an optical physicist in Huntsville, Alabama.

Alumnus	Degree and Year		Comments
Mclaurin Smith	B.A.	1969	High School Teacher in Mississippi.
David F. Elmore	B.S.	1969	M.S. in 1971 from the University of Colorado. Candidate for Ph.D. at the University of Colorado. Member of Southwestern's track team.
Kenneth M. Cushing	B.S.	1969	Candidate for Ph.D. at the University of Florida.
Steven Rand Walker	B.S.	1969	Peace Corps (Malaysia)
Douglas S. Goodman **†	B.S.	1969	Candidate for Ph.D. at the University of Illinois. Member of Southwestern's football team. Phi Beta Kappa
Richard Raspet **	B.S.	1969	Candidate for Ph.D. at the University of Mississippi.
J. Timothy Atkinson **	B.S.	1970	Control Department - Union Planters National Bank(Mphs)
R. Bradfield Kummer *	B.S.	1970	Candidate for Ph.D. at the University of Florida.
P. Martin Simpson, Jr. *	B.S.	1970	Candidate for Ph.D. at Rice University. Phi Beta Kappa
Thomas C. Marshall **†	B.S.	1971	Candidate for Ph.D. at the University of Florida.
Stephen E. Kendrick**	B.S.	1971	Candidate for Ph.D. at Purdue University.
Earl L. Kiech	B.S.	1971	Candidate for M.S. at Memphis State University.
Michael M. Moses	B.S.	1971	Working in computer science in Memphis.
Klaus F. Heimburg	B.S.	1971	Klaus' father was with Wernher Von Braun at Peenemunde and came with Braun's group to Huntsville, Alabama.

Alumnus	Degree and Year	Comments
David L. Hume, Jr.		Candidate for B.S. in June 1972
E. David Mays		Candidate for B.S. in June 1972
Robert M. Riley		Candidate for B.S. in June 1972
Glenn A. Sowell		Candidate for B.S. in June 1972

* = Graduated with Honors in Physics

** = Graduated with Distinction

† = One of about 30 students chosen from throughout the United States each summer to attend the Columbia University Summer Institute in Space Physics. This highly successful program began in 1961 and terminated in 1968. It was under the direction of Dr. Robert W. Jastrow.

We have in the Department files a fairly sizeable collection of projects that have been done by the students. This collection dates back to 1958. Some of these papers contain reports on Honors projects and work done under the National Science Foundation supported Undergraduate Research Participation Program. There are still others done by students under no formal program but just because they got interested in a problem. Listed below are the project reports we have at this writing.

Alumnus	Title of Project	Year	Honors Project	NSF URP Project	Other
E. S. Dorman	Selected Laboratory Experiments	1958	X		
E. A. Barnhardt	Experimental Studies in Physics of Thin Films and Infrared	1959			X
W. R. Hackleman	Vacuum Evaporation Apparatus	1959	X		
F. E. Bertrand	Investigation of the Hall Effect	1960			X
B. M. Eagle	Examination of the Cenco Radioactivity Apparatus	1960			X
D. P. Glenn	Construction of a Plane Grating Spectrometer Using the Ebert Mounting	1960			X
R. M. MacQueen	Solar Studies, Infrared, Thin Films	1960	X		
D. O. Tate and K. E. Yancey	Spectral Response of a Phototube	1959			X
K. E. Yancey and D. O. Tate	Forced Mechanical Oscillations	1960			X
W. L. Raine	Interferometric and Spectroscopic Studies of Zeeman Splitting	1961	X		
E. T. Ritter	Apparatus for Use in the Determination of Infrared Quantum Vibrational Lifetime	1961	X		

Alumnus	Title of Project	Year	Honors Project	NSF URP Project	Other
E. T. Ritter and W. L. Raine	Part I - Moderate Resolution Solar and Lunar Spectra	1959		X	
	Part II - Determination of the Effective Radiating Temperature of the Ozone Layer over Memphis.			X	
H. L. Swinney	Electricity and Magnetism Laboratory Experiments	1961			X
	Solar Work, Near Infrared Sources, Vacuum Deposition of Thin Films, Thin Film Characteristics	1959		X	
	Spectroscopic Studies of Exploding Wire Phenomena	1961	X		
J. M. Ajello	Project Firefly	1960		X	
	Design and Construction of a Fabry-Perot Interferometer	1962	X		
P. W. Lawrence	Vibration-Rotation Line Intensities of Allene Molecule	1962		X	
	Plasma Arc Source for High Temperature Spectral Studies	1962	X		
W. G. Mankin	Project Firefly	1960		X	
	Design of Beta Ray Spectrometer	1962	X		
P. J. Green	Plasma Physics	1961		X	
	An Experimental Study of the Vacuum Deposition of Thin Aluminum Films	1963	X		
J. D. McCharen	Cosmic Rays, Wavelength Calibration of an Infrared Spectrometer, Solar Furnace, Determination of the Effective Radiating Temperature of the Ozone Layer over Memphis.	1961		X	

Alumnus	Title of Project	Year	Honors Project	NSF URP Project	Other
J. A. Warden	Cosmic Ray Telescope, Determination of the Effective Radiating Temperature of the Ozone Layer over Memphis, Wilson Expansion Chamber, Determination of Half-life of Thoron.	1961		X	
	Construction and Operation of a Nuclear Magnetic Resonance Absorption Apparatus.	1963			X
J. D. Aldridge	Visual, Electrical and Spectroscopic Demonstration of the Franck-Hertz Experiment.	1964			X
J. D. Aldridge and C. W. Brandon	Selected Experiments in Absolute Radiometry	1964			X
W. S. Boyd	Solar Eclipse - Ozone Experiment	1963		X	
	The Torsion Pendulum: A Study of an Impulse-Driven Damped Mechanical Oscillator.	1964			X
	Cleaning Techniques for Deposition of Thin Films on Glass and the Procedure for Using the Thermal Evaporation Apparatus at Southwestern.	1963			X
	Observations of the Photosphere using a Derivative Spectrometer.	1965	X		
C. W. Brandon	Solar Eclipse Report	1963		X	
	Development of Apparatus for the Study of Heated Gases Produced by Lightning	1965	X		
C. W. Brandon and C. W. Robertson	Zeeman Splitting of the Hg Green Line	1964			X

Alumnus	Title of Project	Year	Honors Project	NSF URP Project	Other
C. W. Robertson	Solar Eclipse Report	1963		X	
	Aluminum Thin Films, Film Thickness and Cleaning.	1964			X
	Atmospheric Transmission In The Infrared	1965	X		
S. W. Hoffman	An Experimental Determination of the Infrared Spectral Reflectivities of Ice, Snow and Solid Carbon Dioxide.	1966	X		
S. W. Hoffman and M. F. Wehling	Experimental Determination of the Solar Constant	1964		X	
W. E. Moore	Radiometric Observation of Lightning and the Day Sky	1965			X
R. T. Vaughn, Jr.	Derivative Spectroscopy	1966	X		
J. M. Durham	The Atmospheric Absorption of Electromagnetic Radiation in the Near Infrared Spectral Region	1967	X		
J. M. Durham and J. M. McKnight, Jr.	High Resolution Studies of Atmospheric Absorption Spectra	1965		X	
D. E. Post	The 31 Inch Diameter Telescope	1966		X	
	Infrared Stellar Photometry	1967	X		
D. E. Post and S. A. Roof	Stellar Radiometry	1965		X	
M. E. Smithers	Lightning, Airglow and Meteors	1966		X	
J. E. Weaver	The Design and Construction of a Solar Prominence Telescope	1968			X
F. D. Elmore	Spectral Radiance of a High Intensity Carbon Arc	1969	X		

Alumnus	Title of Project	Year	Honors Project	NSF URP Project	Other
K. M. Cushing	Derivative Solar Spectrum (0.4600 - 0.6000 micron)	1967		X	
	Applications of Optical Derivative Spectroscopy	1969	X		
R. B. Kummer	Flash and Prominence Spectra During the Total Solar Eclipse of 7 March 1970	1970	X		
P. M. Simpson, Jr.	Changes in the Effective Radiating Temperature of the Ozone Layer During the 7 March 1970 Total Solar Eclipse.	1970	X		

Summer 1965 U.R.P.

James M. Durham
Douglass E. Post, Jr.
James M. McKnight, Jr.
Wayne E. Moore

Summer 1966 U.R.P.

Swinton A. Roof
A. Currie Johnston
Clyde Lee Giles
Douglass E. Post, Jr.

Summer 1967 U.R.P.

Kenneth M. Cushing
David F. Elmore

Summer 1968 COSIP

P. Martin Simpson, Jr.
J. Timothy Atkinson
Douglas S. Goodman

Summer 1969 COSIP

Earl L. Kiech
Michael M. Moses
R. Bradfield Kummer

Summer 1970 COSIP

Glenn A. Sowell
E. David Mays
John B. Hampton

Academic Year 1965 U.R.P.

Sara W. Hoffman
R. T. Vaughn, Jr.

Academic Year 1966 U.R.P.

James M. Durham
Swinton A. Roof

In Southwestern's proposal to the National Science Foundation for a grant under their College Science Improvement Program (COSIP) part of the Physics Department's request was for funds to send one of our majors at the end of his junior year to participate in research at the High Altitude Observatory. These students were under the direction of Dr. George William Curtis at H.A.O.. The High Altitude Observatory kindly consented to pay these students, thus making

The Department has been greatly assisted in its efforts to involve students in research by the National Science Foundation. As a result of grants from the National Science Foundation under its Undergraduate Research Participation and College Science Improvement Programs the following students have received financial support for research.

<u>Summer 1959 U.R.P.</u>

Harry L. Swinney
Robert M. MacQueen
Enloe T. Ritter
William L. Raine III

<u>Summer 1960 U.R.P.</u>

William G. Mankin
Joseph M. Ajello
James S. Gray
John L. Streete

<u>Summer 1961 U.R.P.</u>

James A. Warden
Philip J. Green II
Paul W. Lawrence, Jr.
John D. McCharen, Jr.

<u>Summer 1963 U.R.P.</u>

William S. Boyd, Jr.
Charles W. Brandon III
Charles W. Robertson
Jack D. Aldridge

<u>Summer 1964 U.R.P.</u>

Wayne E. Moore
Martin F. Wehling
Martin E. Smithers
Sara W. Hoffman

available to the Department the opportunity to use these funds to support additional students in research on the Campus. The students who worked at H.A.O. are listed below. Enclosures 5 and 6 are copies of letters I received concerning the performance of these students. We are very proud of these students and we are most grateful to Dr. Curtis for these letters.

Summer 1968 at the High Altitude Observatory

David F. Elmore

Summer 1969 at the High Altitude Observatory

P. Martin Simpson, Jr.

Summer 1970 at the High Altitude Observatory

Stephen E. Kendrick

The following students received summer appointments at the Oak Ridge Institute for Nuclear Studies

Enloe T. Ritter - Summer 1960

William G. Mankin - Summer 1961.

Working as a member of the Electro-Optics Group at Cape Kennedy during the Summer of 1964 was Charles W. Robertson.

I am most appreciative of the efforts of Dr. Ralph C. Hon, formerly Chairman of Southwestern's Department of Economics, in bringing outstanding students to Southwestern. Dr. Hon was in charge of the Union Carbide Scholarship Program that began in 1957. During the few years this Program was in effect Dr. Hon was extremely successful in locating outstanding high school seniors in the Memphis area and convincing them to do their undergraduate work at Southwestern. Dr. Hon brought five students to the College under this Program and three of them majored in physics. The three majoring in physics were E. S. Dorman, W. G. Mankin and E. T. Ritter. It was, of course, gratifying to all concerned that these three had an outstanding record while at Southwestern and went on to obtain their Ph.D. degrees in physics. Another of the five students is M. P. Jones who also distinguished himself while at Southwestern and went on to get his Ph.D. in mathematics. He is now Associate Dean at Southwestern. The fifth student, Frank G. Morris, Jr., followed the 3-2 program and also had an excellent record. He is now associated with Proctor & Gamble. This Union Carbide Scholarship Program provided full tuition and fees for four years. The first student to win one of these coveted scholarships was E. S. Dorman. Ed had finished his freshman year when he was awarded the scholarship and the other students held their scholarships for the full four years.

V. Developments In Physics Since 1925

Dr. Rhodes has often paid tribute to Dr. Charles E. Diehl, his predecessor and to Mr. A. J. Weed, the mechanician in the Rouss Physical Laboratory at the University of Virginia for their examples of always refusing to accept the easy way or inferior products instead of the best and most excellent. Dr. Diehl, who obtained his undergraduate degree with a major in physics and mathematics at The Johns Hopkins University, was uniformly helpful in encouraging physics and all of the natural sciences to the point of taking chances on finding the necessary money. Before coming to Southwestern Dr. Rhodes, with the enthuasism and energy of a 26-year-old Ph.D., had made out a list of needed physics equipment for classes likely to be taught and of a size determined from such probable enrollment data as he could obtain. He had been assured by someone that physics was well equipped. Upon his arrival on the Campus in the hot September of 1926 he found practically no apparatus at all. Much of the old apparatus shipped from Clarksville had been broken and those few pieces of "modern" equipment he did find were on the floor of a basement closet. His dismay was complete. He quickly revised all of his previous estimates and presented President Diehl with a list of immediate needs costing some $3,000. There was really no money available and the College was already encumbered with a $700,000 construction debt. Dr. Rhodes clearly remembers the afternoon he presented the urgent and immediate needs for just getting classes started. Dr. Diehl thought a bit and then said, "We can't pay for it, but go ahead and order what you need, taking care that it is of the best quality." This calculated gamble on the future could not help impress mightily a young and aspiring teacher. On a later occasion Dr. Diehl insisted that all apparatus cabinets be constructed of oak to match other building trim rather than of cheaper lumber, "for there must be nothing shoddy or of a substitute nature at Southwestern."

Mr. Weed could make anything required from wood, brass and steel. Plastics had hardly come on the market. Every piece of apparatus he constructed for the graduate students was polished and refined to make it beautiful as well as useful for its intended purpose and he would never release a half done job. He had the capacity and willingness to take infinite pains, even with less important equipment, no matter how great the effort.

The first piece of equipment of a homemade or locally produced nature after Southwestern moved to Memphis was the long wooden "Galileo's plane." This was in the fall of 1926 when Mr. B. B. Scarbrough, who had been a construction foreman on one or more of the original buildings, had accepted for one year the position of Superintendent of Buildings and Grounds. (The next or second year in Memphis, he was succeeded by Mr. John A. Rollow '26, who held this post with various titles until his retirement in 1968). Mr. Scarbrough had made at a Memphis lumber mill, according to specifications given by Dr. Rhodes, this useful plane which still serves its purpose. Where the necessary pool ball was secured is not recalled. The metronome used as a timer came down with other Clarksville apparatus.

Dr. Rhodes took many calculated gambles (or faith in the future) himself, as President. One of these was when he let us establish a machine shop and bring in Mr. G. P. Ruffin.

I think that perhaps most of you know that Peyton Rhodes did his Ph.D. thesis at the University of Virginia. In fact, he holds three degrees from there, his B.A., M.A. and Ph.D.. Dr. Rhodes, in one of the many talks that I have heard him give over the years, pointed out an interesting observation of his of which I had not previously been aware. This observation had to do with the "close coupling," so-to-speak, among the University of Virginia, The Johns Hopkins University and Southwestern. Dr. Rhodes pointed out that some of his professors at Virginia had been trained at Hopkins (namely, Llewellyn Hoxton and Carrol M. Sparrow), that he had sent some of his students to Virginia for their Ph.D. work (John Flowers, Richard Drake and Scudder Smith), that three of the staff members who have been associated with physics at Southwestern (J. H. Taylor, E. S. Dorman and F. R. Stauffer) did their graduate work at Hopkins and that Southwestern has sent several (namely six) of its graduates since 1956 to Hopkins. In a talk given to The Egyptians shortly after he retired Dr. Diehl said of his Hopkins experience "To revert again to my Johns Hopkins' days, where my ideals of genuineness and excellence were fully realized and confirmed ..."

During his first years at Southwestern Dr. Rhodes assembled apparatus to continue research along the lines of the work he and Jesse W. Beams were doing at Virginia, namely, determination of the time intervals between the appearance of certain spectrum lines of helium and mercury. To the best of my knowledge these were the only efforts at research until possibly immediately after World War II.

I think it is safe to say that the major efforts exerted by Peyton Rhodes were along pedagogical lines. This was certainly the pattern followed by most liberal arts colleges until the beginning of the Sputnik era in about 1956. I shall always remember the well organized laboratory work conducted by Dr. Rhodes. The General Physics laboratory, for example, was a model of efficiency and organization. As some of you will also remember, Dr. Rhodes put a lot of emphasis on good lecture demonstrations and he excited in me an interest in this important phase of teaching that has never waned. Photographs of some of his demonstrations and laboratory set-ups are included herein (see Photographs 1, 2, 3 and 4).

Beginning about 1937 Southwestern participated in the Civilian Pilot Training Program and other similar programs before the United States was actually at war. In these programs the Physics and Mathematics Departments bore the brunt of the training. Dr. Rhodes recalls three such programs and said that Robert A. Wlder ('40) may have been the first officer commissioned out of the Southwestern group.

World War II had, of course, a major disruptive influence on physics at Southwestern as it did in most other institutions. Those of us who were privileged to obtain our degrees before entering the military were forced to do quite a bit of self-education. In order to remain financially viable Southwestern trained cadets under the Army Air Force College Training Program. The first section of the 13th College Training Detachment (Aircrew) arrived on the Campus March 1, 1943. Part of this training was in physics, meteorology and certain other closely related subjects. For about 18 months some 1500 college-age men received training in ever changing increments of 50 with 250 on campus at one time. At one time the Physics

Department was running 200 men/day through a rather elementary general physics course using equipment normally available for about 30 students. Laboratories were set up in some 4 rooms and equipment rapidly shifted as needed. At the same time 3 women students were taking a second year electricity and magnetism course (Sara Virginia Sparr, Charlotte Adee Edmondson and Mrs. Katherine Boyd)

Suffice it to say that a considerable burden fell upon the Physics Department and many of us students assisted in any way we could, mostly however, as laboratory assistants. The Department which had previously been a one man department, namely, Peyton Rhodes, was expanded by bringing in O. C. Yonts, W. A. Mueller and J. D. Simpson (physics teacher at Central High School, Memphis, Tennessee). It should also be pointed out that at about this time (1944) Dr. Rhodes had been appointed Vice President of Southwestern. He was appointed President in 1949 bringing to a close his teaching career in physics.

The period 1947 to 1956 was one of considerable staff turnover with the attendant difficulties normally associated with such disruptions. One professor, Dr. David E. Matthews, died during the Christmas recess. The others were here for relatively short periods. I remember quite vividly the physical appearance of things when I joined the Department in 1956. My regret now is that I did not photographically document the situation. However, I am confident that Robert MacQueen will substantiate this as he was an entering freshman my first year. In fact, he was of great help to me in trying to make some order out of complete chaos. Many of you will recall that physics at that time was housed in the old Science Building (now the chemistry building and called Kennedy Hall). Physics occupied part of the first floor and part of the basement. The lighting in the rooms as well as in the corridors was low by any standard and unbelievably so by modern standards. In addition, every door in the building was solid oak and there was not a single translucent or transparent window in any door. If I might be allowed a certain poetic license at this point let me say that the corridors could best be described as being "black bodies." One of the first things done was to install windows in the doors. Incidentally, we are still using (for one purpose or another) the solid oaken plugs taken from the doors.

From my student days I remembered the high degree of organization and neatness maintained by Peyton Rhodes. The shock on entering the electrical measurements (no pun intended) and optics laboratories on the first floor can be best described by the adjective, unbelievable. There were literally dozens of government surplus wooden filing cabinets stacked on top of each other and crammed with components, a glass turning lathe and the attendant mess of a glass working facility, innumerable other pieces of "stuff" plus many of the old dark stained apparatus cabinets that came with the Department when it moved from Clarksville. In order to read a meter anywhere in those laboratories it was necessary to use a flashlight. Several factors contributed to this non-Rhodesian condition, namely, the rapid turnover of personnel during this period, the lack of anywhere near adequate space for physics, failure of the Physics Staff to root out additional space in the "bowels" of the boiler room and the basement area of the old Science Building and the beginning of the availability of World War II government surplus property, i.e., there was a considerable net inward divergence.

My arrival on the scene here in 1956 coincided rather closely with the beginning of the Sputnik era. I had resigned my position as a physicist in Dr. John A. Sanderson's Optics Division at the U. S. Naval Research Laboratory in Washington, D. C. to come to Southwestern. Many of my colleagues at the Naval Research Laboratory had been working on the Vanguard Project. Shortly after my arrival at Southwestern I was asked to speak at a meeting of the Amateur Astronomers of Memphis at what was then called the Pink Palace (it is now called the Memphis Pink Palace Museum). I remember very vividly driving (incidentally, this was before I stopped driving) to this meeting with the car radio on and heard the announcement of the launching of the first Sputnik. The action following this event is, of course, well known to you. Shortly thereafter the quality and quantity of science teaching in the United States began to change. Small liberal arts colleges, with no tradition in research, began research programs as a means of improving their teaching. Southwestern was no exception.

If one were to inquire about the uniqueness of the physics program at Southwestern he would not find it in the curriculum. The curriculum is more or less standard, i.e., what you would find in most good colleges. The uniqueness of the program lies in the philosophy we have adopted concerning our research efforts and our staff additions.

We asked ourselves the following question, namely, how can a small physics staff in a small liberal arts college provide its students with a really meaningful undergraduate research experience. This question presupposes, of course, our acceptance of the idea that research can be a great stimulus to undergraduate teachers and teaching. Our answer to the question was to restrict our research efforts to one area of physics, namely, optical physics. In so doing our ratio of "staff members/area of research" is as high, or higher, than one will find in many of the large graduate universities.

The reason for the choice of optical physics is simple, i.e., it was my area of specialization. As things have turned out it was a good choice. It is an area in which it is possible to meaningfully involve undergraduates, i.e., it is not too complicated for them at the undergraduate level. Also, it is not nearly as expensive as other areas of physics. Every staff member added to the Department since I arrived has had his graduate training in some area of optical physics.

The majority of the Department's research activity since 1956 has been in the area of infrared physics. This work has involved us in both research on campus and in the field. Several of our field trips have been for the purpose of studying infrared radiation from the sun's corona during the time of a total solar eclipse. As most of you know, the name of the game is "involve the students." On all of our field trips we make every effort to involve as many of our students as possible. Enclosed is an article I wrote for Applied Optics entitled "Optical Physics Research in a Small Liberal Arts College" that might be of some interest to you (see Enclosure 7). We have tried to teach creativity to our students. I will be the first to admit that I do not know how to do this. The teaching of subject matter is a rather straightforward matter. Intuitively I have always felt that one method of teaching creativity is to surround the students by creative teachers.

One of the highlights in the history of physics at Southwestern certainly has to be the establishment of the Laboratory of Atmospheric and Optical Physics (established May 7, 1964 and formally announced June 12, 1964). We had worked long and hard for this. Few people realize just what a high degree of capability we had assembled in the area of infrared physics, atmospheric transmission and atmospheric optics. We were fortunate in being able to get F. R. Stauffer to join the Department and to be Associate Director of the Laboratory of Atmospheric and Optical Physics (L. A. O. P.). I am confident that most people do not know that Fritz is one of the pioneers in infrared balloon astronomy, having received his training from the great master, John D. Strong, at the Hopkins in Strong's pioneering work on the measurement of water vapor on the planet Venus. We were also fortunate in the early days of L. A. O. P. in securing the services of J. L. Streete. He had finished the course work for his Ph.D. at the University of Florida and his thesis adviser, Dr. S. S. Ballard, then Chairman of the Department of Physics and Astronomy at the University of Florida, permitted Jack to do his thesis work under the guidance of the Laboratory of Atmospheric and Optical Physics.

Although the Department had been involved in infrared astrophysics for years none of us were astronomers. We wanted very much to add a professional astronomer to the staff and also to make a major thrust in the teaching of astronomy. Our wishes were realized as a result of the Research Corporation grant in 1967. J. L. Schmitt joined us in 1969 and has done an outstanding job. Largely as a result of his course in introductory astronomy, there are more students registered for courses in the Physics Department than ever before. There are not many small liberal arts colleges that can boast of having a professional astronomer on their staff.

We wanted very much to supplement our work in infrared spectroscopy by capability in visible spectroscopy. In addition, we consider spectroscopy to be a valuable pedagogical area for undergraduates. The Research Corporation grant in 1967 made it possible for us to continue the work in visible spectroscopy, started in 1967 by E. S. Dorman (trained in spectroscopy at Hopkins by the late famous spectroscopist, Gerhard Heinrich Dieke), by adding to our staff J. R. Beacham. Jim is an experienced interferometrist being a graduate of that great school of interferometry started many years ago at Purdue by the late Dr. Meissner. Definite positive strides have been made in improving our offerings in the area of visible spectroscopy.

Beginning about 1965, and extending for a period of about four years, I served as a consultant to the Electro-Optics Group at Cape Kennedy. It is my feeling that this arrangement proved beneficial to all concerned. It should be pointed out that the Electro-Optics Group gave the Laboratory of Atmospheric and Optical Physics the contract on atmospheric transmission work that made it possible for J. L. Streete to do his Ph.D. thesis at Southwestern. The head of the Electro-Optics Group at that time was Mr. Dennis Marquis, who became and still is, quite a moral supporter of Southwestern. I should add that working in Marquis' group at that time were two alumni from the Physics Department, namely, David P. Glenn and Shannon L. Ball.

One of our alumni, Raymond Thomas Vaughn, Jr., was doing graduate work at Vanderbilt when his father, Dr. R. T. Vaughn (then Chairman of the Department of Chemistry here) became ill. It was necessary for Tommy to return to Memphis to assist the family. In order for him to be in Memphis and still be making progress toward his degree the Physics Department at Vanderbilt granted him permission to do his Ph.D. thesis at Southwestern. Tommy was working in the area of spectroscopy under the guidance of Dr. J. R. Beacham. This work was terminated after about a year when, at the death of his father, it was necessary for Tommy to withdraw from graduate work and seek employment to assist his family.

I should also report to you that I have just finished six years on the Advisory Grants Committee of Research Corporation. Research Corporation has a policy that one can serve only six years. It is difficult to tell you just how much this opportunity has meant to me, to the Department and to Southwestern. The opportunity of serving on this Committee has certainly been one of the highlights of my career and now that my six years are up there will be a void in my life that will be difficult to fill.

About four years ago F. R. Stauffer began an introductory physics course primarily designed for pre-medical and pre-dental students. Prior to this the Department had offered a single introductory physics course and it was primarily designed for science majors. This new introductory course is filling a definite need on the part of many students. Beginning about 1966 Southwestern began to offer a Natural Science course. The idea behind this was to get more Southwestern students involved in some science. In the Natural Science course there are two years of work, one being on Chemistry and Biology and the other on Physics and Chemistry. The Physics Department has been involved in the course dealing with Physics and Chemistry and E. A. Barnhardt has given the lectures and laboratory work associated with the physics part of this course.

At the beginning of this school year I was approached by two of the regional science supervisors in the Memphis Board of Education, Messrs. Thomas Cohn and James Hester, concerning ways in which the Department might be of assistance to high school physics teachers in the city. Shortly after this several of these teachers met with me at Southwestern and I suggested the desirability of their establishing somewhere within the city what might be called a Resources Center. In this center would be located the following:

(a) equipment to enable a high school teacher to work up lecture demonstrations

(b) equipment to enable a high school teacher to work up new laboratory experiments

(c) a central storehouse for government surplus property

(d) a place where commercial manufacturers of scientific apparatus could display their apparatus for the teachers to study and evaluate for possible purchase.

I volunteered the services of the staff to help them in carrying out such a program. I was appalled to find that the physics teachers had not been utilizing government surplus property and agreed to accompany Messrs. Cohn and Hester once a month to Nashville in order to be able to suggest to them suitable items for purchase and to be able to suggest to them other items they might want to purchase for the parts they could obtain by stripping the apparatus. In this latter connection I even volunteered the services of my number four son, Harold Sparr Taylor, who although he is only in the eighth grade is quite good at stripping operations having been of great assistance along this line to me for years. My number three son, John Charles Taylor, has also been of great assistance to the Department over the years in volunteering "free labor". This program seems to have been well received by the high school teachers, and I am happy to report that the trips with Cohn and Hester to Nashville have begun. I have already given the teachers a two hour lecture demonstration in mechanics and will continue these demonstrations in other areas of physics throughout the year. We have also agreed to help these teachers with difficult concepts in physics and assist them in working problems associated with their texts.

Along similar lines we were asked several years ago to assist the Naval Air Technical Training Center (Millington, Tennessee) in setting up a program in physics and in providing tours through the Department and lectures to some of their students. Enclosure 8 is a copy of the letter of appreciation we received from the Naval Air Technical Training Center.

A teacher in an undergraduate college faces considerable difficulty in trying to maintain a viable research program. For one thing, he may not have kept up with the literature sufficiently to know where the frontier is in his area of interest. In addition, he has a much broader spectrum of demands on his time than does his counterpart at a graduate university. We have certainly felt over the years the need for consultation in the areas of astrophysics and atmospheric optics. The physics part of Southwestern's COSIP grant from the National Science Foundation was largely concerned with monies to finance just such a need. In our efforts in infrared astrophysics we have been greatly helped over the years by the High Altitude Observatory (Boulder, Colorado). I first met this outstanding group when we shared facilities during the 1959 total solar eclipse expedition to the island of Fuerteventura (Canary Islands). Over the years they have provided us with professional consultation in the area of astrophysics. Their staff members have visited us and they have permitted us to send out both staff and students to work at the High Altitude Observatory and at their solar observing station located at Climax, Colorado. It would be most inappropriate if I did not list at least some of the people from the High Altitude Observatory who have been most helpful, namely,

(a) Dr. Walter Orr Roberts - Founder and former Director of the High Altitude Observatory and former Director of the National Center For Atmospheric Research

(b) Dr. John W. Firor - Formerly Director of the High Altitude Observatory and now Director of the National Center For Atmospheric Research

(c) Dr. Gordon Newkirk - Director of the High Altitude Observatory

(d) Dr. J. A. Eddy - Member of the staff at the High Altitude Observatory.

It is with a great deal of pleasure that I report to you that two of our alumni, Dr. R. M. MacQueen and Dr. W. G. Mankin, are now on the staff at the High Altitude Observatory. Incidentally, Bob MacQueen and Bill Mankin are reputed to have performed the most elaborate and complicated experiment ever attempted by the High Altitude Observatory on a total solar eclipse expedition during the one in Mexico in 1970. Bob MacQueen is the Principal Investigator for the H.A.O. White Light

Coronagraph Experiment (WLCE) that will be flown in the forthcoming SKYLAB.

While Dr. Alexander was President he joined Southwestern in the Southern College University Union. This consortium consists of Southwestern, University of the South, Centre, Millsaps, Birmingham Southern, Centenary, Emory and Henry, Fisk University and Vanderbilt University. This consortium has established several committees, and I have served on the Science Policy Committee since it was formed. Theoretically we should be able to come up with one or more programs of action that will assist the member colleges and universities in their science efforts. As of this writing we have not been conspicuously successful but we are trying.

Physics has not been very effective over the years in attracting women students. This, however, is not a problem unique with Southwestern. Even when we look at the number of men students studying physics the numbers are not large. Again, this is a problem not peculiar to Southwestern. On the national scene the number of students in physics has been declining over the past few years. In contrast to this national trend the total number of Southwestern students taking courses offered by the Physics Department is greater than it ever has been and the number of students expressing an interest in majoring in physics is about what it has been over the last several years. Hopefully, Southwestern will never try to play the numbers game for surely we shall lose. I have always thought of Southwestern as being a college where quality of student was more important than quantity. I sincerely hope that the academicians will resist the attempts of the so-called "business types" to degrade the spiritual nature of educating a student and not try to compare it, cost-wise, with the purchase of a can of beans. President Diehl once said

"There is such a thing as cheap higher education, but there is no such thing as good higher education that is cheap."

All of the natural sciences and mathematics at Southwestern could easily handle additional students, i.e., majors. In view of the outstanding science facilities it appears highly desirable for Southwestern to make every effort possible to recruit more serious students for these areas of study.

Physics has provided Southwestern with much publicity over the years. Although I have not actually made this study, I would be willing to speculate that the amount of publicity received by the Physics Department exceeds that of any other academic department The various expeditions on which the Department has been involved have been well represented in the press. Over the years we have built up a truly outstanding collection of 35 mm color slides of the various expeditions and activities. Members of the Staff have given many talks to the Rotary, Civitan, Engineers Clubs, etc.

On the national scene the Department has received considerable recognition. This has been due partly to the publications by the Staff and also to the unique undergraduate program in optical physics. At the Detroit meeting of the Optical Society of America in October 1967 your author gave an invited paper on "Undergraduate Activities in Optical Physics at Southwestern" as a part of the Optical Society Symposium on College Optics. In May 1965 he gave a paper as one of the United States representatives to The International Commission On Optics, meeting at the Institute of Optics in Paris, on the optical physics program at Southwestern. On November 4, 1971 he gave an invited paper at the meeting of the Southeastern Section of the American Physical Society on "The Undergraduate Physics Program at Southwestern At Memphis."

The physics staff has given, and continues to give, an unbelievable number of tours through the Physics Tower. When we designed the Physics Tower we wanted something more than just a new science building. We wanted something unique. High school students visiting the Campus are invariably brought to the Physics Tower for a tour.

Southwestern has an interesting tradition in Physics. May this always be true.

VI. Physics Moves Into New Quarters

Many former physics students will remember the status of our facilities before we moved into the new Physics Tower. Physics had taken over completely the basement of the old Science Building. By taking over the acid storage room, the paint room, the old coal storage bin, the wood shop used by Buildings and Grounds and John Rollow's office, all located in the basement of the old Science Building we were able to hold out until we could get new facilities. I should add that the Staff of the Physics Department did every bit of the electrical wiring, painting, laying of floor tile, etc. necessary to make usable the space in the basement. In addition, we had built an Observatory out on the Campus with a roll-back roof. Much of our metal stock was stored in the corridors of the basement in the old Science Building.

I am including herein (see Enclosure 9) a copy of an article written for Applied Optics describing the Physics Tower. I would like to take this opportunity to state for the record that Peyton Rhodes, who was then President, gave the Physics Staff an almost free hand in the design of the Physics Tower from a systems point of view. Another way of putting this might be to say that the design of a physics building is too important to trust to an architect.

Peyton Rhodes contends, and I agree with him, that the old Science Building is probably the most beautiful building on the Campus. Be that as it may, there is not another building on the Campus that even approaches the Physics Tower in functionality of design and I think it is a building of which all of you can be proud.

I would like also to take this opportunity to establish for the record my appreciation of the assistance received from Professor E. A. Barnhardt in the matter of choosing laboratory and office furniture, the placement of electrical outlets and the myriad of other activities in connection with the Physics Tower. I also asked him to photographically document the construction of the Physics Tower which he did. I doubt if any building has been better, or more often, photographed than this tower. The Department has literally hundreds of slides showing the location of all pipes and conduits on each floor.

Enclosed is a letter (see Enclosure 10) sent by the Department to friends of the College describing the new Physics Tower. Along with this letter we sent some sketches (see Enclosures 11 through 19) illustrating some of the unique optical physics capabilities in this new facility. These sketches were drawn by Swinton Alphonse Roof ('69).

VII. Grants, Contracts, Gifts and Moral Support

Many of you will recall Dr. Rhodes' custom of saying a few words to the graduating seniors at the end of the commencement exercises. I remember on one such occasion he told them to be sure of what they wanted because very likely it would be achieved. This profound statement has certainly been the case in physics. We knew what we wanted but no one offered it up on a silver platter. We have worked long and hard to try to get what we thought we needed. It has been interesting to see that Dr. Rhodes' charge to the graduating class is true. In addition, you meet some of the finest people while you are in the process of accomplishing your mission.

Southwestern, using only its own resources, could never have afforded the physics facilities we now have. Some of you who will read this review of the history of physics at Southwestern are just beginning a teaching career and others among you will probably do so in the future. It has been my experience since coming to Southwestern that if you have a worthy project, or idea, that there is very likely someone somewhere who will be willing to give you support. What I am saying, in somewhat different terms, is Rhodes' charge, namely, be sure of what you want because you will probably get it. In a somewhat lighter vein I like to recall what Dr. Rhodes told me when I joined the staff, namely, he did not care what we did in physics so long as it was creative and did not cost any money.

Physics at Southwestern is certainly indebted to the Air Force Cambridge Research Laboratories, in particular, to Dr. John Nelson Howard, Chief Scientist for the Air Force and Editor of the journal, Applied Optics. It was Dr. Howard who gave us our first contract. Dr. Howard and I had been friends for years before I joined the staff at Southwestern. He is one of the outstanding infrared physicists alive today. I first met him when I was doing my thesis under Dr. John D. Strong at Johns Hopkins. It is a real credit to John Strong, as a teacher, that he saw to it that his students achieved a miximum visibility. By that I mean that he always had many outstanding physicists visiting his laboratory and he strongly encouraged, almost insisted, that his students present papers at the meetings of the Optical Society of America. The personal contacts in the area of optical physics I made as a student of Strong at The Hopkins and later as a member of Sanderson's Optics Division at the Naval Research Laboratory have been of inestimable value to me and to the Southwestern Physics Department.

The contract work provided by the Air Force Cambridge Research Laboratories for work in the general area of infrared physics made it possible for the investigators to supplement their salaries and for Southwestern to realize some money in the form of indirect costs. In addition, these contracts provided money for us to purchase equipment needed to carry out the investigations and from time to time we were sent equipment by the Air Force for use on the contracts. This equipment, in addition to being used on the contract work, was used in our teaching and laboratory work with the students. Southwestern could never have afforded such equipment on its own. When government funds for research were reduced a few years ago we lost our contract with the Air Force. However, the equipment we had accumulated here over the years under the Air Force contracts was transferred (i.e., on paper) to the General Services Administration which in turn transferred it to the Department of Health, Education and Welfare and we ultimately obtained title to the majority of it through our State Outlet for Government Surplus Property (H.E.W.). We obtained title to some $100,000 worth of optical physics equipment. Included in this equipment was the 31 inch diameter reflecting telescope now located in the South Dome on the Physics Tower. The only piece of equipment we had to relinquish was the "hasty scan" infrared spectrometer. This piece of equipment had seen much service by the Staff and was first used by us on the 1959 total solar eclipse expedition to the Canary Islands (island of Fuerteventura) (see Photograph 37).

We have been assisted tremendously over the years by the National Science Foundation. The imaginative leadership and financial assistance in science education and research provided by them have helped us in many ways. We have participated in their Undergraduate Research Participation Program, the College Science Improvement Program, the Matching Equipment Grants, Summer Institutes, Short Courses and Research Grants.

Dr. Alfred Kelleher, of Research Corporation (a philanthropic foundation located in New York City), became very much interested in the Department in the early sixties. He was particularly impressed by our undergraduate research activities. By about 1964 we felt we had developed considerable expertise in infrared physics, atmospheric transmission studies and other closely related areas and that we should formalize this fact by the formation of the Laboratory of Atmospheric and Optical Physics as an integral part of the Department. Alfred Kelleher was of great assistance to us in urging President Rhodes to establish the laboratory. In June, 1964 Research Corporation gave Southwestern $25,000 to assist with the founding of the Laboratory of Atmospheric and Optical Physics (see Photograph 17). The first full-time professional secretary in the history of physics at Southwestern was paid by some of these funds.

I do not know of a substitute for money or its equivalent. Research Corporation has certainly been generous to physics in this respect over the years. However, they also gave us moral support and encouragement. It is of considerable help to a department to know that an organization like Research Corporation believes in what the department is doing. In addition to the grant mentioned above Alfred Kelleher was of considerable assistance to Southwestern in receiving a grant of $275,000 in 1967 for the support of Biology, Chemistry, Physics and Mathematics. This grant was used by the various departments to obtain additional personnel and to purchase research equipment.

By the early 1960's the Department had achieved a large degree of national visibility. As mentioned previously Research Corporation had become greatly interested in activities here. Another organization that became interested in us was the Optical Society of America. The late Dr. Van Zandt Williams, former President of the Optical Society of America (and President of the American Institute of Physics at the time of his death), became one of our staunchest supporters. He saw in the Department a model of what small colleges could do in the area of undergraduate research in optical physics. This was a period of time in American education when the Optical Society of America became greatly concerned over the shortage of optical physicists. The Board of Directors of the Optical Society of America appointed Dr. Van Zandt Williams to head up its "Optics--An Action Program" to deal with this problem. Dr. Williams approached his assignment by breaking the problem down into various Tasks. One of these, namely Task IV, dealt with Undergraduate Research in Optical Physics. He placed the responsibility for carrying out this Task at Southwestern. I remember very well receiving the letter from Dr. Williams asking me to assume responsibility for Task IV. The letter was delivered to me at Climax, Colorado in December, 1962 while Robert MacQueen, Ace Emery and I were making near infrared measurements on the solar corona using the High Altitude Observatory's recently completed 16 inch diameter coronagraph. Task IV activities culminated in the Conference held at Southwestern on June 8-12, 1964 and was financed by grants from the Office of Naval Research and the National Science Foundation.

Enclosed is an article Dr. Williams and I wrote describing the Southwestern Conference (see Enclosure 20). Incidentally, it was during this Conference that Dr. Rhodes formally announced the formation of Southwestern's Laboratory of Atmospheric and Optical Physics. One of the results of the Conference was the desire on the part of many teachers for the Optical Society of America to take a more active part in education. Shortly thereafter the Office of Research and Education was formed within the Optical Society of America. It was with the greatest of pleasure when we in physics here learned that our good friend and great supporter, Dr. John A. Sanderson, had been appointed to head up the Office of Research and Education. They could not have found a better man for the job anywhere. Before terminating this paragraph I need to establish for the record an additional comment concerning Dr. Williams. Early in 1963 he and Dr. Robert E. Hopkins (then Director of the Institute of Optics, University of Rochester, and who later was President of the Optical Society of America) had come to Southwestern for a visit. During this visit Dr. Hopkins gave a very interesting lecture demonstration on optical phenomena using a laser. At this time Dr. Williams was a vice-president at The Perkin-Elmer Corporation. Shortly afterwards he became president of the American Institute of Physics. I recall very vividly during this visit taking Williams and Hopkins out on the ampus where we had the obile bservatory located in preparation for the total solar eclipse expedition to Alaska during the summer of 1963. They were extremely impressed by the quality and quantity of instrumentation they saw. Shortly after his return home Dr. Williams had The Perkin-Elmer Corporation send the Physics Department nine potentiometric recorders as a gift. These potentiometric recorders (both Leeds and Northrup and Brown) were valued at about $1,000 each.

Before leaving The Perkin-Elmer Corporation I should mention another friend and supporter, namely, Dr. E. Horace Siegler. Horace and I met at the Hopkins where he obtained his degree in physics under the late Dr. G. H. Dieke. On many occasions since coming to Southwestern I have received large "care packages" of "optical goodies" from Horace. These have consisted of first surface mirrors (plane, spherical, ellipsoidal and parabolical), filters, choppers, gratings, scatter plates, etc. These costly items, received as gifts, have been of inestimable value to us in our work.

Government surplus property is made available to colleges and other non-profit institutions through various state outlets (usually located in the capital city) by the Department of Health, Education and Welfare. We are allowed to go once every thirty days, or once a month, whichever comes first. I should report to you that we have pursued this source of equipment vigorously. Items obtained under this program cost just a fraction of their initial acquisition cost to the government. Our entire machine shop, with the exception of the shaper,which was purchased new, was obtained as government surplus. Over 90% of all our metal stock is obtained from this source. Another case is that of the sun telescope (2 foot diameter paraboloid, 24 foot focal length) which was obtained for $5. I would like to take this opportunity to establish for the record the deep appreciation of the Department to Mr. Harvey T. Marshall, director of this program in the state of Tennessee, for the assistance he has given us over the years in these matters.

Shortly after we moved into the new Physics Tower another benefactor came upon the scene, namely, the late Dr. Joseph Chandler Morris. For those of you who have not visited the Physics Tower let me tell you that outside Room 226 there is a bronze plaque bearing the inscription "Joseph C. Morris Electrical Measurements Laboratory." I can recall having heard Dr. Rhodes speak of Joe Morris for many years, as far back as my student days. However, I did not have the privilege of getting to know him until about the time construction on the Physics Tower began. Dr. and Mrs. Morris' daughter, Grace, was graduated from Southwestern in 1957. Dr. Morris obtained his undergraduate degree in physics from Tulane and his Ph.D. in physics from Princeton. Dr. Morris had been chairman of the physics department at Tulane and vice-president for finances of Tulane. He was a classmate at Princeton of Van de Graaff and knew personally Frederick Gardner Cottrell, inventor of the Cottrell electrostatic precipitator and founder of Research Corporation. Dr. Morris was also one of the pioneer amateur radio operators in the United States, an avocation that remained with him all his life. He enjoyed major scientific stature in the United States. He was a member of the Council of Library

Resources. During World War II he served as Director of the Office of Scientific Personnel of the National Research Council and also as Associate Director of the San Diego Anti-Submarine Laboratory of the Office of Scientific Research and Development. He was on the initial Board of Directors of the National Science Foundation and holds the distinction of having served longer than any other member to this date. At the time of his death he was Secretary-Treasurer of the Gulf Central Steamship Company (New Orleans). He had been active in this Company since its inception in 1947, having been a founding stockholder, director and officer.

I sincerely regret that all of you did not know him. He knew how to enjoy life. He was involved. On several occasions my wife and I visited Dr. and Mrs. Morris in their gracious home in New Orleans, and they in turn have visited often with us. Mrs. Morris, a great lady, now lives alone in their home. Their daughter, Grace, is living in Saint Louis and their son, Joe, Jr. lives in Knoxville where he is associated with the University of Tennessee Computer Center.

Dr. Morris told me once that he was impressed by two things, namely, the new Physics Tower and the esprit d'corps in the Department. Shortly thereafter he made his first gift to Southwestern in the amount of about $25,000. The limitations on the gift were that the monies be used exclusively for the purchase of electrical and electronic measuring equipment. I should take this opportunity to state that it was indeed a pleasure to watch Dr. Morris operate. He knew what money was for and he knew how to use it. He also knew how to make money. A further stipulation on the grant was that we were to take approximately $7,000 of it and purchase some electrical measuring equipment from the physics department at Tulane. Dr. Morris had, prior to his gift to Southwestern, made arrangements with the people at Tulane for them to sell to us $7,000 worth of equipment at prices that Dr. Morris had initially paid for the equipment when he purchased it years ago. As you well know many pieces of electrical equipment never wear out, in fact, they improve--a case in point being standard inductors, etc. Southwestern sent a truck to Tulane to bring back this equipment. Incidentally, Dr. Morris had paid out of his own pocket the cost of having someone come in and pack everything for us at Tulane and even paid to have someone help us load it on our truck. He had even taken the additional trouble to alert the campus police at Tulane to meet our truck and assist us in getting through the maze of cars on their campus to the physics building. After the truck was loaded, Mrs. Morris insisted that we come by for a festive lunch she had prepared. The late Mr. Hubbard (of the Buildings and Grounds staff), Bill Johnson and I had gone down to get the equipment at Tulane. After we arrived back at Southwestern my colleague, Allen Barnhardt, looked up the current prices of the equipment we brought back and reported the value of the equipment to be about $60,000. Again I repeat that Dr. Morris knew how to use money.

With the remaining $18,000 Dr. Morris wanted us to try to match it with a grant from the National Science Foundation and use the monies to obtain additional electrical and electronic measuring equipment. This we did. Dr. Morris wanted me to hand carry the proposal to Dr. Lyle Phillips at NSF which I did. There seemed to be no limit to what Joe Morris would do for the Department. He paid for my airline ticket to Washington and back and had even called in advance of my going to NSF to make sure someone would be there to receive me and to give me a personally conducted tour through the National Science Foundation. It is a pleasure to be able to report to you that NSF funded our proposal. In fact, it was the largest matching equipment grant made in the state of Tennessee that year. Such was the effectiveness of Joseph C. Morris.

On another occasion he asked that we send down a truck and he would give us his bound and unbound physics journals. This we did and our librarian, Mr. Albert Johnson, evaluated them at $11,000. There were later gifts totaling about $16,500. Some of this money was used to purchase equipment for setting up an amateur radio station (2 kilowatts) and to purchase a rotary beam antenna. After Dr. Morris' death, Mrs. Morris gave the Department the physics books from their home library. President Bill Bowden and his wife, M. J. Williams (our Treasurer and one of our Vice Presidents) and his wife, my wife and I drove down to New Orleans (December 1970) in two station wagons and brought back these books. His library holdings were unbelievable (evaluated by Albert Johnson at $10,000). We brought back to the Department library the following: 1,526 hardback books and 224 paperbacks. In keeping with his great love of electrical measurements and elecrtonics, the number of his books in these categories exceeded that in any other area of physics. We have all his books dealing with electrical measurements and electronics in the Joseph C. Morris Electrical Measurements Laboratory.

Another great favor Dr. Morris did for the Department was to make it possible for us, through his own personal contacts, to participate in the Western Electric College Gift Program and a similar program conducted by the Texas Instruments Company.

Shortly after we moved into the Physics Tower I began an Inventory System for our equipment. Such a system is highly desirable for insurance purposes and for being able to keep up with, and locate, the various pieces of apparatus. At the present time all apparatus having a replacement cost of $25 or more is inventoried. For each piece of equipment inventoried a card is filled out giving the appropriate data and a self-adhesive paper inventory tag is affixed to the piece of equipment (see Enclosure 21). Four different colored tags and cards are used, depending on the primary function of the piece of equipment being inventoried. The system is as follows:

Yellow - For equipment whose primary function is for teaching.

Blue - For equipment whose primary function is for research.

Green - For equipment whose primary function is in a supporting category, i.e., machine shop equipment, calculators, typewriters, cameras, etc.

Red - For laboratory furniture (tables, chairs, cabinets, etc.), office furniture, library furniture, etc.

The inventory tags are further identified as to the primary area of physics for which the equipment is intended, for example

T O - Teaching Optics

T M - Teaching Mechanics

T E - Teaching Electricity (or Electronics)

T A - Teaching Atomic (or Nuclear)

T H - Teaching Heat

T S - Teaching Sound

The above would all be Yellow tags. A similar breakdown is used for the research inventory tags (which are blue). This breakdown is somewhat conventional but it has proven very satisfactory.

As of this writing all equipment obtained by the Department since we moved into the Physics Tower has been inventoried provided it has a replacement value of $25 or more. About 90 to 95% of the equipment we had when we moved into the Physics Tower has been inventoried and the remainder will be finished shortly. The time required for this inventory thus far has been considerable. In order to give you some idea of the equipment in the Department I list the data on the following page as being current at the time of this writing.

Category of Equipment		Number of Items Inventoried
Teaching	Optics	229
	Mechanics	66
	Electricity (or Electronics)	1,633
	Atomic (or Nuclear)	35
	Heat	0
	Sound	0
Research	Optics	113
	Mechanics	59
	Electricity (or Electronics)	131
Support		47
Furniture		409

The value of the inventoried equipment is the following:

Category of Equipment	Replacement Value
Teaching	$ 297,297
Research	176,149
Support	83,674
Furniture	150,000

The library holdings of the Department have improved over the years. For the academic year, 1956-57, the library budget for the Physics Department was $200. For the academic year, 1971-72, it was $2700. Enclosed herein is a listing of the journals presently subscribed to by the Department (see Enclosure 22).

Beginning about a year or so ago a new program became available whereby the government transfers certain pieces of excess property to colleges and universities provided the colleges and universities have certain types of grants or contracts. The

Physics Department qualified for this new program by virtue of its NSF grant in support of the SHORT COURSE IN OPTICS FOR COLLEGE TEACHERS held here last summer (see Enclosure 23). We have already requested and received a 35mm Mitchell camera under this new program.

UNITED STATES GOVERNMENT GRANTS AND CONTRACTS

Source	Grant or Contract Number	Date	Amount	Comments
National Science Foundation	G-7975	Summer 1959	$5,600	U.R.P. Program Director - J. J. Freymouth
National Science Foundation	G-12071	Summer 1960 Summer 1961	7,820	U.R.P. Program Director - J. H. Taylor U.R.P. Program Director - J. H. Taylor
National Science Foundation	GE-1124	Summer 1963	5,600	U.R.P. Program Director - J. H. Taylor
National Science Foundation	GE-2764	Summer 1964	5,600	U.R.P. Program Director - J. H. Taylor
National Science Foundation	GE-8068	Summer 1965	5,600	U.R.P. Program Director - J. H. Taylor
National Science Foundation	GY-31	Summer 1966	5,600	U.R.P. Program Director - J. H. Taylor
National Science Foundation	GY-3013	Summer 1967	4,200	U.R.P. Program Director - J. H. Taylor
National Science Foundation	GY-167	Academic Year 1965-1966	1,400	U.R.P. Program Director - F. R. Stauffer
National Science Foundation	GY-2061	Academic Year 1966-1967	1,400	U.R.P. Program Director - F. R. Stauffer
National Science Foundation	GY-1711	1966	12,000	Matching Equipment Grant Director - J. H. Taylor
National Science Foundation	GY-6308	1969	17,900	Matching Equipment Grant Director - J. H. Taylor
National Science Foundation	GY-3781	June 28, 1967	16,260	Physics Department's share of College Science Improvement Program Grant
National Science Foundation	GY-8456	1971	16,600	Support of SHORT COURSE IN OPTICS FOR COLLEGE TEACHERS Director - J. H. Taylor
National Science Foundation	GY-9400	1972	16,960	Support of SHORT COURSE IN OPTICS FOR COLLEGE TEACHERS Director - J. H. Taylor

UNITED STATES GOVERNMENT GRANTS AND CONTRACTS

Source	Grant or Contract Number	Date	Amount	Comments
National Science Foundation	GW-6137	1971	$12,500	Support of Summer Institute For Secondary School Teachers in Astronomy, Director - J. L. Schmitt
National Science Foundation	GA-30617	Sept. 1971	$12,700	Support of research on measurement of intensity ratios of infrared emission lines of helium in solar prominences J. L. Streete, Principal Investigator
National Science Foundation		1963		First Institutional Grant for $10,540. Physics shared in this and others of these grants. These grants were all of about the same magnitude.
Air Force Cambridge Research Laboratories	AF 19(604)-4953	1959-1960	$13,769	The first contract was dated 19 Nov. 1958 and the last contract terminated Aug. 31, 1968. The initial contract was for support of research on time dependent infrared phenomena with J. H. Taylor as Principal Investigator
		1960-1961	$22,451	
		1961-1962	$24,945	
Air Force Cambridge Research Laboratories	AF 19(628)-2371	1962-1963	$24,982	Support of work in theoretical molecular spectroscopy (H.M.Hanson - Principal Investigator), derivative spectroscopy (F.R.Stauffer--Principal Investigator) and infrared stellar radiometry (J.H.T. & F.R.S.) was also supported.
		1963-1964	$24,982	
		1964-1965	$19,987	
Air Force Cambridge Research Laboratories	AF 19(628)-5719	1965-1966	$49,979 (1965-1968)	
		1966-1967		
		1967-1968		

Note: The following staff members were involved, in varying amounts of time, on the contract work done for the Air Force Cambridge Research Laboratories: J. H. Taylor, J. J. Freymuth H. M. Hanson, J. L. Streete, R. M. MacQueen, F. R. Stauffer and E. A. Barnhardt. The following support staff members were involved: G. P. Ruffin and A. C. Emery.

UNITED STATES GOVERNMENT GRANTS AND CONTRACTS

Source	Grant or Contract Number	Date	Amount	Comments
Electro-Optics Group Pan American World Airways Cape Kennedy	Purchase Order No. 0001532	25 Nov. 1964	$20,400	Contract with the Laboratory of Atmospheric and Optical Physics for the design and construction of an atmospheric transmission measurement and monitoring system. Project Manager - J. L. Streete Consultant - J. H. Taylor Consultant - F. R. Stauffer
Applied Physics Group Eglin Air Force Base	F08635-67-C-0149	9 June 1967- Sept. 1969	$29,049	Contract with the Laboratory of Atmospheric and Optical Physics for slant path atmospheric transmission measurements. Principal Investigator - J. L. Streete Research Physicist - E. A. Barnhardt Consultant - J. H. Taylor Consultant - F. R. Stauffer
Atomic Energy Commission		Nov. 15, 1960	$ 9,572	For the purchase of teaching equipment in nuclear physics.
Electro-Optics Group Pan American World Airways		1966		(a) Gift of 6 inch diameter refracting telescope. (b) Gift of Cenco grating spectrometer.
Naval Air Station (Millington, Tennessee)		1963		Gift of three Mark 51 Gun Directors. We helped them set up a physics program and they gave us these in appreciation (after we told them we needed them).

GRANTS AND GIFTS FROM FOUNDATIONS AND INDUSTRIES

Source	Date	Amount	Comments
Research Corporation	12 June 1964	$25,000	To assist in the formation of the Laboratory of Atmospheric and Optical Physics.
Research Corporation	October 1967	$275,000	Physics shared in this grant along with Biology, Chemistry and Mathematics The funds were for adding additional personnel and purchasing research equipment. Physics' share for research equipment was $56,742.
Research Corporation	March 1971	$8,450	For support of research on measurement of intensity ratios of infrared emission lines of helium in solar prominences. J. L. Streete - Principal Investigator
U. S. Steel Foundation	1964	$5,700	Used to help support the Laboratory of Atmospheric and Optical Physics.
Ford Motor Company Presidential Grant	1964	$7,000	Used to help support the Laboratory of Atmospheric and Optical Physics.
McGregor Fund	June 18, 1964	$6,000	Used to build up the library holdings of the Laboratory of Atmospheric and Optical Physics in the areas of astrophysics, atmospheric physics, etc.
The Perkin-Elmer Corporation	1963	$9,000	Gift of nine potentiometric recorders.
F. A. A. (Memphis Municipal Airport)	August 1971		Gift of 40 foot high steel tower. This tower is now located about 800 feet due north of the Physics Tower.
Questar Corporation (Mrs. Marguerite Braymer) New Hope, Pennsylvania	1968	$1,000	Gift of 3 1/2 inch diameter Questar telescope. Thanks to C. H. Schauer, Vice President, Research Corporation.

GRANTS AND GIFTS FROM FOUNDATIONS AND INDUSTRIES

Source	Date	Amount	Comments
Research Corporation	1972	$3,895	Gift of 7 inch diameter Questar telescope. Thanks to Jack W. Powers, Regional Director, Research Corporation.
Research Corporation	1963		Grant to support J. L. Streete on the 20 July 1963 total solar eclipse expedition to Gulkana, Alaska.
Radio & TV Station WMC (Memphis, Tennessee)	1968		Gift of two television camera pedestals.
Sears & Roebuck Co. (Memphis, Tennessee)	June 1963		Gift of camping and cooking equipment used during the Alaskan expedition.
Malone & Hyde Co. (Memphis, Tennessee)	June 1963		Gift of food used during the Alaskan expedition.
Western Electric College Gift Program	Since 1970		Annual gift of equipment.
Texas Instruments College Gift Program	Since 1970		Annual gift of equipment.
Toddle House Industries	June 1960	$1,000	Thanks to Bryan M. Eagle.
Buckeye Cellulose Corporation (Memphis, Tennessee)	March 1970		They made available to our expedition the facilities at their Forestry Research Center in Perry, Florida. Our special thanks to (a) Mr. J. Mason Williams (b) Dr. Walter Beers
Welcome Wagon International	July 1963		They brought us fresh fruit and newspapers from Anchorage to our campsite in Gulkana. Our special thanks to Mrs. Joseph F. Fiala.

GRANTS AND GIFTS FROM FOUNDATIONS AND INDUSTRIES

Source	Date	Amount	Comments
Radio and TV Station WREC (Memphis, Tennessee)	1967		Turntable, amplifiers, studio console monitor, loud speaker.
Memphis, Light, Gas and Water Division	over the past four years		Meters, radio, electronic racks and assorted electrical and electronic equipment.

GIFTS FROM INDIVIDUALS

Name	Date	Amount	Comments
George A. F. Schulte (Coral Gables, Florida)	December 1960		Gift of mirror granding and polishing equipment. This equipment enabled the Department to set up an Optics Shop. It was put into operation in April 1961. This Optics Shop is under the supervision of Mr. A. C. Emery.
O. C. Yonts (Oak Ridge, Tennessee)	1960	$1,700	Ollie's mother,Mrs. E. L. Yonts, gave the Department a Tektronik Oscilloscope and Cart in memory of her husband. This was the first research caliber oscilloscope in the history of the Department.
C. Scudder Smith (Appleton, Wisconsin)	1959		Gift of Heli-Arc Welder.
E. H. Siegler (Darien, Connecticut)			Gift of many "optical goodies" over the years.
W. O. McMinn (Arlington, Virginia)	1970		Gift of Adam Hilger spectrograph equipped with quartz prism.
Mr. & Mrs. J. H. Gary (Memphis, Tennessee)	1964		(a) Gift of air conditioner used in first Observatory. (b) Gift of television set used in the Department's Conference Room.
William B. Allen '53 (Memphis, Tennessee)	Summer 1965		Gift of materials used in the Department's first roll-back roof Observatory.
J. C. Nall (Arlington, Virginia)	1970	$1,000	This gift was used to establish Nobel Laureates in Physics In Memory Of Mr. and Mrs. Henry Clay Nall, Jr. and Mr. and Mrs. Thomas Watt Gregory I know of only one other such gallery in the U.S. and that is the one at the American Institute of Physics in New York City.

GIFTS FROM INDIVIDUALS

Name	Date	Amount	Comments
Peyton Nalle Rhodes (Memphis, Tennessee)	1970	$3,000	Dr. Rhodes personally raised this money from friends of Southwestern to support the 1970 expedition to Florida.
Shannon L. Ball (Greenville, Texas)	1971	$5,000	Gift of five data recording cameras.
Charles Oswald (Memphis, Tennessee)	1964		Gift of housing for 60 inch diameter antiaircraft searchlight mirror.
S. S. Ballard (Gainesville, Florida)	1968		Former Chairman, Department of Physics and Astronomy, University of Florida. He gave us several of his physics textbooks.
Joseph C. Morris (New Orleans, La.)	June 23, 1969	$25,000	For the purchase of electrical and electronic measurement equipment.
Joseph C. Morris	July 1, 1969	2,000	For the purchase of electrical and electronic measurement equipment.
Joseph C. Morris	Sept. 23, 1969	1,000	For the purchase of electrical and electronic measurement equipment.
Joseph C. Morris	March 31, 1970	13,500	For the purchase of electrical and electronic measurement equipment.
Joseph C. Morris	1969	11,000	Value of bound and unbound physics journals given to the Physics Department.
Mrs. J. C. Morris (New Orleans, La.)	December 1970	10,000	Value of physics texts and books from personal library of Dr. Morris.
Dr. Ray H. Hughes (Fayetteville, Arkansas)	1969		Physics Department, University of Arkansas (Fayetteville). Gift of Leeds & Northrup Recording Densitometer.

GIFTS FROM INDIVIDUALS

Name	Date	Amount	Comments
Dr. Robert J. Bell (Rolla, Missouri)	1970		Chairman, Physics Department, Univ. of Missouri (Rolla). Gift of pneumatic infrared detector (Golay cell).
Mr. Paul Wilson (Collierville, Tennessee)	1971		Potentiometric Strip Chart Recorder (Brown)
Dr. W. Likely Simpson (Omaha, Nebraska)	1958		Set of precision tuning forks manufactured in Leipsig, Austria.
Mr. Harry Island (Memphis, Tennessee)	1968	$1500	Gift of some high quality machine shop tools.
Mr. Walker L. Wellford, Jr. (Memphis, Tennessee)	1972		Gift of Dryomatic Dry Conditioner.
To all of those students	Over the Years		Who have done so many things for the Department "for free," from painting, laying tile, taking photographs, assisting with tours, etc.

VIII. Mural Display

As many of you know we have a long tradition of erecting murals to depict major activities and events of the Department. These murals are now located on the second floor of the Physics Tower. All available wall space has now been used on the second floor and future murals will be erected on the remaining floors. These murals serve many purposes. They are very useful to us in giving tours to people visiting the Department. In addition, they help us in keeping up with the history of the Department. It is amazing how easy it is to forget details of events that happened only a few years previously.

Enclosed herein are photographs of these murals (see Photographs 5-16). They measure about 30 inches by 48 inches. The Department makes them from 1/2 inch plywood and strips of molding which are purchased locally.

IX. Sigma Pi Sigma

The Department made application for the establishment of a Student Section of the American Institute of Physics. (See Enclosure 24 for a copy of the letter from AIP dated February 2, 1962 concerning the AIP Student Section at Southwestern). On February 2, 1962 a Student Section was formed here and there is enclosed a photograph of the plaque (see Photograph 18). Bill Mankin was President, Paul Lawrence was Vice President, Jim Warden was Secretary and Charles Brandon was Treasurer in 1962.

In 1963 we made application for the establishment of a Chapter of Sigma Pi Sigma, national physics honor society. The Southwestern At Memphis Chapter was installed on May 27, 1963 with Dr. L. W. Seagondollar, National President of Sigma Pi Sigma and at that time Professor of Physics at the University of Kansas, presiding. A photograph of the plaque is enclosed (see Photograph 19).

Beginning in 1968 the Student Sections od the American Institute of Physics were replaced throughout the United States by the various chapters of the Society of Physics Students. Sigma Pi Sigma is an honor society within SPS. Professor Barnhardt is adviser of the Southwestern Chapter of SPS.

The following student members have been received into Sigma Pi Sigma.

Name	Date Received Into Membership
Jack D. Aldridge	May 27, 1963
William S. Boyd, Jr.	" "
Charles W. Robertson	" "
Norman B. Waite	" "
Charles W. Brandon, III	" "
Sara Witherow Hoffman	May 6, 1965
James Malone McKnight, Jr.	" "
Douglas E. Post, Jr.	" "
Martin E. Smithers	" "
Raymond Thomas Vaughn, Jr.	" "
Archibald Currie Johnston	" "
Michael Ezell Hendrick	November 16, 1966
James Martin Durham	" "
Richard Raspet	December 5, 1967
David Elmore	" "
Kenneth M. Cushing	" "
Swinton A. Roof, Jr.	" "
John T. Atkinson	October 22, 1968
Palmer Martin Simpson, Jr.	" "
Leigh Norman Brasington	April 29, 1969
Stephen Ellis Kendrick	" "
Michael Montgomery Moses	" "
Thomas Carlton Marshall	" "
Raymond Bradfield Kummer	November 14, 1969
Eldon Earl New	April 23, 1970
Glenn Allen Sowell	" "
Robert M. Riley, III	" "
David Hume	" "
Bill Brune	October 20, 1971
Dan Ellsworth	" "

The following Southwestern faculty and alumni have been received into Sigma Pi Sigma

Name	Date Received Into Membership	
Peyton N. Rhodes	May 27, 1963	President of Southwestern
Richard D. Gilliom	" "	Department of Chemistry
Jack H. Taylor	" "	Department of Physics
John L. Streete	" "	Alumnus
John Leigh Schmitt	November 14, 1969	Department of Physics

Others received into Sigma Pi Sigma.

Name	Date Received Into Membership	
Walter Orr Roberts	November 13, 1964	Director, National Center For Atmospheric Research
George T. Reynolds	January 12, 1966	Professor of Physics Princeton University

Transfer Members received into Sigma Pi Sigma.

Name	Date Received Into Membership	
Harvey M. Hanson	May 27, 1963	Department of Physics Southwestern
Robert M. MacQueen	" "	Department of Physics Southwestern

X. Recipients of the Honorary Degree of Doctor of Science

The following Honorands have received Doctor of Science degrees.

Name	Year
Scott Cary Lyon	1926
Oscar Wilkinson	1926
James Lister Skinner	1941
Joel Lafayette Fletcher, Jr.	1944
Joseph A. LePrince	1945
Thomas Hampton Allen	1950
Edward McCrady	1959
John Donovan Strong	1962
Frederick T. Haddock, Jr.	1965
Lewis Lichtenstein Strauss	1966
Douglas H. Sprunt	1967
Walter Orr Roberts	1968
Richard T. Hansen	1971
Alfred Kelleher	1971

Several of these Honorands (Strong, Haddock, Roberts, Hansen and Kelleher) have been involved with the Physics Department in one way or another and their Citations are given on the following pages.

June 4, 1962

JOHN DONOVAN STRONG - You have ably demonstrated in your unusually rich and varied career of teaching and research how achievement in basic scientific exploration proves to be indispensable and fruitful in the so-called practical accomplishments of this present far-space era.

A decade and a half ago you became heir to the great Hopkins classical tradition of Rowland and Wood in the field of optics and spectroscopy. Interestingly, this tradition had wound its way through Princeton and Virginia to Southwestern and then turned back again to Hopkins. There, under your competent direction, the cycle is being completed and strengthened each year as able Southwestern graduates bask or stew or possibly burn in the infrared.

The above unique circumstances make it very pleasing to be able to tell you that the Board of Directors of Southwestern at Memphis has admitted you to the degree of DOCTOR OF SCIENCE, with all the privileges and responsibilities thereunto appertaining, in token thereof this diploma and the appropriate hood are presented to you.

Peyton N. Rhodes
President
Southwestern At Memphis

May 31, 1965

FREDERICK T. HADDOCK, Jr. - Sir, you have achieved unusual distinction as a teacher, as a participant in pure research and as a consultant at the national level in many of the more exotic space programs. The field of radio astronomy, especially in the microwave region, owes a great debt to your work, which has given new information concerning electron temperatures and density in the chromosphere, about long wave radiation from galactic nebulae, planets and cosmic background generally Your part in organizing the National Radio Astronomy Observatory was not inconsiderable. No organization dealing with space radio astronomy has failed to call on you for advice or counsel.

Since Southwestern At Memphis, in a modest way, is pioneering in certain phases of space physics and astronomy, and will certainly be aided by some of your findings, I am glad that the Board of Directors has authorized the conferring upon you the degree of DOCTOR OF SCIENCE with all the privileges and responsibilities thereunto appertaining, in token whereof this diploma and the appropriate hood are presented to you.

Peyton N. Rhodes
President
Southwestern At Memphis

June 3, 1968

WALTER ORR ROBERTS

"To the stars through adversity" reads a maxim often emblazoned on armigerous families and widely known among key-carrying scholars. Of your arms we know little, of your adversities less, of your key something, but of your stars more because of the lifelong gaze you have cast upon them. You, Walter Orr Roberts, have looked on the sun and are not blinded. Light itself has been split and focused, collected and diffused by you so that we may have more light scattered into the corners of our ignorance. Not content with the imperfect vision through our murky sea of air, you have climbed mountains and set temples of research upon their peaks. Your grasp of meteorology prompts us to cry: "O seer, come down from the mountain and do something about the weather!"

Initialed with the letters of knowledge and attainment, you the high priest of discovery now preside over the arcana of American science, while as trustee of foundation and college, fellow of societies domestic and international, editor and councillor, you have both increased public awareness of science and expanded the consciences of your colleagues.

Therefore, the Board of Directors of Southwestern At Memphis has admitted you to the degree of DOCTOR OF SCIENCE with all the privileges and responsibilities thereunto appertaining, in token whereof this diploma and the appropriate hood are presented to you.

David Alexander
President
Southwestern At Memphis

May 31, 1971

RICHARD T. HANSEN

Richard T. Hansen, when you completed your formal studies at The Johns Hopkins University and graduated from the University of Colorado, you could have become just another mechanical engineer among the many who pursue mildly important but anonymous occupations the rest of their lives. Instead, you chose to join the joint Harvard College Observatory-High Altitude Observatory expedition and help set up the Sacramento Peak Observatory at Sunspot, New Mexico. If you will forgive the metaphor, you cut your eye-teeth as a solar observer.

Your interest and curiosity sharpened, you joined the High Altitude Observatory at Boulder, Colorado, and this soon led to your appointment as Observer-in-Charge at the High Altitude Observatory at Climax, Colorado. You returned to be Research Assistant at the High Altitude Observatory in Boulder for a period of years, and then went as Executive Officer of the Joint Institute for Laboratory Astrophysics, University of Colorado. In 1963 you returned as a full Staff Member of the High Altitude Observatory at Boulder where you have achieved the status of a major scientist and gained the esteem of your fellows throughout the world.

In the early 1960's you initiated a long-term investigation of the solar corona. This investigation was carried out with the K-coronameter erected on Mauna Loa in Hawaii. Almost single-handedly you developed the K-coronameter site and made it the outstanding observatory of its kind in the world. You have given extraordinary devotion to the many problems which beset the operation of this facility in such a remote location. You have been an active contributor in solar physics for approximately twenty years. You have made observations with great skill and immersed yourself in their interpretation to give science new insights into the structure of the solar corona and its relation to the interplanetary medium and the geomagnetic activity.

A measure of your contribution is the fact that your observations, your interpretations and your counsel are sought by solar physicists around the world. You have contributed a unique body of information to our scientific knowledge.

You have made an extraordinary commitment to the welfare of the people who work with you. You have maintained a great awareness of the place of the scientists in our society and the impact which a scientific observatory, such as the Mauna Loa station, has upon the local community. You have been tireless in your efforts to explain your scientific endeavors to the local population through the schools and related organizations.

Over the years you have devoted an extraordinary amount of energy to stimulating international cooperation in the science of solar physics. The fact that your friends and collaborators are distributed around the world truly without regard to national boundaries attests to your achievements.

Therefore, the Board of Trustees of Southwestern At Memphis has admitted you to the degree of DOCTOR OF SCIENCE with all of the privileges and responsibilities thereunto appertaining, in token whereof this diploma and the appropriate hood are presented to you.

William L. Bowden
President
Southwestern At Memphis

May 31, 1971

ALFRED KELLEHER

Alfred Kelleher, the consistent and evident threads that can be traced throughout your career are integrity, a widely-ranging and insatiable drive for knowledge, coupled with what your friends describe as the zeal of a missionary.

Originally, you intended to enter the priesthood, but a condition known to all of us as the Great Depression intervened, and you were forced to leave St. Dunstan's University to carve out a new career in the difficult years of the 1930's. At the beginning of World War II you joined the Massachusetts Institute of Technology in their Contract Settlement Office and Radiation Laboratory. During these war years you accounted for millions of dollars worth of equipment loans, shipments and materials utilized in the research of the Radiation Laboratory. You worked in the midst of the top secret laboratory activities which included experimental machine work and instrument-making on special devices. You worked on a special assignment in the Laboratory's office in London, England.

In the immediate post-war years, you were Executive Aide at the Brookhaven National Laboratory where you were responsible for the preparation of regular reports required by the Atomic Energy Commission on scientific activities of the Laboratory, and internal reports concerned with the administration of the Laboratory. While your principal work was preoccupied with matters related directly to science and technology, you found time for significant attention to philosophy and sociology. With assertive independence and integrity of mind you undertook the Project "East River" study, the earliest effort in the nation to study possible results of a nuclear attack on the New York - Metropolitan area. Your concern was borne out of a compassion for the humanity that would be involved in such an event.

In early 1952 you began a significant adventure as Regional Representative and Director of Special Programs for the Research Corporation of New York, a foundation concerned with stimulating science research in colleges and universities in the United States and Canada. You interested yourself with the development and improvement of departmental and interdisciplinary science instruction among college faculties. The program that you originated and directed had wide impact and became the model for similar programs in a number of government agencies and other foundations. In the years that followed you affected profoundly academic science across the country and the evolution of the Research Corporation's own programs for the advancement of science. Habitually, you challenged and helped guide the imaginative thinking that you found among young scientists in budding science departments in many parts of the country. Your concepts played an important role in the decision on the part of the Research Corporation to make unrestricted grants to help colleges with great potential to make "breakthroughs" to potential greatness. Your efforts strengthened the science departments in liberal arts colleges and small universities throughout the United States.

Characteristically looking beyond immediate horizons, you developed the concept of a program through which private industry might help advance science and science education in less developed areas of the world, primarily in Latin America. You carried on this work independently--almost as an avocation, if intensity of interest, devotion and plain hard work can be so characterized for such an unroutine and self-imposed mission. Your creation has been FORGE, which stands for the Foundation for Overseas Research Grants and Education. In 1968 you left the Research Corporation in order to undertake full-time development of the FORGE activity and successfully secured organizational funds from the Ford Foundation, and additional funds from industry for launching FORGE on a continuing basis. To this day you continue to develop a constructive program for support for the academic sciences throughout Latin America. Your efforts have assisted young faculty in the sciences and in engineering in Latin American universities to do research and to teach in their home universities. With the help of private industry, you are making a significant contribution to technological development in Latin America and to a better communication between industry and the academic community in the sciences.

Therefore, the Board of Trustees of Southwestern At Memphis has admitted you to the degree of DOCTOR OF SCIENCE with all the privileges and responsibilities thereunto appertaining, in token whereof this diploma and the appropriate hood are presented to you.

William L. Bowden
President
Southwestern At Memphis

XI. Acknowledgements

Having read this review of the history of physics at Southwestern I am sure it is obvious to all that we are indebted to many people. I have listed many people and organizations by name. Others will be mentioned in this section.

An indispensable ingredient over the years has been the camaraderie among the staff. We have been able to develop a sense of dedication and belonging. The students who have majored in physics have left with a sense of belonging and the Physics Department has provided them a point about which they have been able to nucleate, so-to-speak.

I would like to take this opportunity to establish for the r cord the deep appreciation of the Department for the support it received over the years from John A. Rollow (Engineer of the College) until his death in 1969. John Rollow was one of those unique people who could do anything with his hands and never heard of a 40-hour work week. Many is the time he drove me to Nashville in the College truck to get government surplus property, before Interstate I-40 was ever contemplated, in the cold winter months and no heater in the truck. He sublimated his own life for the cause of Southwestern.

Let me also take this occasion to say that the Department is most appreciative of the opportunity it has had of getting to know some of the parents and families of our majors. These families have great pride in their sons and daughters and in the Physics Department. This support, sometimes visible and sometimes behind the scenes, is very important to a department. As just one of many examples, let me tell you that the parents of C. W. Brandon III (one of our students

who accompanied us on the 1963 total solar eclipse expedition to Alaska) completely surprised the expedition on its return to the Memphis airport after the eclipse. Mr. and Mrs. Brandon had, on their own initiative, arranged for one of the local television stations to greet us on our return. The interviews and camera coverage of the arrival were later shown on television. Another example is the willingness of Bill Mankin's father to come over and help us build our Mobile Infrared Observatory when we were desperately trying to get ready for Project Firefly. Speaking of the Mankins, I am reminded of the occasion when both Dr. John A. Sanderson and Dr. John D. Strong were on the Campus and the Mankins invited them out to their home in Raleigh to let them find out how good ham, biscuits and red eye gravy can be when properly prepared.

We can never refer to the 1963 Alaskan expedition without being reminded of our great obligation to Mr. Claude Bass, a Memphis amateur radio operator, who anchored the Memphis end of the Gulkana-Memphis daily radio contact. Claude maintained a telephone patch with the parents of the students on the expedition and the wives of the staff members. This generous assistance on his part will always be remembered.

Perhaps natural philosophy has a tendency to remove one from sentimentality. Be that as it may, I shall never forget an incident on the Alaskan expedition, and I am certain that the students will never forget. The living conditions on this expedition left something to be desired. We had been in camp about a month living in tents and eating the best we could from canned foods (no reflection on A. C. Emery who kindly volunteered to supervise the cooking) when Dr. Rhodes arrived in Alaska a few days before eclipse time. Arrangements had been made for him to stay in a lodge several miles from the campsite. Each evening he was there he took several members of the expedition, on a rotating basis, to his lodge for a good dinner. An eclipse is a rather moving experience. After the eclipse was over and the measurements completed, Dr. Rhodes asked me to assemble the expedition. This I did. With the expeditionary group assembled near the end of the Mobile Infrared Observatory that housed the radiometers (and facing the Wrangell Mountains) Dr. Rhodes spoke to the group saying what this experience had meant to him and that he sincerely hoped it had such meaning for the others. He then offered a short prayer of thanks. If there is such a thing as a meaningful undergraduate experience, such must have been the case that day in Gulkana, Alaska.

To Dr. John A. Sanderson we are most grateful for the support he has given the Department. He is always standing ready to help when we need him. This grand gentleman of optical physics is one of those people who never misses an opportunity to put in a good word for Southwestern in the right places.

I would also like to take this opportunity to thank Mr. John C. Flippin for his support over the years. Mr. Flippin is the dean of amateur astronomers in Memphis and it has been a real pleasure to know this fine gentleman. Since we have been in the Physics Tower the amateur astronomers of the city have been holding their monthly meetings here and we certainly hope they will continue this practice.

The Department is certainly appreciative of the cooperation and encouragement it enjoyed with our academic dean, Dr. Jameson M. Jones. Jameson is much interested in astronomy and accompanied us on the 1970 expedition. Our best regards go to him in his new association with the Memphis Academy of Arts.

As a result of the work the Department did in connection with Project Firefly (and later with Cape Kennedy) it was necessary for several members of the Department, as well as certain administrative officials and certain members of the Board, to obtain a security clearance from the government. It was required that Southwestern designate someone as Security Officer and it was not possible for someone from the Physics Department to be the Security Officer. This burden fell on the already heavily burdened shoulders of Mrs. Erma Reese Solomon (who has among her other distinctions, that of being secretary to four Southwestern Presidents). Many classified documents came into the Department and Erma had the responsibility of seeing that no one failed to carry out his responsibilities in connection with these documents, which were kept in a government specified locked filing cabinet in my office (which also served as the Departmental office). The first secret material in the history of Southwestern arrived at the Physics Department on Saturday, January 28, 1961 and was duly logged in by Erma Reese Solomon. I am hard pressed to think of something less appealing to her than this task of Security Officer but she carried it out in her usual efficient manner and we are exceedingly grateful to her.

To Viviene Guest, a student at Southwestern who worked part time as the Department secretary, we are certainly indebted for the outstanding job she did in helping with the many details associated with the June 8-12, 1964 Conference on Undergraduate Research Programs in Optical Physics.

Finally, on behalf of the Physics Staff, I would like to extend to former President, Dr. John David Alexander, our sincere appreciation for permitting us to use aluminum domes on top of the Physics Tower rather than having to use a roll-back roof arrangement and also for not insisting, against the Department's advice, that the domes be painted black. His support in connection with the large grant from Research Corporation is greatly appreciated.

XII. Enclosures and Photographs

Enclosure 1 - Catalog Listing of Physics Program (1855)

1855 CATALOGUE, page 9

JUNIOR CLASS

First Term

Horace, Epistles; Cicero de Oratore.	
Gorgias of Plato,	Woolsey.
Rhetoric,	Jamieson.
Greek and Latin Exercises.	
Mechanics.	

Second Term

Tacitus, Germania and Agricolo.	
Antigone of Sophocles,	Woolsey.
Select Latin, Select Greek, or Modern Languages, at the option of the student.	
Natural Philosophy,	Lardner.
Chemistry--Lectures and Experiments,	Fownes.

SENIOR CLASS

First Term

Cicero's Tusculan Questions.	
Demosthenes de Corona,	Champlin.
Mental Philosophy,	Upham.
Mineralogy,	Dana.
Astronomy,	
Meteorology,	Brocklesby.

Second Term

Logic,	Jamieson.
Political Economy,	Say.
Moral Philosophy,	Wayland.
Evidences of Christianity,	Alexander.
Geology,	St. John.
Zoology,	Agassiz & Gould.

N.B.--Anthon's Classical Dictionary and Grecian and Roman Antiquities should be used as Books of Refernces throughout the whole course. Exercises in elocution and composition by the classes in turn every Friday afternoon.

1855 CATALOGUE, page 10

SCIENTIFIC COURSE

For those students who may not desire to pursue the prescribed course in College, the following series of studies, to occupy three years, has been arranged:

FIRST YEAR

First Term

Arithmetic.	
Algebra,	Davies Bourdon.
Chemistry,	Fownes.

Second Term

Algebra, completed.	
Geometry,	Davies.
Meteorology,	Brocklesby.
Rhetoric,	Jamieson.

SECOND YEAR

First Term

Trigonometry, Plane and Spherical.	
Logic,	Jamieson.
Political Economy,	Say.
Mineralogy,	Dana.

Second Term

Mensuration of Surfaces and Solids.	
Surveying and Navigation,	Davies.
Analytical Geometry,	Davies.
Natural Philosophy,	Lardner.
Zoology,	Agassiz & Gould.

THIRD YEAR

First Term

Mental Philosophy,	Upham.
Natural Philosophy, continued.	
Analytical Geometry, continued.	

Second Term

Moral Philosophy,	Wayland.
Evidences of Christianity,	Alexander.
Geology,	St. John.
Astronomy,	Herschell.

Enclosure 2 - Catalog Listing of Physics Program (1925)

1925 CATALOGUE, pages 92-93

PHYSICS

1 and 2. General Physics.
A course in General Physics treating the subjects Mechanics, Heat and Sound during the first semester, and Magnetism, Electricity, Light and Modern Theories during the second semester.

Lectures and recitations three hours a week. Laboratory one period, three hours per week.

3. Electricity and Magnetism.
A practical problem course in direct currents, covering more complicated circuits than in Physics I, the theory and use of primary and secondary batteries, and an elementary treatment of generators and motors.

Recitation and lectures three hours a week. Laboratory three hours a week. Prerequisites, Physics 1 and 2, and Mathematics 5 and 6.

4. Alternating Currents and Radio.
A brief study of some alternating current problems followed by a thorough discussion of the underlying principles of radio communication. The whole subject will be illustrated by class and laboratory experiments.

Hours as in Course 3, which is prerequisite to this course.

5 and 6. (Mathematics 9 and 10). Theoretical Mechanics.
This course includes the Elementary problems on both static and kinematics, and also a few of the more advanced problems. The following subjects will be covered: Composition and Resolution of Forces, Center of Gravity, Friction, Machines, The Catenary, Rectilinear Motion, Curvilinear Motion, Central Forces, Constrained Motion, Impact Work and Energy, Moment of Inertia, and Rotary Motion.

Three hours a week, both semesters. Lectures, recitations, and problems. Prerequisites, Mathematics 7 and 8.

21 and 22. Laboratory courses to accompany Physics 5 and 6.

7. Electrical Theory.
An introduction to the mathematical theory of Magnetism and Electricity.

Three hours per week, first semester. Prerequisites: Physics 1 and 2; Mathematics 7 and 8.

8. Physics of the Ion.
The latest developments concerning conduction through gases and radioactivity.

Three hours per week, second semester. Prerequisite: Physics 7.

23 and 24. Electrical Measurements.
Measurements of potential, current, resistance, reactance, hysteresis, etc.

One period of at least three hours each week, both semesters. Prerequisites: Physics 3 and 4; Mathematics 7 and 8. Physics 7 and 8 should accompany this course.

9. Theory of Heat and the Elements of Thermodynamics.

Three hours per week, first semester. Prerequisites: Physics 1 and 2; Mathematics 7 and 8. Not offered in 1925-26.

10. Advanced Course in Light.

An introduction to the theory of Physical Optics.

Three hours per week, first semester. Prerequisites: Physics 1 and 2; Mathematics 7 and 8. Not offered in 1925-26.

Enclosure 3 - Catalog Listing of Physics Program (1972)

1971-72 CATALOGUE, pages 134-137

Requirements for a major in Physics leading to the B.A. degree:
(1) Physics 101-102, 103-104, 201-202, 203, 204, 205, 206, 305, 306, 401, 405.
(2) Mathematics 103, 104, 105, 201, 202.

Requirements for a major in Physics leading to the B.S. degree:
(1) Physics 101-102, 103-104, 105, 201-202, 203, 204, 205-206, 301-302, 303-304, 305, 306, 307, 401, 402, 403, 404 or 405 406 or 407.
(2) Mathematics 103, 104, 105, 201, 202, 261.
(3) A reading knowledge of French, German or Russian.

NOTE: Students interested in a Physics major should take Physics 101-102 in the freshman year. The importance of mathematics in physics cannot be overemphasized, and prospective majors are urged to take 4 years of mathematics in high school. All prospective physics majors should consult with the Chairman before registration.

101-102. General Physics (I-II) [3-3] NP
The elements of mechanics, heat, sound, electricity, magnetism, optics and modern physics. Prerequisites, a knowledge of algebra and trigonometry.

103-104. General Physics Laboratory. (I-II) [1-1]
Basic experiments in the topics covered in Physics 101-102, designed to acquaint the students with typical experimental problems and to demonstrate many types of scientific apparatus.

105. Special Topics in Physics. (III) [3] NP
A more intensive study of certain of the topics introduced in Physics 101-102; in particular, alternating-current circuit theory and geometrical and physical optics.

107-108. Introductory Physics. (I-II) [3-3] NP
A study of the classical fields of physics, with an introduction to modern physics. Satisfies the science sequence required for the liberal arts and science curricula. Intended primarily for non-physics majors and pre-medical and pre-dental students. Co-requisite: Physics 103-104. Prerequisite: A working knowledge of high school algebra and trigonometry.

115-116. Astronomy I(-II) [3-3] NP
An introduction to modern astronomy. Topics such as cosmology, galaxies, the interstellar medium, the structure and evolution of stars, motions of stars, the sun and the solar system will be discussed.

117-118. Astronomy Laboratory (I-II) [1-1]
Laboratory instruction in the use of astronomical instruments and data. Corequisite: Physics 115-116.

201-202. Structure of Matter (I-II) [3-3] NP
This course is designed to give the student an over-view of current knowledge and theories concerning the structure of matter. Classical mechanics is treated at an intermediate level as a basis for the understanding of atomic structure. Electromagnetic waves and quanta will be discussed. The use of elementary wave mechanics will be applied to the electronic structure of atoms, molecules and solids. The kinetic theory of gases, plasmas and solids as well as an introduction to nuclear physics will be covered. Prerequisites: Physics 101, 102 and Mathematics 105.

203. Techniques Laboratory. (I) [1]
This course is designed to provide the student the opportunity to learn and develop various laboratory techniques. Vacuum and gas handling, glass blowing, deposition of thin films, soldering, waxes, glues and cements, testing o optical surfaces, photography. Lectures on machine shop practice, kinematic and semi-kinematic design of apparatus. Scientific illustrating and technical sketching. One of the objectives of this course is to emphasize "improvization". Prerequisites: Physics 103,104.

204. Modern Physics Laboratory. (II) [1]
Experimental problems dealing with the crucial developments in modern physics. Measurement of the charge of the electron, charge to mass ratio of the electron, Planck's constant, velocity of light, gravitational constant. Selected experiments in nuclear physics, electron spin resonance and nuclear magnetic resonance experiments. Prerequisite: Physics 103,104.

205. Electromagnetic Radiation. (III) [3] NP
A study of the behavior of electromagnetic waves, both in free space and in material bodies. Coherence, interference, diffraction, dispersion, and polarization. Modulation transfer functions. Absorption and emission of light, blackbody radiation laws, electro-optical and magnetooptical effects. Prerequisite: Physics 202 and Mathematics 201, 202.

206. Experimental Optical Physics. (III) [1]
A laboratory course designed to teach experimental techniques in optical physics. Lens and mirror systems, polarization, dispersion by prisms and diffraction gratings, radiation detectors and radiometry, interferometry, thin films and metallic reflection.

301-302. Electromagnetic Theory. (I-II) [3-3] NP
Maxwell's field theory of electromagnetic properties of matter: Maxwell's equations, the electric and magnetic fields in vacuo, phenomenological treatment of the electrodynamics of ponderable matter. Transient and steady-state currents, and the theory of linear circuits. Prerequisite: Physics 102. Co-requisite: Mathematics 201-202.

303-304. Electrical Measurements Laboratory. (I-II) [1-1]
A laboratory course designed to teach the fundamentals of electrical measurements: AC bridge measurements, nonlinear devices, filters, measurements at audio and radio frequencies.

305-306. Classical Mechanics. (I-II) [2-2] NP
A study of the statics, kinematics, and dynamics of material bodies, including motion in a central field, constrained motion, Lagrange's and Hamilton's equations, variational formulations, and rigid body motion. The course is designed to serve as an introduction to, and an aid in understanding, the more recent theories of the structure and behavior of matter. Prerequisites: Physics 102 and Mathematics 202.

307. Thermodynamics and Statistical Mechanics. (III) [2] NP
Classical thermodynamics: the first and second laws and their consequences. Kinetic theory of gases. Maxwell-Boltzman statistics; introduction to Bose-Einstein and Fermi-Dirac statistics. Fluctuations. Prerequisites: Physics 102 and Mathematics 202.

401.Quantum Mechanics. (I) [2] NP
The elementary formalism of quantum mechanics. Theory of measurement. Application of the Schroedinger equation to the study of the hydrogen atom and its spectrum. Time independent purturbation theory will be developed. Prerequisites: Physics 302, 306 and Mathematics 302.

402. Electronics (II) [3] NP
Theory and applications of the principal types of non-linear circuit elements: electron tubes and semiconductors. Prerequisite: Physics 304.

403. Electronics Laboratory. (II) [1]
Design, construction, and testing of electronic circuits. Prerequisite: Physics 304.

404. Solid State Physics. (I) [2] NP
Crystal structure; lattice vibrations and phonons. Energy band theory and Fermi surfaces. Imperfections in solids and optical phenomena. Superconductivity. Prerequisite: 205, 302, 306.

405. Nuclear Physics. (I) [2] NP
A study of the single and collective preperties of fundamental particles as found in nuclei. Including interaction and collision dynamics, energy levels, symmetry properties, and nuclear structure. Prerequisites: Physics 205, 302, 306.

406. Astrophysics. (II) [3] NP
An introduction to the physics of celestial bodies, emphasizing the relationship between theoretical and observational methods. The course will include radiation laws, radiative transfer, the structure of stellar atmospheres, the formation of emergent stellar spectra, stellar interiors, and gaseous nebulae. Prerequisites: Physics 302 and Mathematics 201, 202.

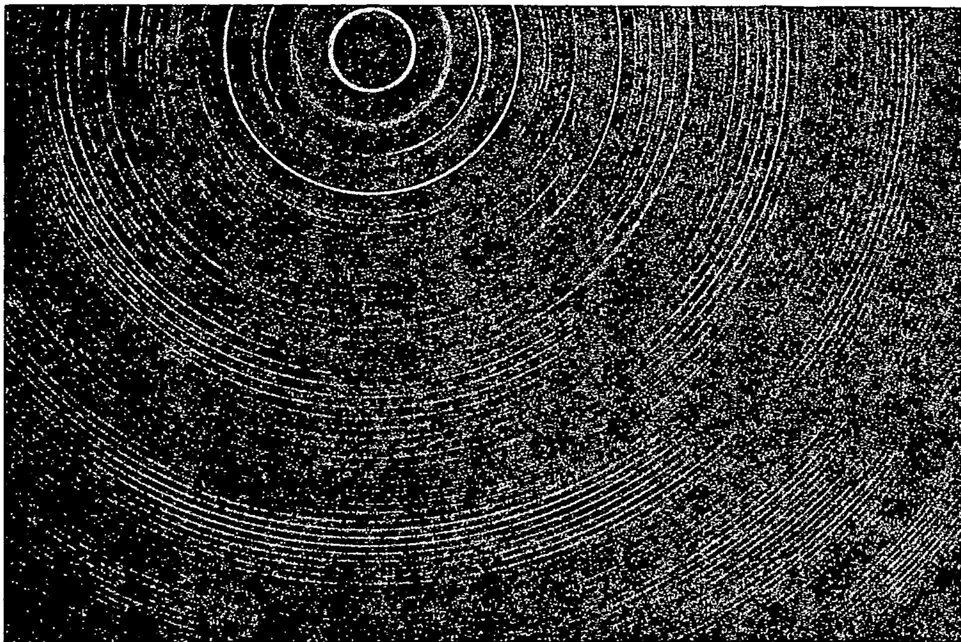
407. Spectroscopy. (II) [3] NP
Introduction to the quantum theory of atomic and molecular processes, and to the principal methods of investigation. Grating mountings and spectroscopic design, high-resolution spectroscopy: wavelength and intensity measurements. Interferometric spectroscopy, Fourier spectroscopy. The special methods applicable to the ultraviolet, visible, and infrared regions of the spectrum. Two hours of lecture and not less than three of laboratory a week. Prerequisite: advanced standing in physics.

408. Modern Optics. (III)[2] NP
This course will extend the topics discussed in Physics 205. The content will be largely determined by the interests and needs of the student. Prerequisite: Physics 205.

409-410. Topics in Theoretical Physics. (I-II) [3-3] NP
A course in which subject matter to be treated on a relatively advanced level will be chosen to meet the needs of the individual students. Enrollment only after consultation with the instructor in charge. Prerequisites: Mathematics 202 and advanced standing in physics.

411-412. Honors Research. (I-II) [3-3] NP
Open to candidates for honors in Physics. Special laboratory research in a recognized branch of physics, usually related to research being carried on by members of the department.

Honors in Physics
(1) Courses required: those listed for the B.S. degree with a major in physics, Physics 409-410.
(2) Special laboratory research in a recognized branch of physics usually related to research being carried on by members of the Department. A creditable thesis must be presented at the end of the year.
(3) Examinations: Mechanics and Thermodynamics; (b) Electricity, Magnetism, and Electronics; (c) Optics, Radiometry, and Modern Physics, (d) Theoretical Physics and the honors research.



YOUR CAREER IN OPTICS

THE OPTICAL SOCIETY OF AMERICA

Enclosure 4

Missile Optics—Career at Cape Kennedy

Dave Glenn calibrates his infrared detection gear . . .

DAVID P. GLENN entered Southwestern at Memphis College back in 1956 with the firm intention of becoming an electrical engineer. Things electrical had always interested him, and at Ensley High School in Birmingham, Alabama, he had been a member of the Electron Club and had built his own hi-fi set. At Southwestern, Dave met and was inspired by Dr. Jack Taylor, head of the Physics Department and a noted expert in the field of infrared technology. Taylor's enthusiasm for optics spilled over into his freshman and sophomore physics courses, and Dave wondered more and more about his choice of a career. By his junior year, he was working for Taylor (days, nights—at 75 cents an hour) and there was no doubt: Dave gave up his earlier plan and instead got a bachelor's degree in physics from Southwestern and went on to the University of Florida for a master's degree with specialization in optics. For his master's thesis, Dave switched to the other end of the spectrum and studied (under Professor Stanley S. Ballard) the absorption of short wavelength ultraviolet radiation in certain alkali halide crystals widely used for optical elements in that important wavelength region.

Even while he was finishing his master's thesis, Dave got a part-time job at Cape Kennedy (then Cape Canaveral) with Pan-American World Airways, which runs the Atlantic Missile Range for the Air Force. Dave's job was to prepare for publication data on the infrared and visible radiation emitted by ballistic missiles. Both at launch and upon reentry, missiles emit lots of radiation—at launch from the hot gases in their exhausts; upon re-entry because of the heat generated when they encounter the atmosphere once again. Measuring this radiation is a prime method for detecting missile launchings or for tracking incoming missiles—both important elements in building a defense against missiles. So the data Dave Glenn was helping to assemble were eagerly welcomed by research and development groups all over the country working on the problem of missile defense.

Dave liked the work at the Cape so much that he decided to go to work full time for PAA upon getting his master's degree. His responsibilities as a Project Engineer in the Infrared Group are varied. He still helps get out the data on missile radiation, but he also sets the specifications for the improved measurement equipment that his group needs to do a better job. This equipment is built to his order by outside optical firms, but putting the pieces together and calibrating it is another of Dave's jobs.

The assembled equipment is used at Cape Kennedy and at Ascension Island, 5000 miles down range; these stations are supplemented by other equipment carried in ships, balloons, aircraft, or even rockets. Dave doesn't run the apparatus—he has technicians assigned to do that. He does set up, plan, and control measurements, though.

Says Dave of this latest phase of his career in optics: "I like my job. It's exciting here at the Cape. It's demanding, sure, but it keeps me in close touch with developments in optics and in the space effort. I work in a number of areas and work with whole systems as well as with individual instruments. For the next year, our biggest challenge lies down at the Ascension Island end of the missile range—we want to make our instruments down there more sensitive, give them even finer resolution."

Enclosure 6 - Letter from Dr. George W. Curtis concerning P. Martin Simpson, Jr.

HIGH ALTITUDE OBSERVATORY
BOULDER, COLORADO 80302

8 September 1969

Dr. J. H. Taylor, Chairman
Physics Department
Southwestern at Memphis
Memphis, Tennessee 38112

Dear Dr. Taylor:

As you know, Mr. P. Martin Simpson worked for us this past summer and as his predecessor he did a fine job of quickly becoming a very useful member of our observing staff. It was a pleasure to have him around and my only regret is that we could not keep him for another six months.

In view of the high quality of students that your Department has the secret of developing, I hope you will not hesitate to communicate to me the name of any student who would be interested in working at Climax next summer. Silence on your part will mean to me that no one is interested or that in your opinion nobody fits our rather special requirements.

Sincerely yours,

George Wm. Curtis.

George Wm. Curtis

/rf

Enclosure 5 - Letter from Dr. George W. Curtis concerning David F. Elmore

HIGH ALTITUDE OBSERVATORY

BOULDER, COLORADO 80302

9 September 1968

Dr. J. H. Taylor, Chairman
Physics Department
Southwestern at Memphis
Memphis, Tennessee 38112

Dear Dr. Taylor:

This past summer the Climax station of the High Altitude Observatory employed one of your students. As Scientist-in-charge of our Climax station I would feel remiss in my duties if I did not mention to you the splendid job that Mr. D. Elmore did for us. He quickly and pleasantly meshed in a very special environment but more to the point he became a full-fledged observer in record time. His contribution to the scientific life of Climax was a real one and I feel you should know how very pleased I was with him and his work. Do I need to add that the excellent training he received in your Department must share the honors for his performance at Climax.

I do hope that HAO and your Department will maintain their very special relationship and that you will not hesitate to recommend to us students whom you feel would make good use of a temporary or permanent job at Climax.

Sincerely yours,

George Wm. Curtis

George Wm. Curtis

GWM/cgc

A Laboratory of the National Center for Atmospheric Research

Operated by the University Corporation for Atmospheric Research
Under Contract with the National Science Foundation

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Optical Physics Research in a Small Liberal Arts College

J. H. Taylor

To encourage more activity in the field of optical physics in the small colleges the program at Southwestern is described. It is believed that the Southwestern program has been effective in motivating many undergraduate physics majors to pursue optical physics as a career in graduate school. The undergraduate is directly involved in the program. The small size of the staff has not been a handicap since the department is concerned only with this one research program.

I. Introduction

In 1956 when the author joined the Physics Department at Southwestern it was a one-man department. The college had previously undergone a succession of turnovers in this department, and when it was unable to obtain a man in physics it asked the writer, an alumnus, to return. Prior to coming to Southwestern the author was working with L. F. Drummeter, Jr., and H. W. Yates in J. A. Sanderson's Optics Division at the Naval Research Laboratory. The situation that was inherited at Southwestern was typical of most small liberal arts colleges in the pre-Sputnik era. The efforts of the department previously had been purely pedagogical. No attempt at research had ever been made; there was no equipment for research and no money in the budget for it. With a teaching load of six 3-hr courses per semester plus three different laboratory courses, the prospects for launching a research program were not only exceedingly dim but ridiculous to contemplate.

II. Effect of Research Activity on our Undergraduate Physics Program

We believe that the program described below has had a positive influence on our physics majors. There is definite evidence that it has been effective in motivating many of them toward the pursuit of optics as a career. In the past 6 years there have been 21 students graduating with a B.S. degree, and all but two have gone to graduate school, including Vanderbilt University, University of Florida, Ohio State University, Louisiana State University, University of North Carolina, Harvard University, Virginia Polytechnic Institute, Rensselaer Polytechnic Institute. Six of them are now at The Johns Hopkins University in various stages of graduate work. This is doubly gratifying in view of the shortage of undergraduate physics majors who now enter the field of optics.

It is felt that the research program being pursued, in which the undergraduate physics major is directly involved, is important regardless of the significance of the results in that it provides an excellent proving ground, so-to-speak, for physics majors. In a large university it is likely that such participation would be reserved for graduate students.

The author is in the Department of Physics, Southwestern College, Memphis, Tennessee.

Received 31 May 1963.

Southwestern has for many years had an Honors program. In the Physics Department those physics majors who qualify for this program can do work beyond that normally required for the B.S. degree. The program consists of two semesters of a theoretical physics course plus a project, usually experimental. Staff research provides excellent material for Honors research projects, and, in general, a student will work on a problem in some phase of optics of current interest to the staff. Although our experimental research activities are solely in the field of optical physics we try for a balanced physics curriculum. Our majors begin their work in the freshman year and, by the time of graduation, will have completed at least seven physics courses (each of two semesters' duration). In order for the majors to participate in the research program as early as possible the optics course (two semesters) taken in the sophomore year, was changed to Optics and Radiometry, and a senior-level course on Infrared Spectroscopy was added.

Since no research could be started the first year it was felt that the least that one could do would be to begin to develop the "right arm" of any experimental program; namely, machine-shop support facilities. The full-time services of an instrument maker were obtained a few months later. The room which he inherited as a shop was equipped with, at most, a few hand-tools and nothing in the way of metal stock. The limited budget mentioned previously made it impossible to purchase any new machinery whatsoever for the shop. Realizing this, the acquisition of government surplus machine-shop equipment was pursued. Government surplus is made available through the Department of Health, Education and Welfare for a fraction of its original cost. Before too long a facility was assembled that one was not ashamed to call a machine shop. Currently included in the shop are three lathes varying in sizes from 25.4-cm swing to 38.1-cm swing; two Number 2 milling machines, one horizontal and one vertical; one 91.4-cm DoAll metal cutting saw; one 40.6-cm drill press and one 17.8-cm shaper. This equipment, excluding the shaper, was government-surplus obtained for an average cost of $175 each. It should also be mentioned that various metal stock has been obtained from the above source.

At the end of the second year, and with the machine shop in competent hands, it was obvious that additional teaching staff would have to be secured if one was going to have any time for research. Shortly thereafter a second man at the Master's level was added to the staff.

Most likely in almost everyone's life a memorable experience

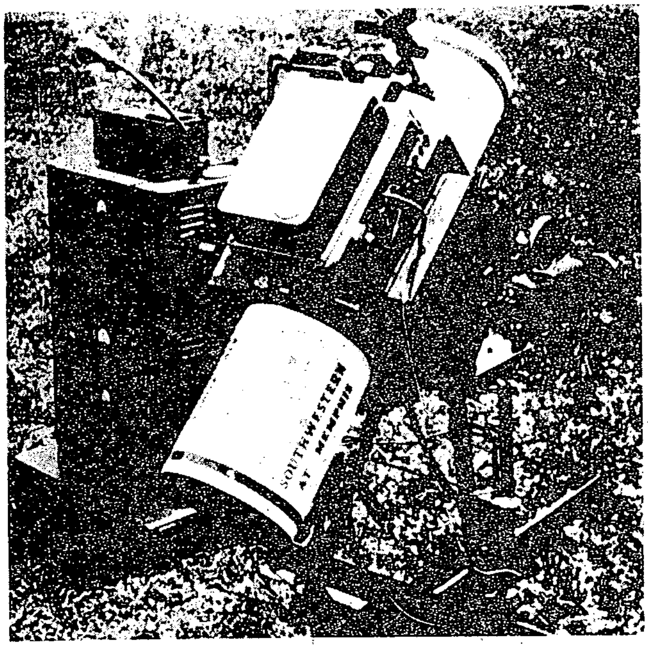

Fig. 1. Apparatus assembled to study near infrared radiation from the sun's atmosphere during a total solar eclipse. The apparatus consists of a 25.4-cm diam (f/4.5) reflecting telescope feeding a Perkin-Elmer "hasty scan" spectrometer.

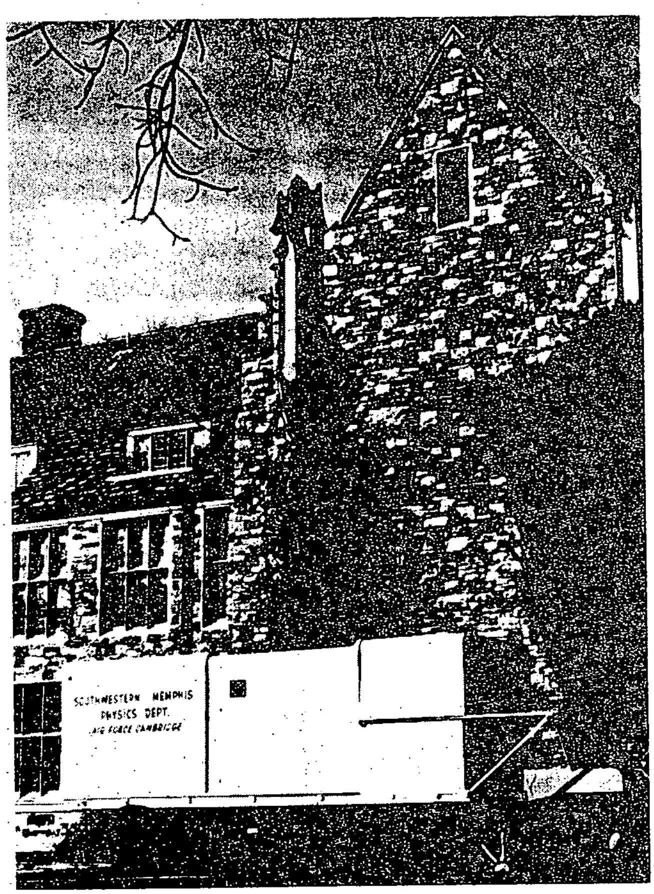

Fig. 2. Completed mobile infrared observatory. This observatory consists of three sections. The section on the left slides over the center section and the section on the right slides out on the tracks.

stands out where a kind word by a friend, or that break, when one really needed it, leaves a lasting impression. Such was the author's experience with the Air Force Cambridge Research Laboratories. The writer will always feel a deep debt of gratitude to John N. Howard of AFCRL for having given the initial contract for work in the field of infrared physics and to his colleague, John Garing, for his continued support in this respect. With this initial contract a Perkin-Elmer Model 112 spectrometer (having "hasty scan" capabilities) and associated equipment were made available. Equipment of this kind would never have been possible for us otherwise. Since that time (1958) much additional infrared equipment has been obtained.

About two years later the department added another staff member (a molecular spectroscopist) at the Ph.D. level, who is doing work under contract with the AFCRL and, shortly thereafter, a full-time electronic technician.

The department now has a modest optics shop. Due to the generosity of a former undergraduate classmate of the writer, the Physics Department gained a modified Draper polishing-machine, a rough-grinding machine, and a diamond saw. Our electronics technician, who for many years has been interested in amateur astronomy, took a concentrated summer course in optical

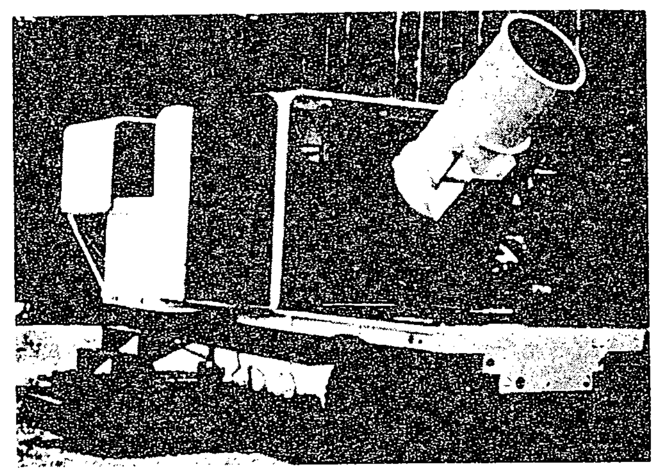

Fig. 3. Photograph of mobile observatory with the end sections open. The 78.7-cm diam radiometer (f/2) is mounted on a government surplus 40-mm antiaircraft gun mount.

production and testing techniques at the Institute of Optics at Rochester in 1962 and he is now in charge of this phase of our work. Mirrors up to 20.3-cm diam can be aluminized using thermal evaporation apparatus built here. This evaporation apparatus has also been of much pedagogical value in the optics laboratory course.

III. Research Program

The nature of the program is such that this laboratory is often engaged in field expeditions. It has made a trip to the Canary Islands to participate in the total solar eclipse of 2 October 1959, to Santa Rosa Island (Florida) in July-August 1960 to participate in Project Firefly and to Climax, Colorado (High Altitude Observatory) in December 1962 for near-infrared solar studies using a coronagraph. It is now preparing for a trip to Gulkana, Alaska, to make infrared studies of the corona during the total solar eclipse of 20 July 1963. The research activities are described below.

Total Solar Eclipse of 2 October 1959

Figure 1 shows the apparatus that was assembled in our laboratory to study the near infrared radiation from the sun's

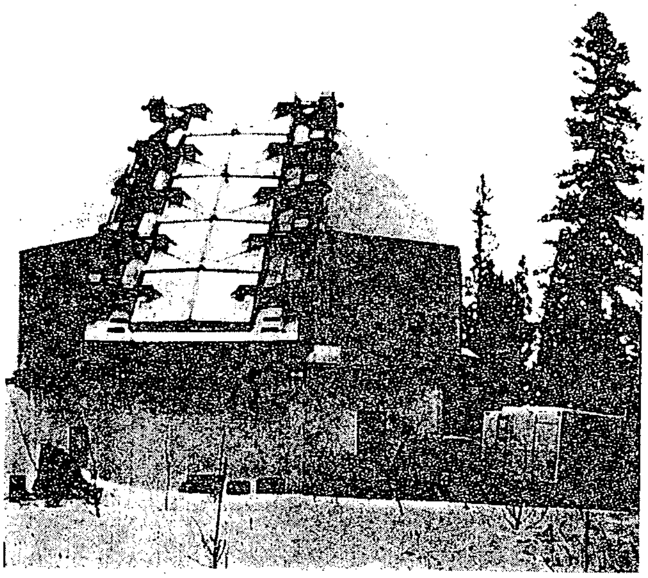

Fig. 4. Photograph of the Physics Department's small trailer located outside the large dome at the Climax Observing Station. This trailer was obtained from government surplus and was used to transport equipment on this expedition.

atmosphere during a total solar eclipse. The apparatus consists of a 25.4-cm diam ($f/4.5$) reflecting telescope of the Newtonian type feeding a Perkin-Elmer "hasty scan" spectrometer. This apparatus was mounted on a sturdy camera-panning head obtained from government surplus for \$5.00. This equipment was carried to the island of Fuerteventura, but, unfortunately, clouds at the time of totality prevented the acquisition of data.

Project Firefly (July-August) 1960

This work was concerned primarily with studying the infrared radiation (in the PbS region) from high-altitude chemical releases. To prepare for this expedition a government-surplus trailer (see Fig. 2) was obtained for \$100.00. It was decided to build on this flat-bed trailer a mobile infrared observatory that could be carried to any part of the world. The finished mobile observatory in three sections is shown in Fig. 2, built entirely by the

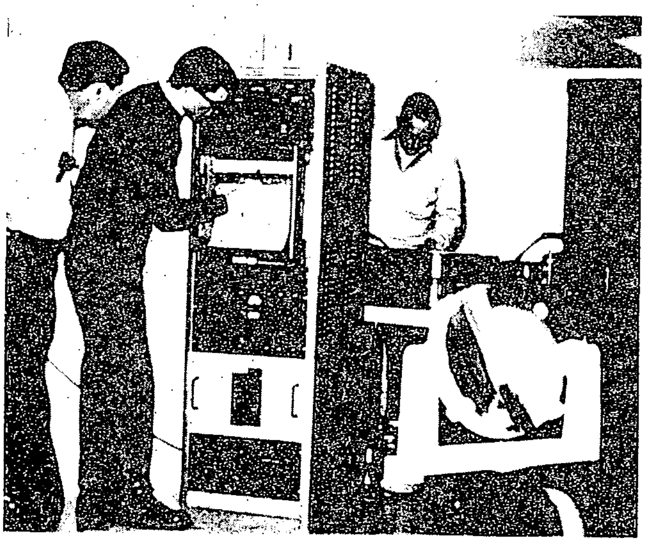

Fig. 5. Photograph showing some of the spectroscopic equipment that was set up in the spectrometer room of the large dome at the Climax Observing Station.

physics department. Figure 3 shows the observatory in the open position. On the larger end will be seen a 78.8-cm diam radiometer ($f/2$), mounted on a government-surplus 40-mm anti-aircraft gun mount. Four of our physics majors accompanied us on this expedition, under the NSF Undergraduate Research Participation Program.

High Altitude Observatory (December 1962)

Our next efforts to study infrared radiation from the sun's atmosphere were made in December 1962, where John Firor, Director of the High Altitude Observatory, invited this laboratory to use the Observatory's 40.6-cm diam coronagraph. Their coronagraph (located at the Climax Observing Station) was successfully used to study the infrared radiation from the solar atmosphere in the PbS region.[1] The equipment was carried to Climax in a trailer obtained for \$65 from government surplus (Fig. 4). Some of the spectroscopic equipment that was set up in the spectrometer room of the large dome at Climax is shown in Fig. 5.

Total Solar Eclipse of 20 July 1963

For the past several months this laboratory has been preparing to participate in the total solar eclipse of 20 July 1963. The expedition (consisting of 12 persons, 4 of whom will be undergraduate students majoring in physics) will go to Gulkana, Alaska, in an attempt to study infrared radiation from the sun's atmosphere in the 1–15 μ region. These students will be partici-

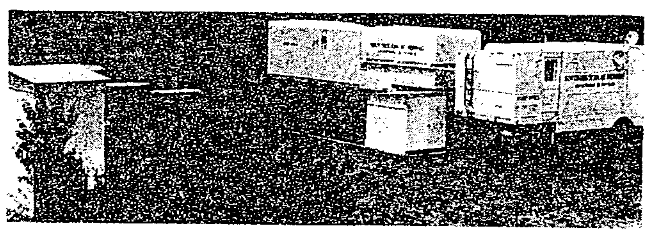

Fig. 6. Photograph of mobile infrared observatory and small trailer set up as they will be in Alaska. The right end of the observatory has been lengthened and the roof section of this end redesigned (see Fig. 3). The small white house covers 76.2-cm diam coelostat and the large white house covers a 76.2-cm secondary mirror.

pating under the NSF program to encourage research on the part of undergraduates. Figure 6 is a photograph of the mobile observatory and small trailer set up as they will be in Alaska. (It was necessary to increase the length of the observatory for this expedition.) The tracks on which the new section slides are dismantled and stored under the observatory when it is in transit.

Two scanning infrared spectrometers (Perkin-Elmer), each fed by a 35.6-cm diam ($f/4.5$) parabola, are located in the new section. Mounted under each of these spectrometers is a 12.7-cm diam (63.5-cm focal length) camera that is boresighted with the spectrometer. Each of these two systems (namely, camera, spectrometer, and associated mirrors) is mounted on a Mark 51 gun director (see Fig. 7). These Mark 51 gun directors were obtained without cost from the Naval Air Technical Training Center (Millington, Tennessee). On the other end of the observatory are mounted two radiometers (see Fig. 7). In addition, there is also mounted alongside the large radiometer a 12.7-cm diam (152-cm focal length) camera (see Fig. 8). All of these cameras were built in our laboratory using government surplus aerial camera parts.

The small trailer (see Fig. 6) houses an infrared spectrometer (Perkin-Elmer) and associated optics to measure the temperature of the ozone layer during totality. Under the small white

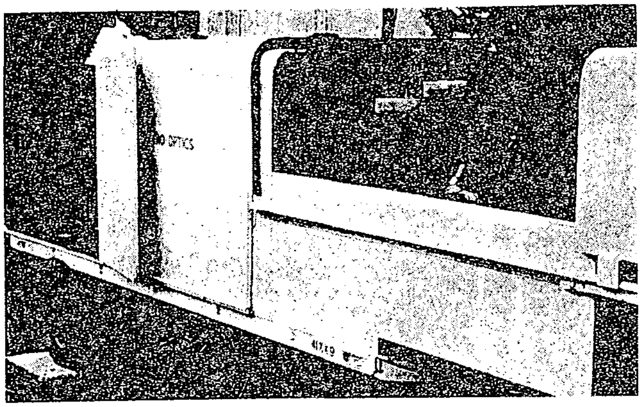

Fig. 7. Photograph showing the mobile observatory in the open position. On the right end can be seen two infrared spectrometers (Perkin-Elmer) mounted on Mk51 gun directors. On the left end of the observatory are mounted two radiometers and a long focal length camera.

Fig. 8. Photograph of radiometer section of the mobile observatory. Mounted on the upper left of the large radiometer is a 12.7-cm diam (152-cm focal length) camera.

house is a 76.2-cm diam coelostat (built in our machine shop) and under the large white house is a 76.2-cm diam secondary pick-off mirror. Radiation from the sun is directed into the small trailer.

As pointed out above, this work is done under contract with AFCRL but the magnitude of this particular expedition is more than the contract can cover financially. In view of the opportunity such an expedition affords for the training of young physicists in the field of infrared, additional funds were sought to help defray the expense. Even though every attempt has been made to keep the cost to a minimum it can be readily appreciated that considerable expense is involved. It should be pointed out that the expedition will sleep in tents and will cook its own food! A local wholesale distributor of groceries assisted us by giving the food; another local firm gave all the tents, cooking utensils, etc.; finally, we were given four new tires which were needed on the mobile observatory. The Research Corporation, in particular Alfred Kelleher, made it possible by means of a grant for us to take on the expedition a former student of ours who is now in his third year of graduate work.

Laboratory Activities

In addition to field trips, the staff maintains a continuing laboratory program. The laboratory has an infrared grating-spectrometer (Perkin-Elmer) equipped with a fore-prism monochromator that is to be used to study near infrared radiation from plasma arcs. The plasma arc being used was recently constructed and used by one of our students as part of his Honors work.

Figure 9 shows a Fabry-Perot interferometer of the pressure-scanning type being built in our laboratory. It consists of 10.2-cm diam fused-quartz plates (flat to $^1/_{20}$ wavelength) and is being designed primarily for auroral studies. Mention should also be made of work being done to measure quantum vibrational lifetimes in the infrared using a technique suggested by John Strong. Another activity is the construction of a radiometer to measure infrared radiation from planets. Designed primarily as a pedagogical instrument to be used by our students, the collimator for

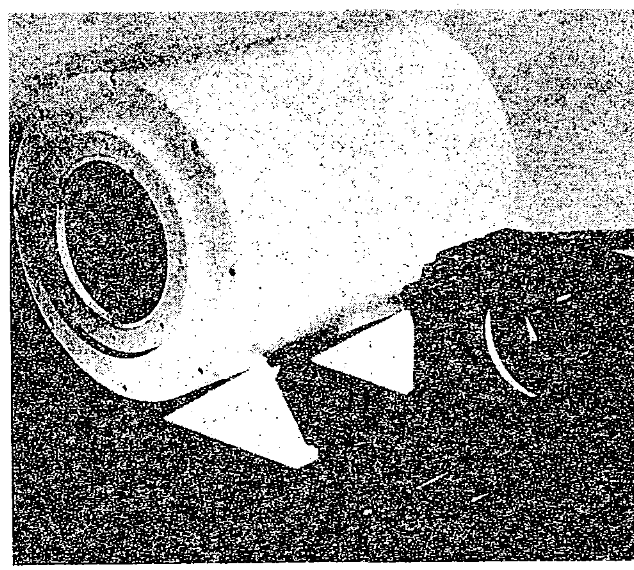

Fig. 9. Photograph of Fabry-Perot interferometer (10.2-cm diam fused quartz plates) of the pressure scanning type that is being built by the Physics Department for auroral studies.

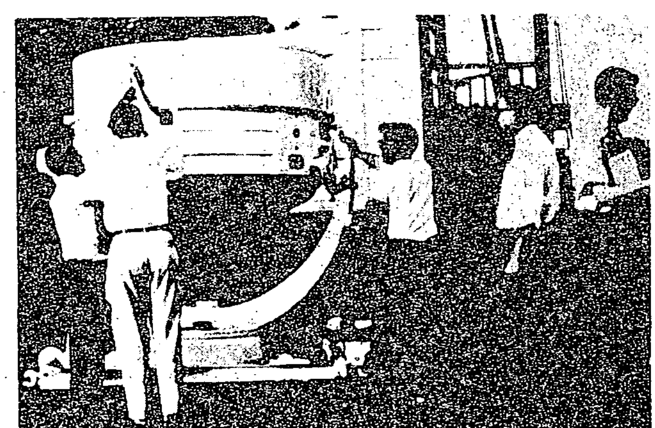

Fig. 10. Planetary radiometer (153-cm diam) being assembled by the Physics Department.

the radiometer is a 153-cm diam anti-aircraft searchlight mirror. Figure 10 shows this instrument located on our campus.

IV. Conclusions

The author believes that the research program described here has been of value both to the undergraduate program in physics and to the physics staff. Such a program helps to motivate a student during what is probably the most sensitive period of his career, at a time when it is possible to really "fire him up". Because of a limited staff we have had to direct our efforts into one field of activity, and even the Honors program is designed so that it can assist staff research. It is felt that with a "one for all and all for one" attitude, a modest amount of headway in this particular field of endeavor can be made.

When discussing research in small colleges it should be pointed out that the ratio of staff members/field of research is probably comparable to that in many large universities, particularly if the large universities are concerned with many different research programs and if the small colleges confine their activities to one or two fields of endeavor.

In addition to the various people already mentioned by name in this paper the writer would like to express appreciation to John Strong and V. Z. Williams for their continuing encouragement, and to thank Harvey T. Marshall, Director, State Educational Agency for Surplus Property (Nashville, Tennessee) for his assistance in obtaining many specialized pieces of equipment from government surplus.

Reference

1. J. H. Taylor and R. M. MacQueen, "Near Infrared Observations of the Solar Atmosphere," Appl. Opt. (in press).

Editor's note: John Howard remembers the letter he received in 1957 from Jack Taylor at Southwestern asking for research support. Taylor was alone in the Department with many teaching duties, no graduate students, no equipment; just a splendid background from Johns Hopkins and NRL and an impressive list of previous publications. He had sent the same letter seeking support to several possible sponsors, but this was the time period immediately preceding the first Sputnik when research funding was unusually austere. It so happened that AFCRL had just acquired an infrared spectrometer that had been specially constructed to work with a large cloud-chamber, and that particular effort had just collapsed. Howard sent Taylor this instrument plus an infinitesimal amount of funding—all that AFCRL could scrape up at that moment. In practically no time Taylor had students working out advanced problems on this instrument, he had matched it with a home-made Newtonian telescope to do sky studies, and was making plans to study solar eclipses. His success in turning out students eager to continue in optics research testifies to the capability of a dedicated teacher to inspire.

NAVAL AIR TECHNICAL TRAINING CENTER

MEMPHIS 85, TENNESSEE

IN REPLY REFER TO
CODE 54

5 FEB 1962

Dr. J. H. Taylor
Physics Department
Southwestern At Memphis
Memphis, Tennessee

Dear Dr. Taylor:

During the past several years you have rendered a valuable service to this command through your conduct of indoctrination tours attended by students of the Electronics Technical Officers Course, Naval Air Technical Training Center. These tours covered the physics laboratory and infrared research facilities of Southwestern at Memphis.

Upon returning from the tours, students have repeatedly commented on your unusual ability to present advanced theories in understandable language; your willingness to discuss, at length, all aspects of these theories; and, above all, your splendid spirit of cooperation.

It is felt that your efforts have served to further the motivation of the students and to broaden their horizons.

On behalf of the command I wish to express appreciation for the assistance you have so willingly extended.

Sincerely Yours,

B. E. CLOSE
Captain, U. S. Navy
Commanding Officer

Enclosure 8 - Letter of Appreciation from the Naval Air Technical Training Center (Millington, Tennessee)

Reprinted from **APPLIED OPTICS,** Vol. 8, page 197, January 1969

A Decade of Optical Physics in a Small Liberal Arts College

J. H. Taylor

The development of a program of optical physics research involving undergraduates is described. Some of the problems encountered by college teachers trying to maintain a research program are discussed. A Physics Tower that has been uniquely designed for work in optical physics is discussed in considerable detail. The optical physics facilities include two domes for housing telescopes, one dome housing an optical tracker, two domes housing a coelostat system, dark tunnel, sun telescope, and spectroscopic and radiometric laboratories. Radiation from the sun can be directed throughout the Physics Tower.

I. Introduction

The purpose of this article is to report on developments in optical physics at Southwestern, a college of liberal arts and sciences, since the writer joined its Department of Physics in 1956. A previous article[1] describes the development of the program through 1963 and the present article is concerned primarily with activities since that time.

We are convinced of the importance of a meaningful research experience in the undergraduate curriculum. This is probably the most sensitive period in the life of a student. It is a period when it is possible to really fire him up. The decision was made to limit our research activities to one area of physics, namely, atmospheric and optical physics. Because of the limited staff size, all efforts are directed into this general area of research. The staff is convinced that, with a "one for all and all for one" attitude, definite headway in this area of physics can be made. Our ratio of staff members/field of research is comparable with that in many large universities, particularly if the large universities are concerned with many different research programs.

In developing a reserach program in which undergraduates can participate, it is imperative that it be within their approximate reach. This is not to say that it should not extend their reach. As a matter of fact, it should. It is helpful if the research is exciting to the student. The situation in graduate school is considerably different from that at the undergraduate level. At the graduate level, students have already made the decision to specialize in physics. At the undergraduate level, one has as part of his obligation the selling of the cultural and scientific aspects of physics. If the research program is exciting and interesting, and one in which the student feels he can profitably participate enthusiasm is assured.

The area of optical physics satisfies most of the above conditions, being the heart of the space program as well as of astrophysics. It is a field possessing considerable pedagogical value and the possibility of carryover to other areas of physics. Research participation in this area brings the student in contact with many of the important concepts of physics. It is an area not burdened by excessive complexity, in which the student can actively participate as an individual. The student is not lost as a small contributor in a great team effort on a complex project, the whole of which he does not understand. Instead, he is a member of a much smaller group and becomes directly involved in the work.

The success of the program of deliberate specialization in atmospheric and optical physics led to two significant developments. One was related to a program of the Optical Society of America to stimulate interest in the teaching of optics. The writer was asked to head the part of the program concerned with undergraduate research programs in optical physics. One of the highlights of these activities was the Conference On Undergraduate Research Programs in Optical Physics held at Southwestern 8–12 June 1964. A report on this Conference has appeared in the literature.[2] The Office of Research and Education of the Optical Society of America is one of the benefits that resulted from the Conference. This office is under the direction of J. A. Sanderson.

A second development was the decision by the College to establish a Laboratory of Atmospheric and Optical Physics as an integral part of the over-all activity of the Department of Physics. This was a bold step for a small liberal arts college of approximately a thousand students, but a step which won the approval and financial support of Research Corporation, which, through its Alfred Kelleher, was most helpful in numerous ways in

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Received 20 May 1968.

the formative stages of this unique thrust in undergraduate education.

The Laboratory of Atmospheric and Optical Physics was established in June 1964, in timely coincidence with the Optical Society Conference mentioned above. The Research Corporation grant enabled the appointment of F. R. Stauffer as Associate Director of the new laboratory, and the employment of a full-time secretary. For some years prior to this, expert technicians in machine shop and electronics had been employed. Adequate technical and secretarial help, more or less taken for granted in large universities, is especially significant in a small liberal arts college. The support of Research Corporation in the formation of this new laboratory was therefore of special significance and usefulness to our long-range planning.

A teacher, particularly in a small college, needs the stimulus and ideas from leading authorities in his field of endeavor and continual up-dating by association with full-time research groups. Assistance along these lines was obtained in June 1967 when Southwestern was included in the first round of grants of the National Science Foundation's new College Science Improvement Program. The physics part of this grant is already proving very helpful because now the Department has funds to obtain consultants to assist in its research program and to support student and faculty research during the summers. The first year of this program has begun and Harold S. Stewart (E. H. Plesset Associates) and John A. Eddy (High Altitude Observatory) are serving as consultants, Stewart in atmospheric optics and Eddy in astrophysics. John Firor (formerly Director of HAO and now Director of NCAR) has been most helpful in connection with this program. During the summer of 1968, one physics major who had finished his junior year was sent to HAO to participate in one of its research programs. In addition, a staff member (F. R. Stauffer) spent the month of August 1968 using the coronagraph facilities at Climax, Colorado in connection with his derivative spectroscopic measurements. The Department of Physics is most grateful to the National Science Foundation, not only for this opportunity to participate in the new College Science Improvement Program, but also for having been permitted for several years to participate in the Undergraduate Research Participation Program which has enabled many students to become involved in meaningful undergraduate research experiences.

II. Research Program and Staff

In discussing research at the undergraduate level, one must realize it is highly unlikely that it will be of the so-called frontier type. On the contrary, it might very well border on the pedagogical. We are convinced, however, that the latter type is also important. As a matter of fact, it is difficult to imagine a student's trying to do research without having been involved in several of these near-research type, or pedagogical, experiments. Quite often these pedagogical experiments enable a student to obtain data for which there is a definite need, although the experiment might have been done by several other investigators previously. An example is the spectroscopic determination of the effective radiating temperature of the ozone layer lying above the surface of the earth. Over the past decade, the staff has developed several such pedagogical research type experiments and is constantly trying to develop others. Some of these experiments are the following: (a) wavelength and absolute radiometric calibration of spectrometers and radiometers, (b) lunar radiometry, (c) Fourier spectroscopy, (d) solar spectrum in the ir and identification of atmospheric absorbers, (e) effective radiating temperature of the ozone layer lying above the earth, (f) atmospheric transmission in the ir (g) atmospheric scintillation, (h) lunar spectrum in the near ir, (i) solar limb darkening in the ir, (j) absolute radiometry of the solar disk, (k) stellar radiometry in the ir, and (l) radiation exchange between earth and space as a function of wavelength. The facilities here are uniquely set up to perform these and other similar experiments.

In order to carry out our teaching and research program, we have a teaching staff of five and a supporting staff of four. Additional staff will soon be available as a result of a grant made to Southwestern in October 1967 by Research Corporation. This grant was given for the purpose of obtaining additional personnel and research equipment in the Departments of Biology, Chemistry, Mathematics, Physics, and the Computer Center. In the case of physics, the additional personnel will be an astrophysicist and an electronics engineer.

The supporting staff consists of a secretary for the Department of Physics and the Laboratory of Atmospheric and Optical Physics, Sally Ross, an electron-

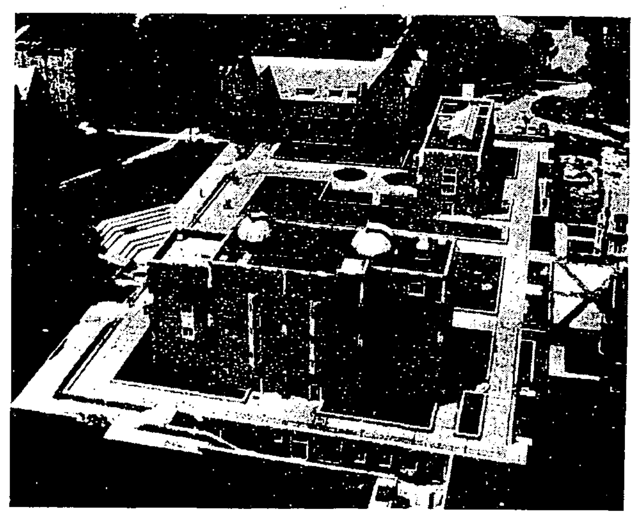


Fig. 1. Aerial view of Frazier Jelke Science Center. The building in the foreground is the Physics Tower. The large building in the background (Berthold S. Kennedy Hall) houses the Department of Chemistry and the Computer Center. To the right of Kennedy Hall is the Biology–Mathematics Tower. That part of the area of the Science Center below ground level and located between the Physics Tower and Kennedy Hall houses the Department of Biology.

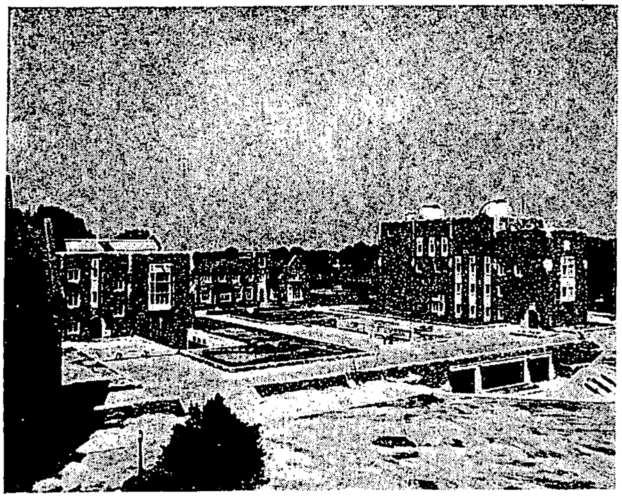


Fig. 2. Photograph of Frazier Jelke Science Center. In the left-hand portion can be seen part of Kennedy Hall. To the right of Kennedy Hall is the Biology-Mathematics Tower. In the background and to the right of the Biology-Mathematics Tower can be seen the Thomas W. Briggs Student Center. To the right of the Student Center is the Physics Tower.

Fig. 3. Photograph of Physics Tower. The toilets, stairwells, elevator, pipe shafts, vertical duct systems, etc., have all been located on one side.

ics technician, A. C. Emery and two machinists' G. P. Ruffin and W. N. Johnson. The teaching staff consists of E. A. Barnhardt, E. S. Dorman, F. R. Stauffer, J. L. Streete, and the writer.

The present research areas are the following: (a) atmospheric transmission (horizontal and slant)—Streete and Barnhardt, (b) derivative spectroscopy—Stauffer, (c) spectroscopy (visible and uv)—Dorman, and (d) stellar radiometry—Taylor.

In all of the research, every effort is made to involve the students at the earliest possible time in their careers. Experience over the past decade has convinced the staff that this student involvement has been quite effective in helping to motivate them to pursue graduate work. Since the article[1] previously referred to was written, eleven of our former students have received their Ph.D. degrees and several others are near to completing their Ph.D.

III. Physics Tower

In the recent past, Southwestern has suffered from lack of space for the laboratory sciences. Since Southwestern moved to Memphis from Clarksville, Tennessee in 1925, the laboratory sciences have been located in the Science Building (recently designated Berthold S. Kennedy Hall). As a result of new construction recently completed, the space problem has been solved for many years. This new construction houses the Departments of Biology, Mathematics, and Physics. Kennedy Hall is being renovated and when completed will house the Department of Chemistry and the Computer Center. The total complex will constitute the Frazier Jelke Science Center. The following approximate net areas are available for instruction and research: (a) Chemistry—2320 m^2, (b) Biology—2320 m^2, (c) Physics and the Laboratory of Atomspheric and Optical Physics—2180 m^2, (d) Mathematics—418 m^2 and (e) Computer Center—139 m^2.

Figure 1 is a photograph of a portion of the Frazier Jelke Science Center. During the excavation stage of the new construction, some mastodon bones were found under an area in the Biology part. We looked in vain for an old prism, or some other "optical physics goodie" under the Physics part but found none. Located on top of the Biology-Mathematics Tower is the Biology greenhouse.

Involvement in the design of the Physics Tower was a unique experience. The Department of Physics was allowed great freedom in planning a building to carry out its teaching and research programs. In order to convey ideas to the architects, the use of scaled models was most helpful. Figures 2 and 3 are photographs of the Physics Tower. It has six stories including one below ground level, and, in cross section, is similar to an aircraft carrier. This aircraft carrier aspect can be seen in Fig. 3. The toilets, stairwells, elevator, pipe shafts, vertical duct systems, etc., have all been located on one side in what would correspond to the island on an aircraft carrier. The dimensions of the Physics Tower, exclusive of the island, are approximately 9m × 36m. This width conforms generally with the other buildings on the campus, all of which are of collegiate Gothic type. This aircraft carrier design feature greatly increases the functionality and flow pattern of the building. The interior walls are nonload bearing which makes for easy modification in the future should the need arise.

Figure 4 is a photograph of the Physics Tower showing some of the optical physics facilities. Each of the five domes was manufactured by Observa-Dome (Jackson, Mississippi). The two large domes are 549 cm in diam and the inside of each is sprayed with polyurethane to a thickness of about 3 cm. The intermediate sized dome (located on the north end of the Physics Tower) is 183 cm in diam and is also sprayed on the inside with polyurethane to a thickness of about 3 cm

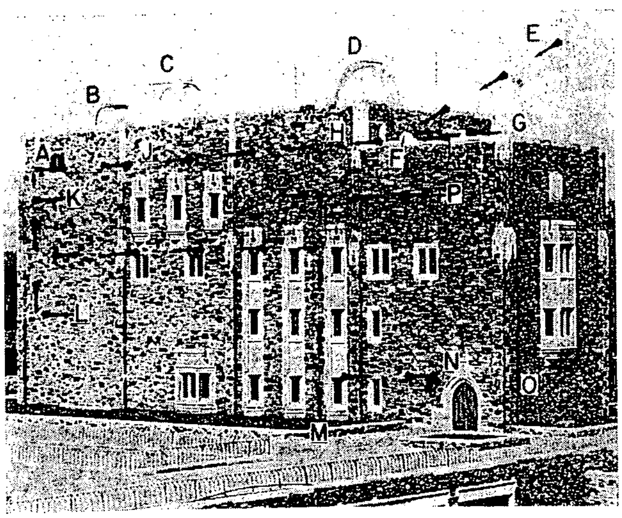


Fig. 4. Photograph of Physics Tower showing the Optical Physics Facilities. The arrows indicate those areas of the Physics Tower to which solar radiation can be directed. The long axis of the Physics Tower runs north and south. North is to the left. *A*—radiometry laboratory, *B*—dome housing optical tracker, *C* and *D*—domes for housing telescopes. (At the present time there is no telescope under Dome *C*. Dome *D* houses a 78.7 cm diam reflecting telescope, cassegrainian type.) *E*—radiation from the sun, *F*—dome housing coelostat primary, *G*—dome housing coelostat secondary, *H*—dark tunnel (2134 cm long and 183 cm wide), *J*—sun telescope (located in dark tunnel), *K*—ir radiometry laboratory, *L*—optics laboratory, *M*—to visible and uv spectroscopy laboratory and general physics lecture room (both located below ground level), *N*—to Stellarama, *O*—display area, *P*—ir spectroscopy laboratory.

Located on the south end of the Physics Tower are two smaller domes, each 91.4 cm in diam. The instruments under the various domes are indicated in the caption of Fig. 4. Dome *D* houses a 78.7-cm diam reflecting telescope (cassegrainian type). At the present time, dome *C* does not house a telescope.

Domes *F* and *G* (see Fig. 4) house a coelostat primary and secondary. These domes are each hinged to the top of a cylindrical base (see Fig. 5). They are light enough that a student can easily open them. The portion of the Physics Tower where the coelostat system is located is referred to as the porch. A single door and a double door open onto the porch. The single door will shortly be provided with a port opening through which the beam from the coelostat secondary can enter. Various window materials (glass, Irtran, etc.) will be used in the port, depending on the region of the spectrum being studied. The porch also provides an out-of-doors working area.

Behind the single door opening onto the porch (see Figs. 4 and 5) is a dark tunnel (21.34 m long and 1.83 m wide). Located in the dark tunnel, is a sun telescope. Figure 6 is a photograph of the dark tunnel showing the sun telescope. The sun telescope (61-cm diam parabolic mirror, 731-cm focal length) is fed by the coelostat system. The sun telescope is mounted on a massive cart that can be rolled out of the dark tunnel when not in use. This sun telescope mirror was obtained for $5 from our state outlet for government surplus material (Department of Health, Education, and Welfare). Just inside the south end of the dark tunnel there is a 30.5-cm × 30.5-cm opening in the floor covered by a hinged metal plate. Underneath this opening is a similar opening in each of the other floors (and in the vertical walls), so that by means of mirrors, the coelostat beam can be directed to the various laboratories and also to the General Physics lecture room located below ground level. The coelostat beam can also be directed vertically downward into the Physics Tower by means of a similar arrangement of openings at the northern end.

Dome *B* (see Fig. 4) houses an optical tracker obtained from a radar van. This radar van was obtained from government surplus for $35. An ir radiometer will be mounted on the optical tracker and used to study radiation from planets, satellites, and stars. Figure 7 is a photograph of the periscope section of this optical

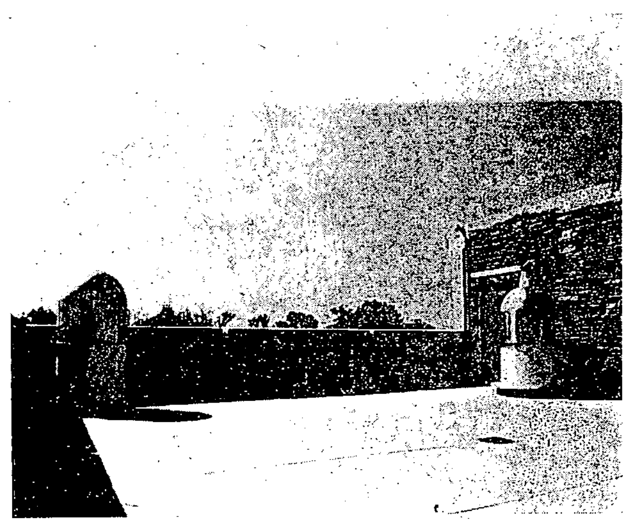


Fig. 5. Photograph of coelostat domes (primary and secondary) located on porch of Physics Tower.

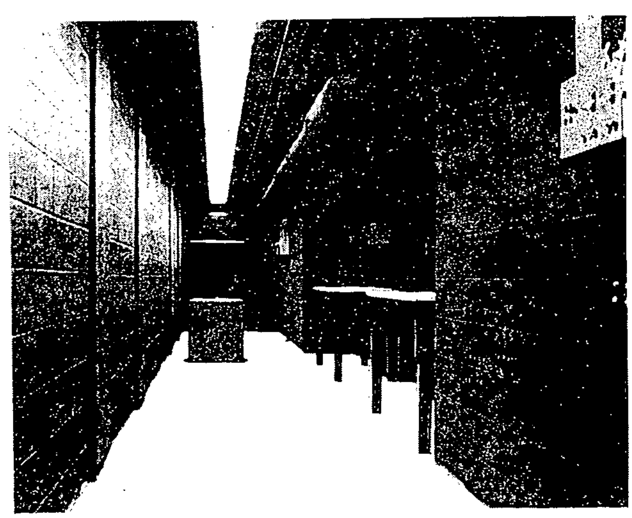


Fig. 6. Photograph of dark tunnel showing sun telescope.

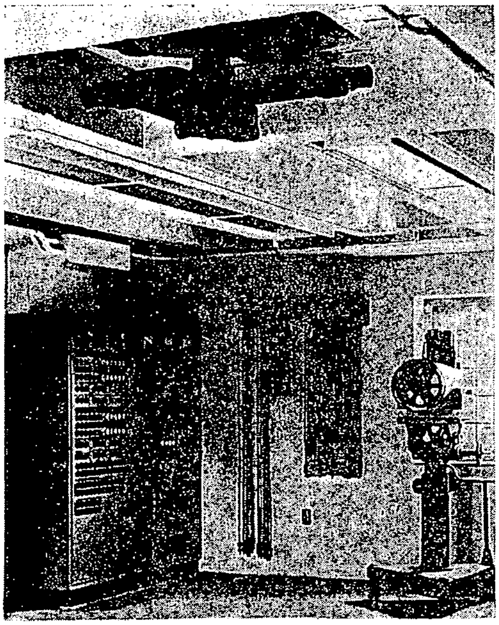


Fig. 7.—Photograph showing a section of the radiometry laboratory located underneath the dome housing the optical tracker. The periscope used with the optical tracker is located in the ceiling of the laboratory. In the background can be seen one of the eleven Hampden electrical distribution centers used in the Physics Tower.

tracker and also shows part of the specially designed radiometry laboratory located underneath the optical tracker. The three windows in the radiometry laboratory (facing west, north, and east, respectively) are designed so they can be opened to lie back flat against the outside of the building. In this laboratory, students will carry out measurements of the exchange of radiation between the earth and space and will make radiometric temperature measurements of the ozone layer lying above the earth. Also, this laboratory will be used for radiometric studies of lightning.

Figure 8 is a photograph of the electronic recording room used in connection with the 78.7-cm diam telescope (dome *D* in Fig. 4). An electronic recording room approximately half this size is used with the other dome (dome *C* in Fig. 4). Each of these electronic recording rooms has a console similar to the one shown in Fig. 8. These consoles (but not the equipment mounted in them) were obtained for a very modest fee from government surplus.

Located on the roof of the Physics Tower (see Fig. 3) are several antennas. In addition to commercial television, there is an antenna for use with WWV, an experimental antenna, and two horizontal antennas (these cannot be seen in the photograph) for studying whistlers and sudden enhancements of atmospherics. The recorder readouts for these latter two are located on the sixth floor. It is planned to put additional readouts for use by students in the display area located on the second floor.

The following is a listing, by floors, of some of the facilities in the Physics Tower: *First Floor*—general physics laboratory, general physics lecture room, visible and uv spectroscopy laboratory, optics shop, electronics shop, dark room, machine shop; *Second Floor*—display area, departmental office, thin films laboratory, electrical standards laboratory, electrical measurements laboratory, drafting room; *Third Floor*—electronics laboratory, conference room, optics laboratory, dark room; *Fourth Floor*—library, advanced laboratory; *Fifth Floor*—ir spectroscopy laboratory, ir radiometry laboratory, dark room; *Sixth Floor*—see Fig. 4 (*A,B,C,D,F, G,J*). In addition to the above mentioned facilities, there are other pedagogical and research laboratories, as well as offices, small class rooms, and storage rooms. The physics library houses bound journals and a selection of texts from the main college library. Only five laboratories have windows. However, all offices, conference room, library, drafting room and machine shop have windows. The fact that the building is centrally air conditioned makes it possible to eliminate the windows.

In the display area (see Fig. 4) are several large glass doored cabinets in which it is planned to display interesting pieces of optical physics apparatus. Also located in this area will be what we are calling Stellarama. This system consists primarily of a 15.2-cm diam parabolic mirror, 3414-cm focal length, fed by the coelostat system. The optics for Stellarama are now in hand and it is expected that the system will be in operation shortly. This assembly will provide an image of the sun approximately 25.4 cm in diam for visual examination by students as they enter the Physics Tower. Studies are underway to determine the feasibility of a prominence telescope for possible inclusion in the display area.

As shown in Fig. 1, the area of the Frazier Jelke Science Center below ground level is considerable. The perimeter of the main corridor around this area is approximately 300 m. It is planned to utilize this for long-path atmospheric studies, controlled atmospheric turbulence experiments, and others. In addition to this indoors path, it is planned to set up an atmospheric

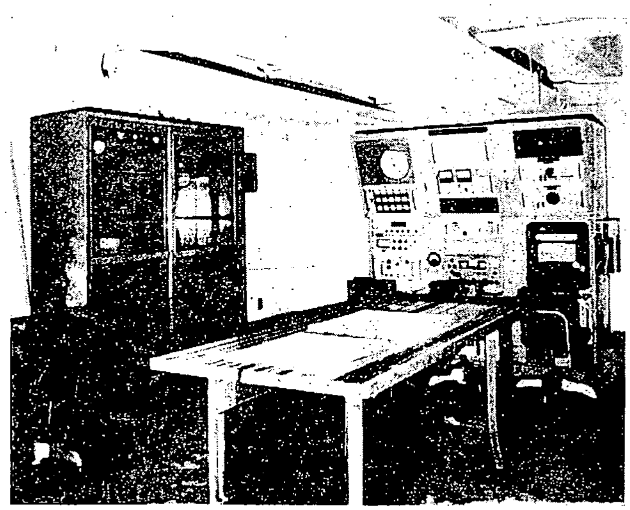


Fig. 8. Photograph of electronic recording room showing console in the background.

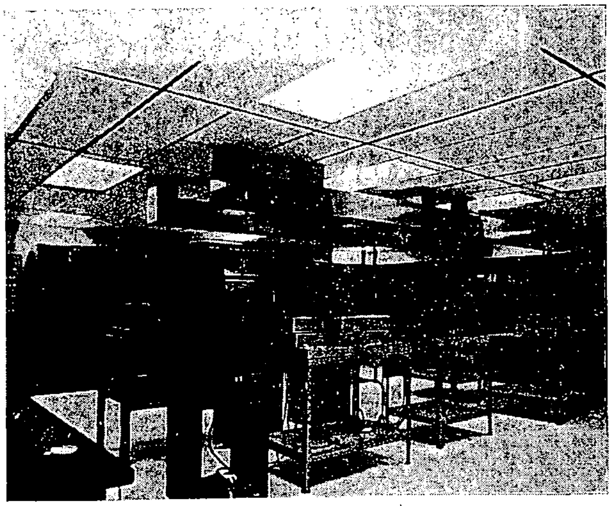


Fig. 9. Photograph of ir spectroscopy laboratory showing electrical facilities, air, gas, and water being fed into the laboratory through the ceiling. In the foreground, next to the relay rack and recorder, is a Perkin-Elmer ir grating spectrometer. The other spectrometers shown in the photograph are prism instruments.

transmission system between the top of the Physics Tower and the tops of other buildings on the campus for measuring transmission during adverse meteorological conditions such as fog, rain, and snow.

In the Physics Tower, the electrical facilities, air, gas, and water are brought into the laboratories through the ceilings. No facilities come out of the floors. Only drains are located in the floors. This arrangement permits great flexibility. Figure 9, a photograph of the ir spectroscopy laboratory, shows the electrical facilities, air, gas, and water being fed into the laboratory through overhead units. In addition to this arrangement, wall-mounted units are also used. The Physics Tower is equipped with ac, dc, and 400 Hz power. The 400-Hz power will be useful, in view of the fact that much electronic equipment available through government surplus is designed for use at 400 Hz. Also available is 150-A, 150-V dc. The special electrical facilities were manufactured by the Hampden Engineering Corporation (East Longmeadow, Massachusetts). Figure 7 shows one of the eleven Hampden distribution centers located throughout the Physics Tower. It should be pointed out, however, that the 150-A, 150-V dc power is not distributed through these centers. Instead, this high current is controlled at the various stations throughout the Physics Tower where it is available. Closed circuit television outlets are available throughout the building. Electrical facilities and closed circuit television are available on the porch and electrical facilities are available on the roof area between the large domes. Conduits for an intercommunication system to be installed at a later time are in place. The greater part of the furniture in the Physics Tower was manufactured by the E. H. Sheldon Equipment Company (Muskegon, Michigan).

In a building the size of the Physics Tower, there are many square feet of wall space in the corridors. It is planned to utilize this space to try to instill in the students an appreciation for the historical development of physics. Efforts along this line will be limited to the area of optical physics and closely related fields. In addition to photographs of the Nobel prize winners in physics, it is hoped to obtain photographs of the great laboratories and observatories of the world, apparatus used in some of the experiments that have had great influence on man's understanding of nature, famous optical physicists and their laboratories, etc. In addition, there will be a display of photographs of interesting astrophysical and atmospheric phenomena.

IV. Conclusion

In looking back over the decade, one fact is quite evident, namely, physics at Southwestern is indebted to many people from whom encouragement and material assistance have been received. It is also obvious to the writer that the Department of Physics is most fortunate in having had two college administrators (President P. N. Rhodes until his retirement in 1965 and since then by his successor, President J. D. Alexander) who were most understanding and encouraging. Without this assistance from the administration, the program would not have been possible. Finally, the writer would like to take this opportunity personally to thank the Optical Society of America, Research Corporation, National Science Foundation, and the Air Force Cambridge Research Laboratories for their encouragement and support over the years.

References

1. J. H. Taylor, Appl. Opt. **2,** 1075 (1963).
2. Van Zandt Williams and J. H. Taylor, Appl. Opt. **4,** 617 (1965).

SOUTHWESTERN AT MEMPHIS
A College of Liberal Arts and Sciences
FOUNDED IN 1848
MEMPHIS, TENNESSEE 38112

Enclosure 10 - Letter sent by the Department to Friends of the College describing the Physics Tower

Enclosed are some sketches we had made showing the various optical physics capabilities in the new Physics Tower. In addition, there is a photograph of the Physics Tower.

The folded sheet is a cross section through the Physics Tower showing the location of the two large domes (each 18 feet in diameter), the intermediate sized dome (6 feet in diameter) housing an optical tracker and the two small domes (each 3 feet in diameter) housing the coelostat primary and secondary mirrors. By means of hinged openings (12" x 12") in each floor it is possible to direct radiation from the sun to various laboratories throughout the Physics Tower. This drawing of the cross section does not show the machine shop, the electronics shop, the optics shop, the general physics laboratory or any of the store rooms.

The following information might be helpful in understanding the various sketches.

(a) Stellarama - located in the Dark Tunnel (70 feet long and 6 feet wide) is a parabolic mirror with a focal length of about 112 feet and a diameter of 6 inches. This mirror is fed by the coelostat system and an image of the sun (about 10 inches in diameter) is formed in the Instructional Display area on the second floor. This image of the sun permits the students to observe sun spots.

(b) Sun Telescope - located in the Dark Tunnel. This telescope is 24 inches in diameter and has a focal length of 24 feet.

(c) Observatory - the sketch shows one (namely, the large dome located farthest to the right in the sketch showing a cross section through the Physics Tower) of the two observatory domes. It houses a 31 inch diameter Cassegrain reflecting telescope (f/4.5). Also shown in this sketch is the electronic recording room used in connection with the telescope.

(d) Spectroscopy Laboratory - this laboratory is located on the first floor and in the sketch the spectrometer is shown being fed with solar radiation from the coelostat. The spectrometer is mounted on a massive steel reinforced concrete block that is suspended on air. For purposes of illustration the front wall of the room surrounding the grating spectrograph has been omitted from the sketch.

(e) Optical Tracker - this system is housed under the six foot diameter dome. In the sketch the periscope can be seen. Boresighted with this optical tracker is an infrared radiometer.

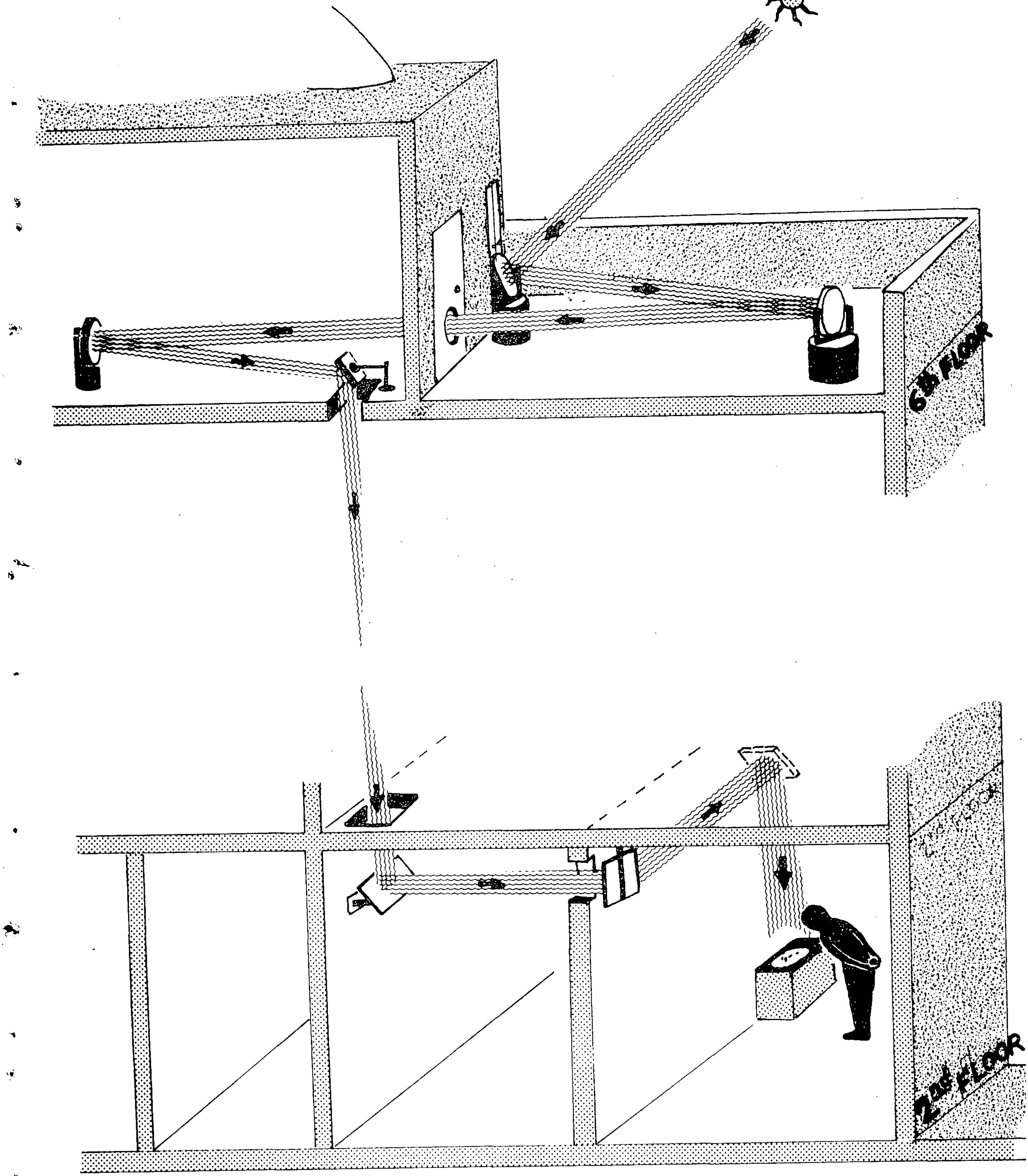
(f) Radiometry Laboratory - this laboratory is located on the sixth floor immediately underneath the dome housing the optical tracker. This laboratory is provided with large windows that open and lie back flat against the outside of the building. Some of the studies the students perform in this laboratory are:

(1) Atmospheric Transmission Studies
(2) Lightning Studies
(3) Radiation Exchange Studies.

I thought you might be interested in having a set of these prints.

Yours very truly,

Enclosures

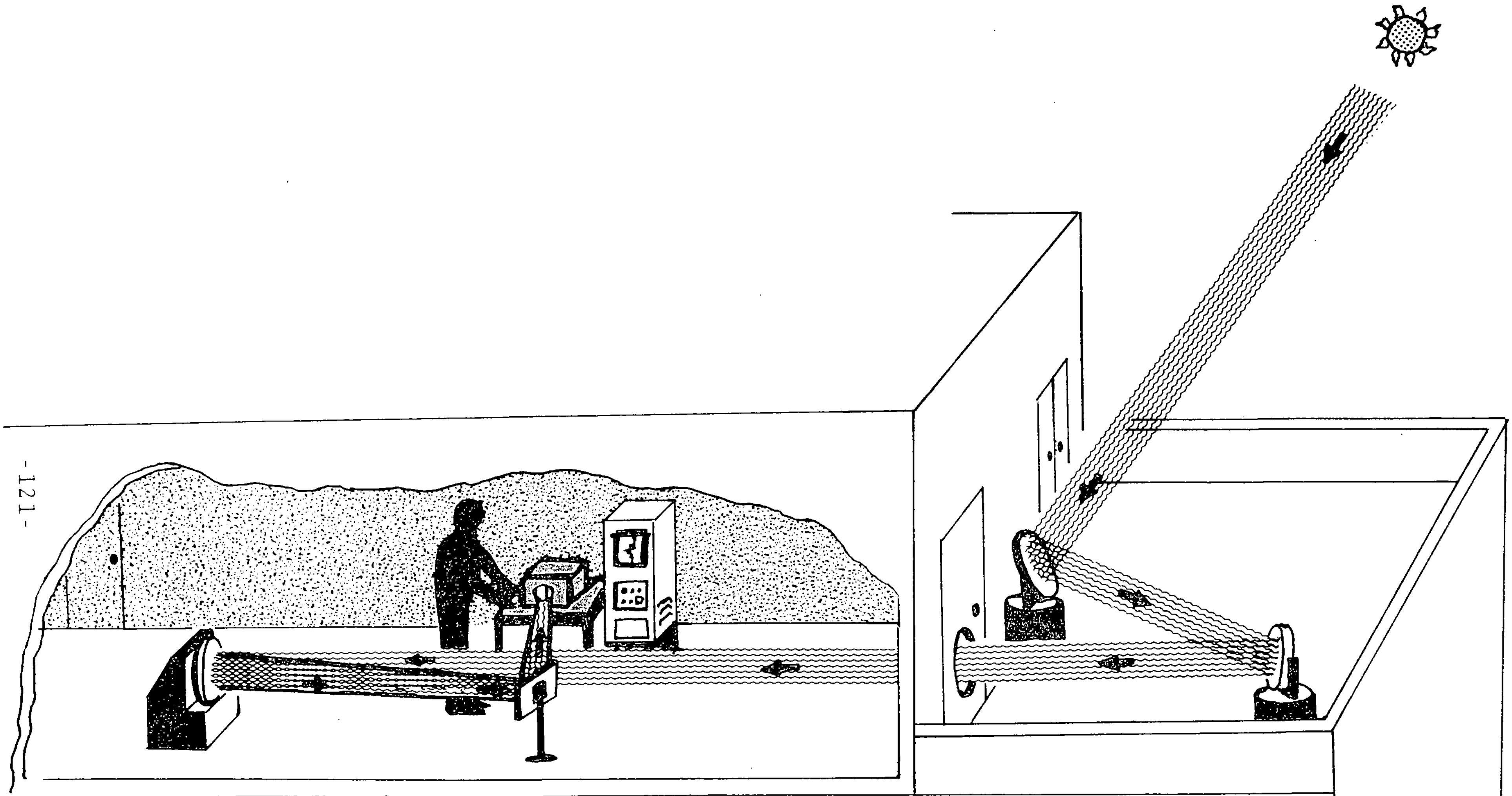


STELLARAMA

Physics Tower

Southwestern At Memphis

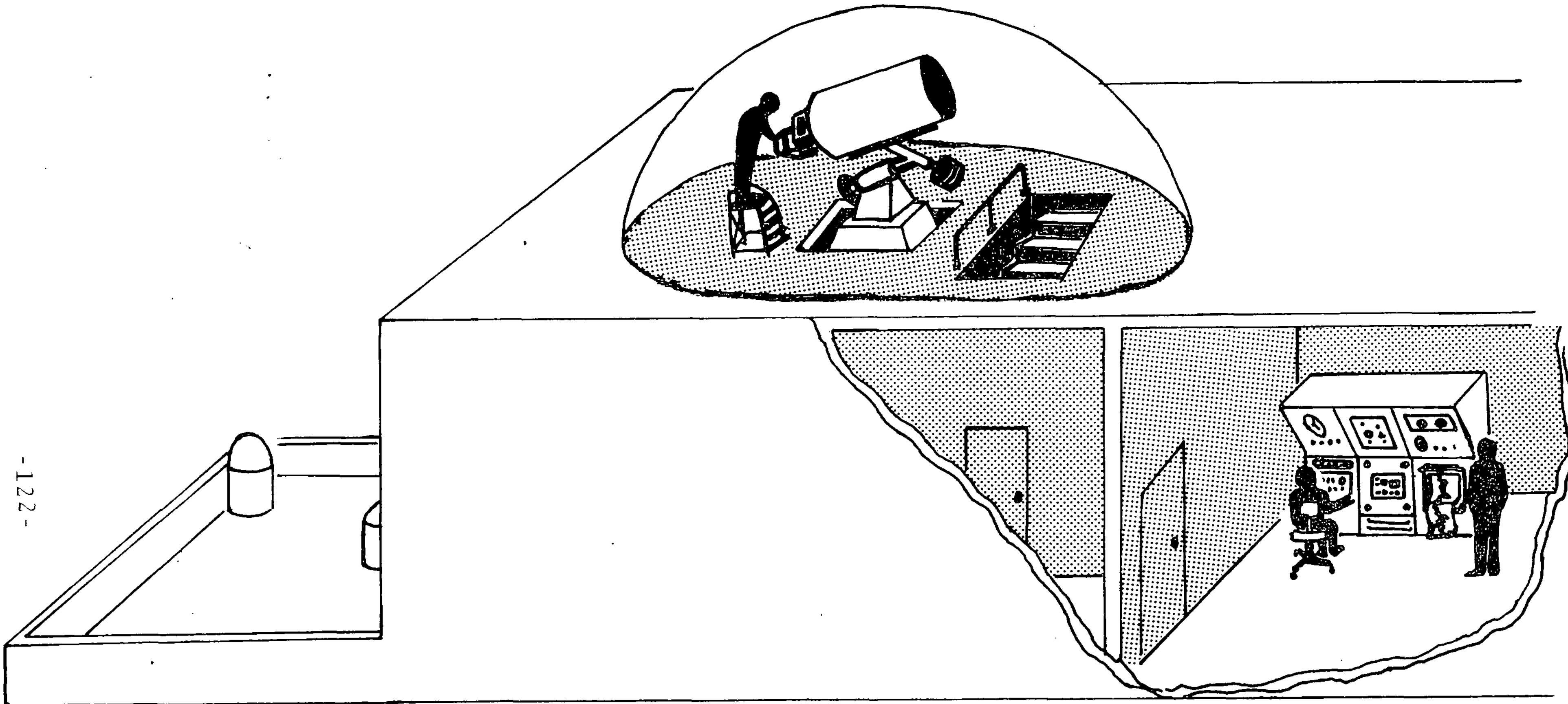
Enclosure 11 -
Sketch illustrating
Stellarama



SUN TELESCOPE

Physics Tower
Southwestern At Memphis

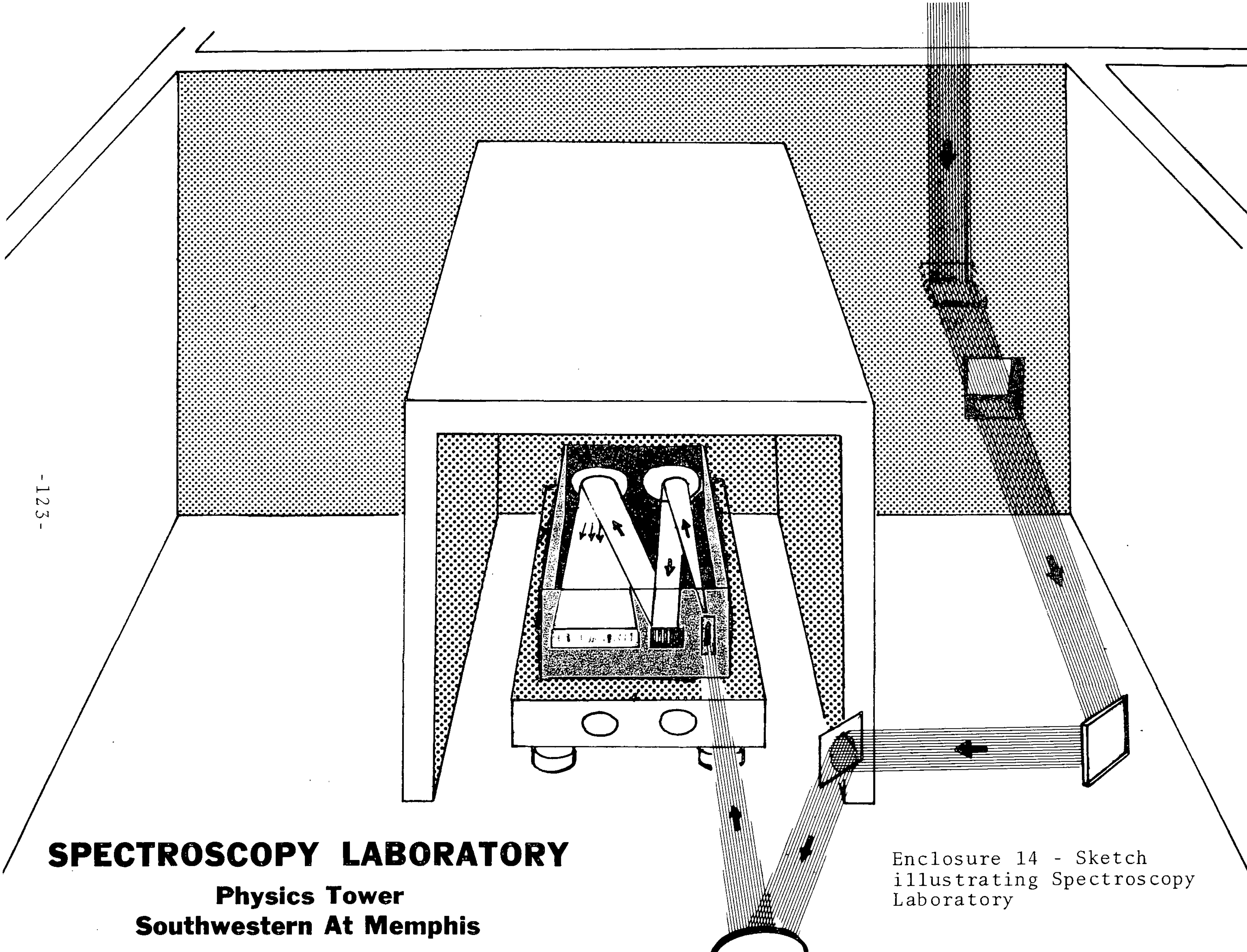
Enclosure 12 - Sketch illustrating Sun Telescope



OBSERVATORY

Physics Tower
Southwestern At Memphis

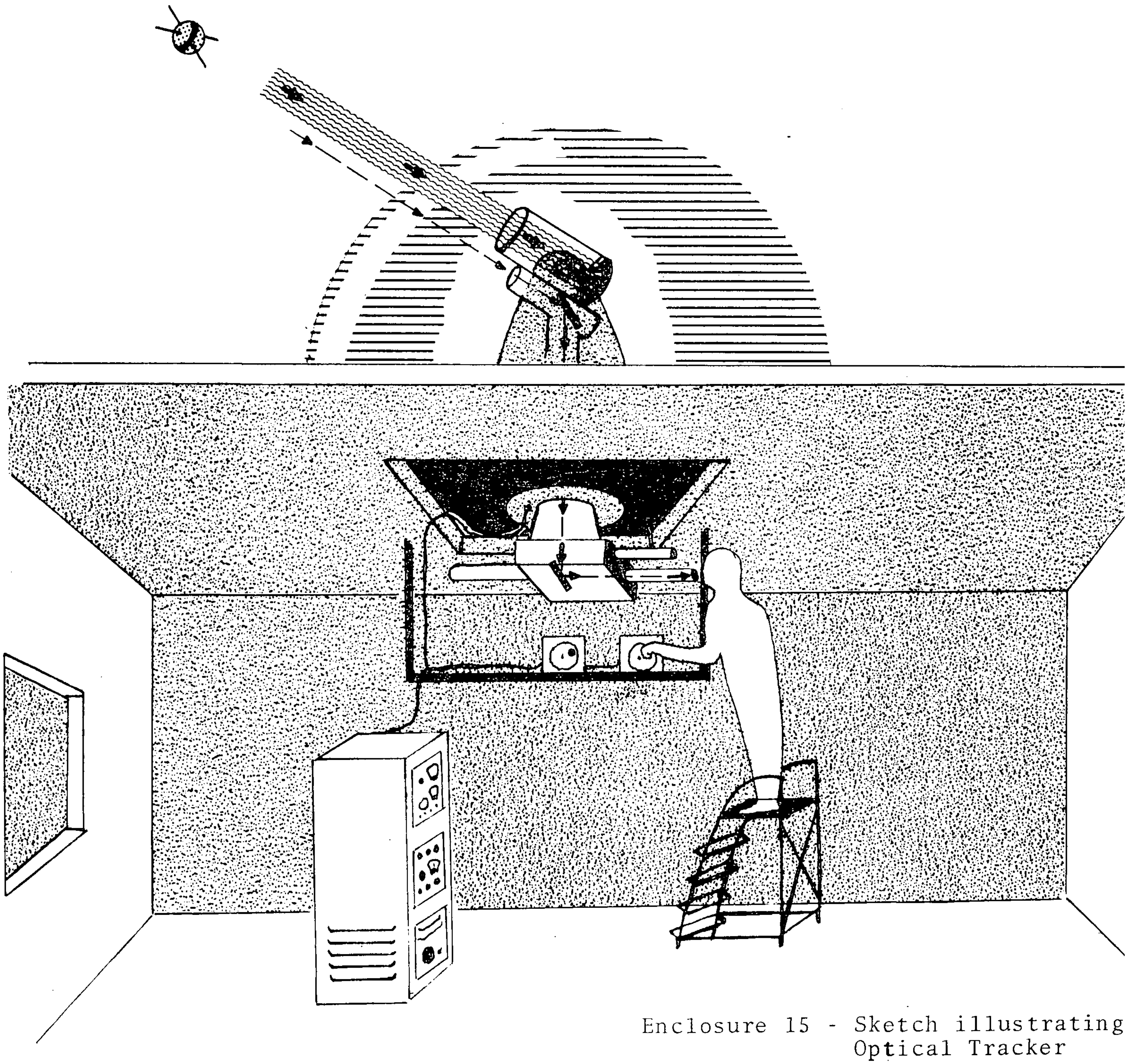
Enclosure 13 - Sketch illustrating Observatory



SPECTROSCOPY LABORATORY

Physics Tower
Southwestern At Memphis

Enclosure 14 - Sketch illustrating Spectroscopy Laboratory

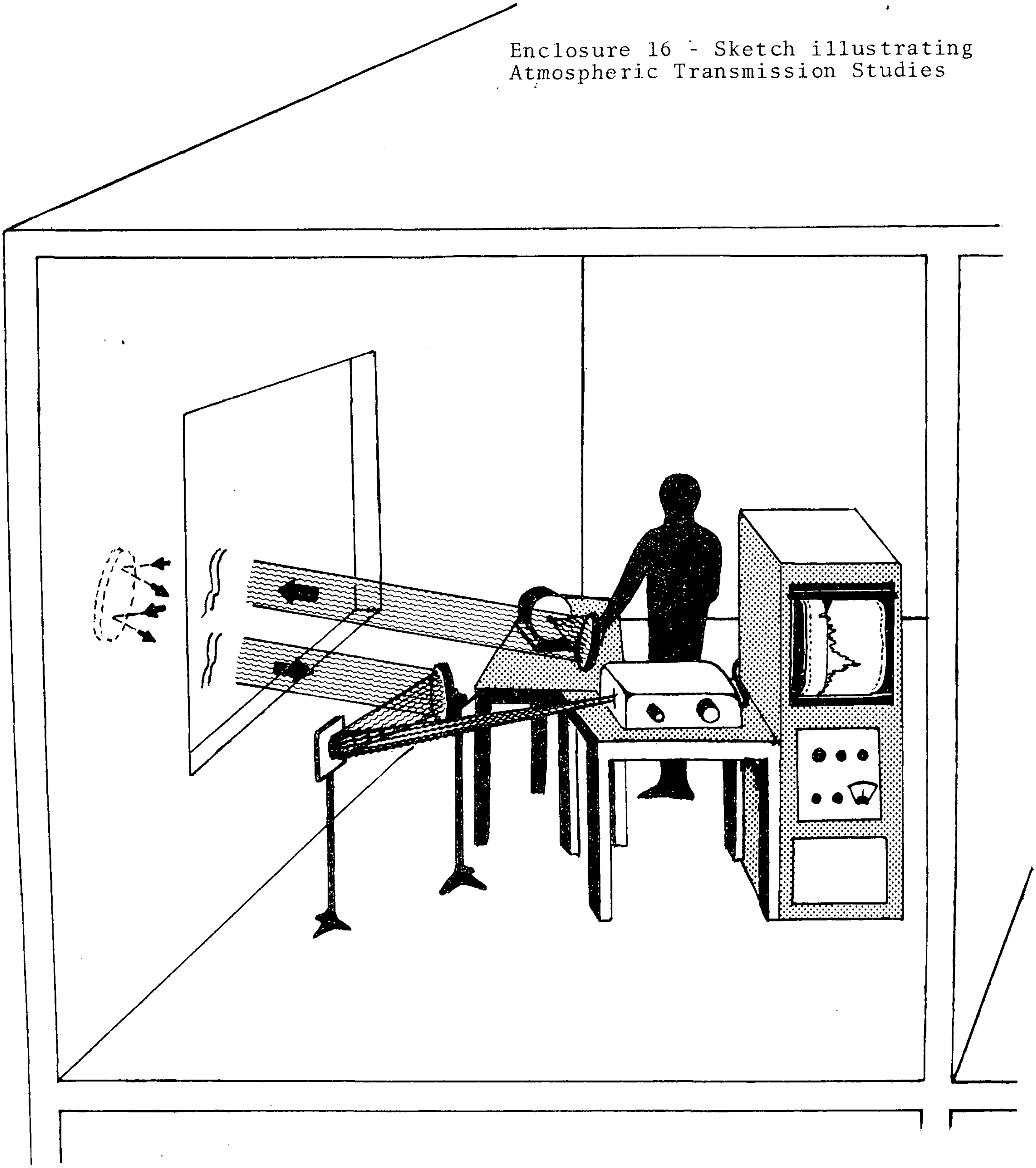


Enclosure 15 - Sketch illustrating Optical Tracker

OPTICAL TRACKER

Physics Tower
Southwestern At Memphis

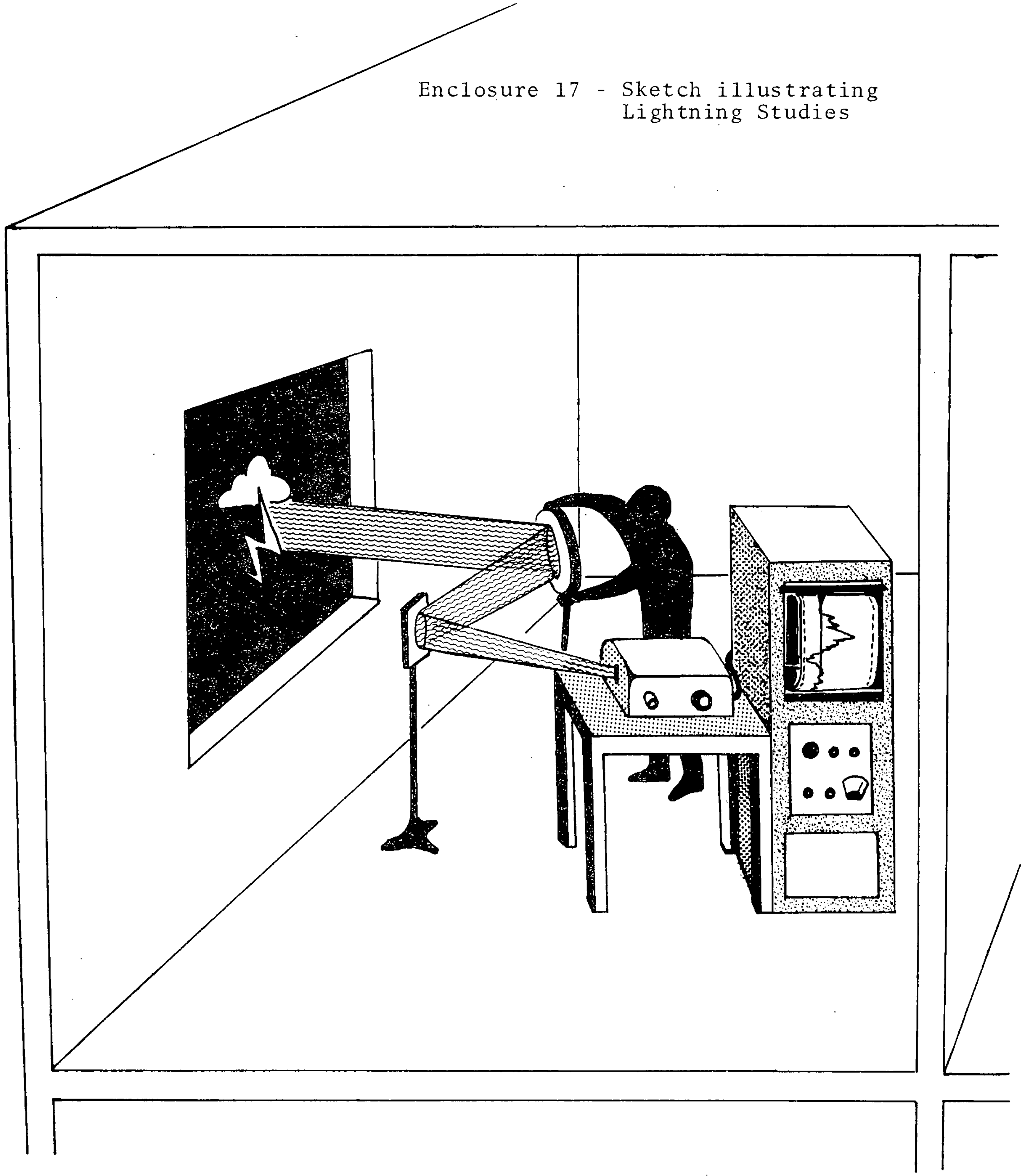
Enclosure 16 - Sketch illustrating Atmospheric Transmission Studies



RADIOMETRY LABORATORY (Atmospheric Transmission) Studies

Physics Tower
Southwestern At Memphis

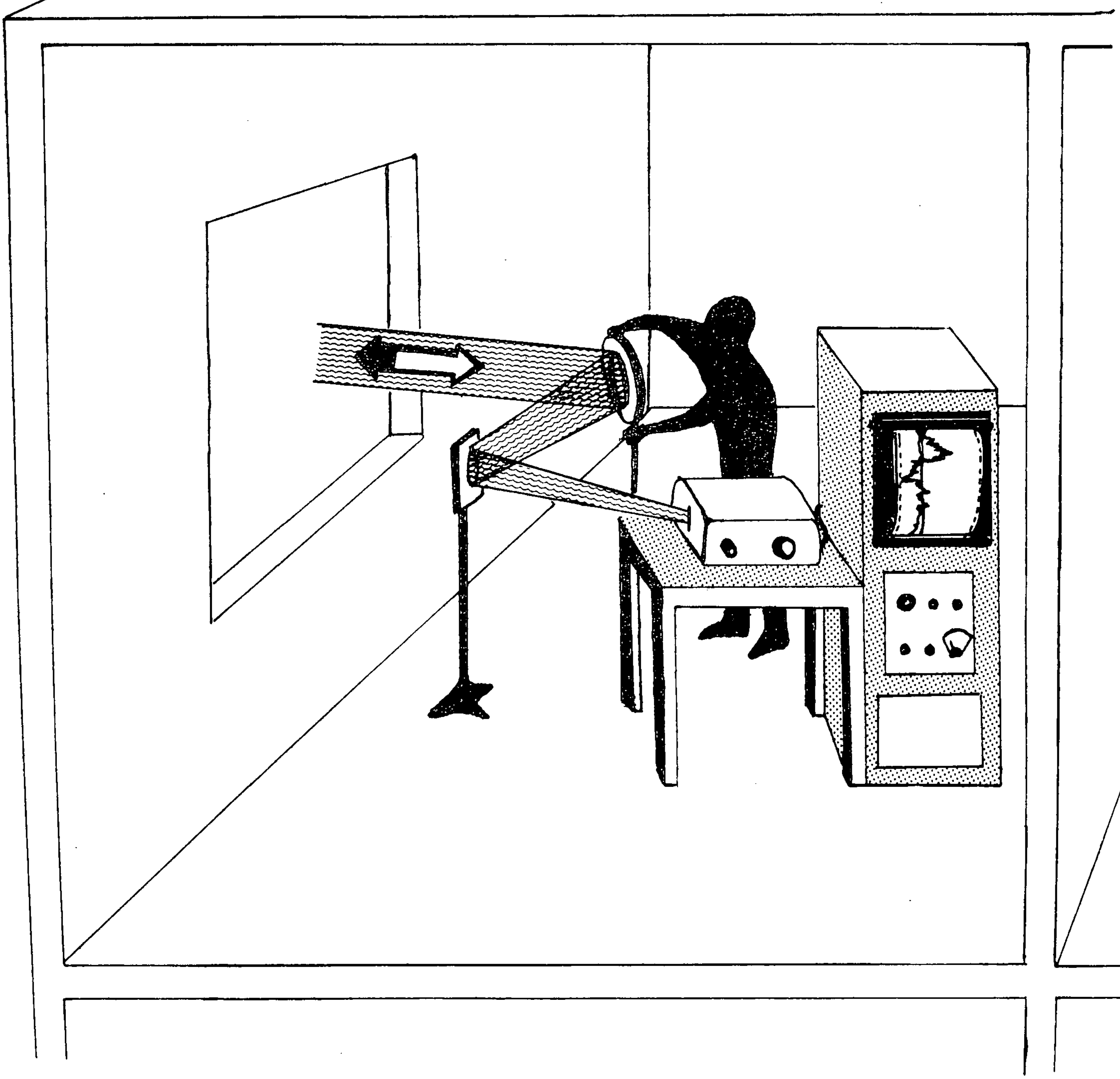
Enclosure 17 - Sketch illustrating Lightning Studies



RADIOMETRY LABORATORY (Lightning Studies)

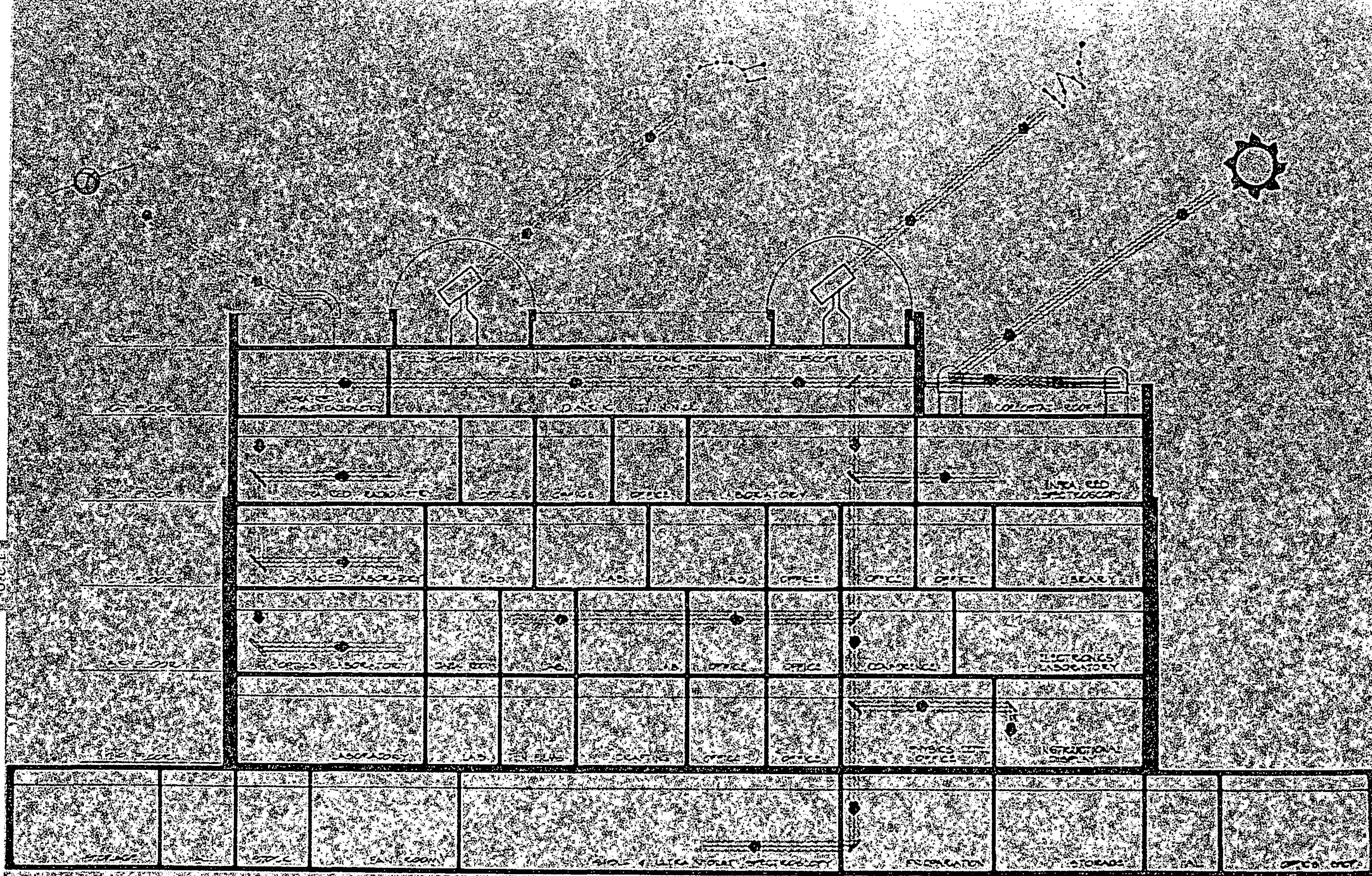
Physics Tower
Southwestern At Memphis

Enclosure 18 - Sketch illustrating Radiation Exchange Studies



RADIOMETRY LABORATORY (Radiation Exchange) Studies

Physics Tower
Southwestern At Memphis



CROSS SECTION THRU PHYSICS TOWER
SOUTHWESTERN AT MEMPHIS

Enclosure 19

Reprinted from **APPLIED OPTICS**, Vol. 4, page 617, May 1965

Report on the Conference on Undergraduate Research Programs in Optical Physics Held 8-12 June 1964 at Southwestern College, Memphis, Tennessee

Van Zandt Williams and J. H. Taylor

The initial activity of Task IV of *Optics—An Action Program* was the mailing of a letter to the chairman of each physics department that offers a Bachelor of Science degree in physics (these number about 750). This letter described the purpose of Task IV and also inquired as to whether or not that department was interested in starting research in optical physics. 284 replies were received. Of this number, 188 expressed an interest in initiating a program of research in the field of optical physics or closely related subjects. A later mailing to this group of 188 indicated that 106 of them were interested in attending a conference. Grants were obtained for the conference sufficient to invite 80 to attend. In addition to the 80, several others attended at their own expense.

The majority of physics departments that expressed interest in Task IV are small, i.e., with staffs numbering 2, 3, 4, 5, and 6 men. Data obtained during the conference yielded profile information of the participants that will permit a base for progress measurement in the future. Most of the participants were in the 30–45 year age bracket. The majority of the participants offer optics in either the junior or senior years, use Jenkins and White as a text, and devote about 30% of their course to geometrical optics, 60% to physical optics, and 10% to special topics.

This conference provided an opportunity to assemble and get to know some of those college and university professors who are interested in optical physics research at the undergraduate level. The invited lecturers brought to the attention of conference participants some of the topics included in modern optical physics and also many ideas for research projects.

The week's schedule, the invited lecturers, and their subjects are shown in Table I on page 619.

The participants had an opportunity to make known to Task IV leaders some of the ways in which they can be helped in the field of optical physics. Although some of the suggestions were probably unrealistic, one desire very obviously runs throughout: that the Optical Society of America take a more active leadership. Participants also repeatedly requested opportunities to update their education in modern optical physics.

V. Z. Williams is with the American Institute of Physics, 335 E. 45th Street, New York, N.Y. 10017. J. H. Taylor is with Southwestern College, Memphis, Tennessee 38112, and is the leader of Task IV (Undergraduate Research Programs).

This conference was conducted under grants from the National Science Foundation and the Office of Naval Research.

Prior to the conference, each participant was assigned to one of eight groups. Each group was assigned a chairman and a vice-chairman. In addition to attending the invited lectures, each of the eight groups met several times during the conference to discuss the various topics it had been assigned. On the last day of the conference each group presented a report of its work. Groups I–V were concerned with research in optical physics; the topics assigned them were:

Group I—Coherence effects, lasers, nonlinear optics, magneto-optics.

Group II—Spectroscopy—atomic, molecular, solid state; interferometry; fluorescence and luminescence.

Group III—Radiometry and photometry; sources and detectors; far ultraviolet and infrared.

Group IV—Atmospheric and space optics; astronomy; meteorology and space surveillance; aurora and airglow.

Group V—Optical materials, thin films, fiber optics, optical constants, polarization, geometrical optics.

Groups A–C were concerned with supporting aspects of research; the topics assigned them were:

Group A—Available time for research, consultant aid from field experts, summer employment in optical industry for professors and students.

Group B—Financial support, equipment—surplus and other, reference materials.

Group C—Education and curriculum—professors, students.

The chairmen (first name under leaders) and vice-chairmen (second name) were:

Groups	Leaders	College or University	Address
Group I	S. C. Bloch	University of South Florida	Tampa, Florida
	Robert L. Martin	Lewis and Clark College	Portland, Oregon
Group II	D. D. Snyder	Andrews University	Berrier Springs, Michigan
	Edward C. Parke, Jr.	Humboldt State College	Arcata, California
Group III	D. C. Martin	Marshall University	Huntington, West Virginia
	James W. Riggs	La Sierra College	La Sierra, California

Groups	Leaders	College or University	Address
Group IV	Fritz Stauffer	Southwestern College	Memphis, Tennessee
	Allen Barnhardt	Western Kentucky State College	Bowling Green, Kentucky
Group V	W. A. Hilton	William Jewell College	Liberty, Missouri
	Charles H. Holbrow	Haverford College	Haverford, Pennsylvania
Group A	D. G. Proctor	Baldwin Wallace College	Berea, Ohio
	L. A. Youngman	Pan American College	Edinburg, Texas
Group B	W. A. Murtaugh	Providence College	Providence 8, Rhode Island
	Donald C. Peckham	The St. Lawrence University	Canton, New York
Group C	S. B. Elliott	Occidental College	Los Angeles, California
	Raymond G. Wilson	Illinois Wesleyan University	Bloomington, Illinois

A detailed report on this conference has been prepared for distribution to the National Science Foundation, the Office of Naval Research, and for use by the Executive Office of the Optical Society of America. There are not sufficient copies of that report to distribute to all who are interested in Task IV, and it is too lengthy to be reproduced here. This paper contains only the group reports and recommendations.

The technical research programs of Group Reports I–V are given with very slight editing. The comments in these reports which bore on the support areas were combined with Reports A–C into what is referred to below as "Recommendations of the Conference for Programs in Direct Support of the College Research Effort".

Group I Report

1. A major recommendation of this group is that an OPTICAL HANDBOOK be assembled. The proposed handbook would be of such a comprehensive nature that it might be organized best under the auspices of OSA. Suggested material to be included is as follows:

(a) Sections on modern techniques of performing optical measurements, with special attention to current literature.

(b) Compendium of optical parameters of materials.

The compendium of optical constants might well start with an exhaustive literature search. The compilation of existing data will then reveal gaps which might be filled in by measurements at various small colleges willing and able to participate in the program. Optical properties of interest to Group I include the complex index of refraction at least from infrared through ultraviolet, index of refraction as a function of incident power and/or external static fields, capabilities for harmonic generation and mixing, suitability for lasers, properties of detectors, etc. Such a table should enable an investigator to choose a laser, possibly in conjunction with a harmonic generating crystal or Raman effect, to obtain coherent radiation at almost any frequency in the optical region. The limitations on the range of variables in the proposed handbook are yet to be determined.

2. The problem of coherence is fruitful, both experimentally and theoretically. Many experiments of fundamental importance can be done by small laboratories with one or two lasers and some auxiliary equipment. Such experiments include interference between independent coherent sources, interference of incoherent sources, information capacity of partially coherent sources, etc. Teaching should emphasize temporal and spatial coherence requirements in wavefront-division and amplitude-division interferometers.

3. Comments concerning the excellent demonstrations with lasers left little doubt that most participants would obtain at least one if financial barriers were lowered. It was suggested that fifty or more small colleges, oscillating coherently, should approach various manufacturers for a group order and determine if the financial threshold could be lowered. Semiconductor lasers also should be investigated. Motto: Any optical experiment worth doing, is worth doing again with a laser.

4. Nonlinear optics provides an extremely wide field for a small laboratory. The Edisonian method could be used by undergraduates in searching materials for harmonic generation, mixing, limiting, detecting, modulating, etc. Experimental analogs with radio frequency communication techniques may be constructed (example: laser superhet receiver). Modern signal processing techniques in the optical region should be explored. Inverse effects should be investigated (e.g., inverse Faraday effect).

5. The elementary magnetoionic theory may be presented to undergraduates quite readily. Demonstration experiments of cyclotron resonance in gaseous plasmas are readily performed with microwave optical apparatus and surplus magnetron magnets. For laboratories with research magnets, fundamental measurements at infrared and visible wavelengths in solid-state plasmas offer a challenge. Nonlinear effects should not be overlooked.

6. The following research problems suitable for small laboratories were also discussed:

(a) Optical imaging with coherent and incoherent radiation.

(b) Search for new types of interferometers (utilizing high-coherence and consequent long-path difference).

(c) Study of coherent-mode structures in interferometers and optical waveguides.

(d) New measurement of angular momentum of light.

(e) Resurrection of antique optical phenomena for re-examination with modern techniques and materials.

Group II Report

In Group II, the colleges represented were in the range from 750 to 5,000 students. The departments averaged about four faculty members. The average number of physics majors graduated each year by these colleges ranged from 1 to 20 students.

The members of Group II came to the conference looking for assistance in the meeting of specific needs of their own, of their departments, or of their school. Interaction with individuals with similar problems and resources was an important phase of the conference. The participants were eager to improve their competence and proficiency in modern optics. Group II feels that the ideas presented in the following sections of this report represent a summary of conference gains in terms of (1) problem areas delineated, and (2) recommendations for solution.

Group II agreed that there is a spectrum of meanings for the terms study, project, and research. At one end of the continuum is the research study or project for the undergraduate student. Research at this level is seen primarily as a teaching tool and a way of assisting the student to get a feel for the phenomena of physics. A secondary advantage of student research lies in the possibility of attracting good students into the field of optical physics. Research at the other end of the spectrum is used in the

Table I. Conference Program

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:15 a.m. until 9:15 a.m.	P. N. Rhodes Welcome address V. Z. Williams J. H. Taylor Keynote addresses	J. A. Sanderson Radiometry and photometry	R. W. Terhune Nonlinear optics	J. D. Strong Interferometry	Reports from Groups I, II, III
9:30 a.m. until 10:30 a.m.	R. M. Scott Space optics	N. S. Kapany Fiber optics	G. B. Wright Magnetooptics	K. Kessler Spectroscopy	Reports from Groups IV, V
BREAK					
10:45 a.m. until 11:45 a.m.	Group meetings	H. J. Kostkowski Research ideas in optical pyrometry	W. Wolfe Optical materials	L. N. Hadley Thin films	Reports from Groups A, B, C
LUNCH					
1:30 p.m. until 2:30 p.m.	H. S. Stewart Seeing and scintillation	L. Mundie Sources and detectors	F. S. Johnson Airglow and aurora	D. H. Rank Adventures in ir spectroscopy	
BREAK					
3:00 p.m. until 4:00 p.m.	G. Newkirk Balloon astronomy	W. Ellis Aspects of Federal support for scientific research	M. A. Jeppesen Place of optics in proposed physics curricula	E. N. Adams Optical character recognition	Southwestern Physics Department open for inspection. Most of the commercially available micro- wave equipment for teaching optical physics was on display. This was sent by F. E. Christiansen and W. Kelly *AIP*. During the afternoon, Alfred Kelleher and Dr. Marcey *Research Corporation* spoke with several of the participants.
4:15 p.m. until 5:15 p.m.	C. W. Kersey Surplus property	A. K. Levine Lasers	W. Wolfe Optics in an engineering curriculum	Group meetings	
5:30 p.m. until 6:30 p.m.	Group meetings	J. N. Howard Defense Department interest in optical physics	H. Breed Proposed under- graduate course in optical physics	Group meetings	
DINNER					
7:30 p.m. until 8:30 p.m.	G. Newkirk Film on Coronascope II	A. K. Levine L. Bodi Fluorescence demonstration	R. Blakney Laser demonstration	Group meetings	
8:30 p.m. until 9:30 p.m.		L. Eisner Demonstration of Barnes Educational Spectrometer ES100	Open House at home of President and Mrs. P. N. Rhodes	Group meetings	

classical sense. Faculty members desire to do research leading to some modest advance in knowledge. From such research the department can profit by being able to attract more competent new PhD's. If the research is of the proper caliber, it is possible for the school to benefit by acquisition of funds for additional equipment and facilities. The group recognized that most faculty research projects would heavily involve students.

Research is going on at small colleges. In addition, students are being involved in projects, honor studies, and research. Everyone in Group II, however, agreed that additional effort should be made.

Suggested Research Problems

As part of Group II's mandate, they were requested to collect suggestions for suitable research. Many of the following can be done cooperatively with staff and/or students in chemistry, or other related departments.

(1) Use laser beam to measure scattering in an arc or plasma jet, for electron-density measurement.

(2) Interferometric measurements in arc and plasma jet, for electron-density and temperature distribution.

(3) Ultrasonics for determination of velocity of sound in transparent materials.

(4) Compound semiconductors: dielectric constants—index of refraction; fluorescence; spectra—absorption, emission—as function of temperature or pressure; microtechniques for small crystals.

(5) Optical properties of thin films: reflection and refraction; magnetic rotation of polarization.

(6) Optical characteristics of diatomic molecules.

(7) Literature search for specific areas in optics.

(8) Optical properties of noble-gas compounds.

(9) Surface effects.

(10) Field-emission microscope.

(11) X-ray diffraction studies.

(12) X-ray activation, study of color centers.

(13) Interferometric studies of plasmas in magnetic fields.

(14) Isotope shift.

(15) Optical activity.

(16) Scattering of microwaves from large flat surfaces, e.g., snow-covered lake ice as a function of depth, etc.

Group III Report

Suggested honors and research projects in these areas: radiometry and photometry, sources and detectors, infrared.

During the group discussions it was noticed that the available facilities varied considerably in the different institutions. Therefore, only a brief outline of the experiments is given.

Suggestions for Honors Projects

1. Construction of a simple radiometer:

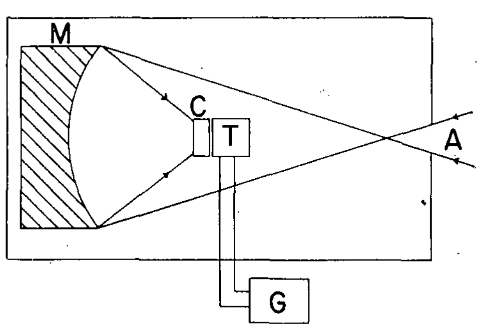


Image of aperture A is focused by mirror M through rock-salt cover C (to prevent air currents) onto detector (thermocouple) T. Output is indicated by galvanometer G or dc amplifier.

2. Construction of thermocouple. See John Strong, *Procedures in Experimental Physics* (Prentice-Hall, New York, 1938), p. 313.

3. Construction of PbS infrared detector. See R. A. Smith, F. E. Jones, and R. P. Chasmar, *The Detection and Measurement of Infra-Red Radiation* (Clarendon Press, Oxford, 1957), p. 169:

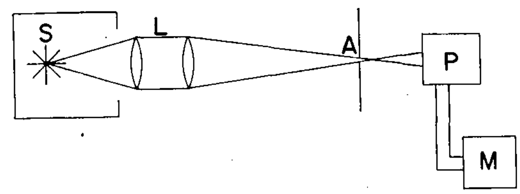
(a) Calibrate cell using a soldering iron as a blackbody.
(b) Study ir from human body and other objects.
(c) Tie to a spectograph and study solar spectrum.

4. Construction of ir gratings by parallel wires wound over two screws; photographic process; printed circuit techniques; photo engraving; and Ronchi rulings.

5. Construction of replica gratings if a metal reflecting grating is available:

(a) Pour collodion over grating surface and let dry.
(b) Put grating with collodion under water overnight. The water runs under collodion film and separates it from grating.
(c) Mount the film on a glass plate by raising the glass plate up under the film while it floats on the surface.

6. Construct a simple densitometer using a lamp, lens, and photocell. [See Wallace R. Brode, *Chemical Spectroscopy*, 2nd ed. (Wiley, New York, 1943), pp. 114, 320.]:



Simple densitometer. S, light source; L, lenses; A, measuring aperture; P, photocell; M, microammeter. Place object to be measured over aperture A.

(a) Make a photographic step-wedge and calibrate photocell as a densitometer.
(b) Determine relative light intensities using the densitometer to obtain the *H* and *D* curves for a photographic film.

7. Determination of the temperature of the moon with the simple radiometer or by use of a telescope with a thermocouple detector at the focus as a radiometer. Calibrate the radiometer with a blackbody larger than the entrance aperture of the radiometer. Use a sheet metal cone, paint with flat black paint, and heat with boiling water. Measure radiation from moon at different zenith angles. [See D. M. Gates and W. J. Harrop, Appl. Opt. 2, 887 (1963).] The spectral response of the PbS reduces the atmospheric absorption and the square-root law is valid. If a thermocouple is used, an 8-μ to 12-μ bandpass filter will be needed to reduce atmospheric absorption effects. The signal of the calibrated radiometer divided by the transmittance of the atmosphere can be used to calculate the temperature of the moon (390°K for full moon).

8. Determine the temperature of the sun by use of the simple radiometer or by use of an optical pyrometer. A smoked plate could be used as attenuator for the telescope. This could be calibrated by use of a pyrometer. A narrow bandpass filter for telescope to match the pyrometer filter will be needed.

9. Construct a blackbody and study its radiation using a spectrometer.

10. Construction of a spectral (0.4-μ to 2-μ) radiometer, using PbS detector, 300 lines/mm grating, glass prism or bandpass filters (similar to Barnes ES-100 Spectrometer).

11. Construction of infrared polarizers from AgCl sheet. Measure extinction with radiometer.

12. Determination of emissivity of silicon carbide (Carborundum Co., Niagara Falls) found in a globar. Cut a notch in the globar, to form blackbody cavity, and compare the radiation from this notch with the unnotched surface. Vary the temperature. Also use spectral (10) radiometer to study emissivity as a function of wavelength.

13. Use the spectral radiometer in connection with a water-cooled aperture (a loop of copper tubing with cold water passing

through it) to determine the emissivity of a body directly by comparing the hot specimen to a blackbody at the same temperature.

14. Construct an optical pyrometer. [See H. J. Kostkowski and R. O. Lee, *Theory and Methods of Optical Pyrometry*, NBS Monograph 41, (U.S. Govt. Printing Office, Washington, (1962).]:

(A) Calibrate the pyrometer against a thermocouple whose current output is known.

(B) Read brightness temperature of various incandescent light sources. Make correction from brightness temperature to true temperature [*Measurement of Radiant Energy*, W. E. Forsythe, ed. (McGraw-Hill, New York, 1937), pp. 23, 379]:

(C) Radiant efficiency of a lamp:

(a) Measure input electrical power.

(b) Measure brightness temperature with optical pyrometer.

(c) Use emissivity of tungsten to correct to obtain true temperature. [See *Handbook of Physics*, E. U. Condon and Hugh Odishaw, eds. (McGraw-Hill, New York, 1958), pp. 6-79.]

(d) Measure the tungsten ribbon filament and compute its area using a measuring microscope.

(e) Calculate radiant energy, P, from Stefan–Boltzmann Law using the emissivity of tungsten.

(f) Determine radiant efficiency by

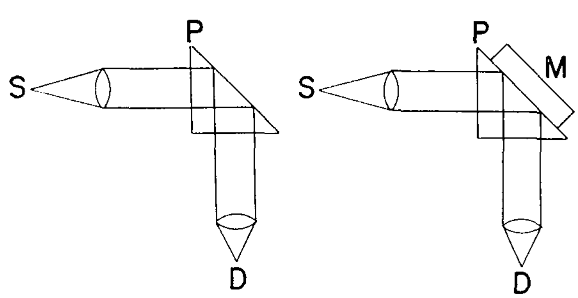
$$\%E = \frac{P \text{ radiant (W)}}{P \text{ input (W)}} \times 100.$$

Suggestions for Research Problems

1. Use infrared detector in conjunction with a reflecting telescope to scan the moon and study temperature variations during a lunation.

2. Build a simple coronograph and use infrared film to photograph area around the sun. Could also study scattering of sunlight by pointing a radiometer toward zones around the sun.

3. Study attenuated total reflection for various materials:



Control and test-experiment arrangements for measurement of attenuated total reflection. S, source; P, total reflection prism; D, detector; M, material to be measured. Surface near P should be polished.

4. Verify Lamberts' law for different kinds of surfaces. Is it a function of wavelength? Consider partial reflection (where angle of reflection = angle of incidence).

5. Cone optics. What happens when a detector is put at the apex of cone? What is gain of cone as a radiation collector? What is effectiveness of cone with a source off the axis of cone? What is effect on radiation collector with distance from cone? Try pyramids made of front surface mirrors. How much of the radiation which enters the cone aperture actually stays in cone? Try various surfaces.

Group IV Report

The approach to the Group meetings was twofold: first, to obtain, share, and discuss possible research ideas with several of the excellent invited lectures; second, to discuss the problems that are met in attempting to establish undergraduate research programs in individual colleges.

Technical

The nature of the research subjects generally implies extensive use of airborne vehicles for primary experimentation. Of the various types of vehicles, only balloons were discussed at any length. Balloonborne or rocket or aircraft experimentation and supporting research can find a place in a small college program. One major obstacle in considering such field work is that of knowing how to get use of the balloon and related facilities—a problem that seems prohibitive to small colleges. Gordon Newkirk *High Altitude Observatory* discussed the procedure in obtaining approval and support from the National Center for Atmospheric Research (NCAR) as far as the vehicle and related facilities are concerned. He described possibilities of NCAR piggyback experiments, or experiments mounted on test flight gondolas. The first step for the experimenter is to petition NCAR with a description of the proposed experiment. Support for the experiment itself is not offered by NCAR but may be sought from the Air Force, Navy, or NASA agencies. If NCAR approves the experiment, balloon and balloon facilities are made available for the experiment. It should be emphasized that logistics and time required for balloonborne field operations weigh heavily against such operations for undergraduate programs, but need not preclude all such experiments.

Some of the many areas in which much more research is required, and often with relatively simple equipment, are listed in summary:

1. Examination of terrestrial atmosphere in layers.
2. Height distribution of aerosols—distribution near the sun.
3. Polarization and scattering at large angles from the sun.
4. Atmospheric absorption as functions of altitude, latitude, zenith angle, time of day, time of year.
5. Photography and photometry of zodiacal light and aurorae.
6. Outer corona studies.
7. Polarization of starlight at very short wavelengths.

Programs that support balloon astronomy but are not actually flown, thereby becoming especially practicable for undergraduate programs, include:

1. How to minimize compound-pendulum motion of balloons.
2. Study of optical properties of materials, including scintillation, x-ray darkening, and fluorescence of materials. Index of refraction, absorption measurements in the ultraviolet for materials suitable for lenses.
3. Coronal investigations in the infrared.
4. Particle concentration and size measurements as a function of altitude.
5. Microwave studies of planets, stars, and sun.
6. Atmospheric seeing and scintillation studies.

Suggestions for research in more general areas include:

1. Study of the amount of glass removed per unit time in a lens-polishing operation.
2. Laser interferometry for long-path measurements through the atmosphere.
3. Precision testing of small optical components (of the order of 0.01 wavelength).
4. Study of the lower atmosphere—transmission, slantpath transmission.

5. Study of the nature of coherent scattering and comparison with incoherent light scattering.
6. Infrared background noise.
7. Divergence of flux as a function of altitude.
8. Interferometry applied to measurement of earth tides.

It is to be noted that many of the foregoing items are not at the forefront of science, and yet represent necessary experimentation from both the scientific and industrial points of view. This is particularly true for studies of optical materials.

Group V Report

In considering the following suggestions, it is important to keep in mind that the project can develop over several years and can involve many students in succession. An initial project could be the construction of an optical instrument. Successive projects could involve its improvement, calibration, and testing. Accessory equipment could be built. By spreading development over a period of time, the cost per year of the instrument could be kept low and the instrument could be constructed with only a few students. It is with these ideas in mind that we suggest a representative list of instruments. Construction of any of these instruments would be a suitable undergraduate project.

After the instrument has been completed any number of experiments are possible. The projects section of this report gives sample experiments relating to the subject matter of the Group. It should be kept in mind that the line between a student project and research is blurred. In many cases research involves only greater precision. In the case of many optical properties even imprecise knowledge is lacking. Useful contributions can be made to this body of knowledge with relatively little difficulty.

Thanks to the efforts of W. C. Connolly, the report includes a bibliography of articles in the *American Journal of Physics* relevant to the topics of Group V. These can serve as starting points for honors projects or research.

Instruments

1. Construction of a Fabry–Perot interferometer.
2. Construction of a grating spectrograph. [See A. M. Bass and K. G. Kessler, J. Opt. Soc. Am. **49,** 1223 (1959).]
3. Construction of an optical pyrometer.
4. Construction of optical instruments from surplus, e.g., projection equipment, telescopes, etc.
5. Building a ruby laser.
6. Design and construction of various interference filters, e.g., thin films.
7. Design and construction of a vacuum system (e.g., for thin film work).
8. Construction of a polarimeter.
9. Construction of a device particularly for measuring small degrees of polarization.

Projects

1. Measurement of transmission, absorption, index of refraction, and reflectivity for solids, gases, and liquids as a function of wavelength, temperature, pressure, etc:

(a) Apparatus needed includes spectrometer, ellipsometer, quarter-wave plate.
(b) For an example of a measurement of index of refraction, see Letter to Editor by M. Laikin, J. Opt. Soc. Am. **51,** 238 (1961).

2. Optical constants of crystals.

Object: Measure n and k (index of refraction and absorption constant) of crystals such as Fe_2O_3, $BaTiC_3$, CdS, TiO_2, ZnO, and others that have an absorption peak in the visible. Compare results for k with those done by transmission method to see if the surface region is different, optically, from the bulk.

Equipment: Ellipsometer, carbon arc or photo spotlight, and interference filters. For ultraviolet, a photomultiplier and a microammeter are needed. [See R. C. Vernon, J. Appl. Phys. **33,** 2140 (1962).]

3. Polarization of diffusely reflected light.

Object: To measure the extent to which partially reflected light is polarized for different materials, wavelengths, and surface conditions.

Equipment: Ellipsometer (or polarimeter) and filters (as above) or perhaps, instead of an ellipsometer, sheet polarizer, quarter-wave plate (and photomultiplier) might be sufficient.

4. Bifluorescence.

Object: Many crystals that fluoresce fluoresce polarized light. Study of this light may help to identify the source of fluorescence. [See S. C. Ganguly and N. K. Chaudhury, Phys. Rev. **95,** 1148 (1954).]

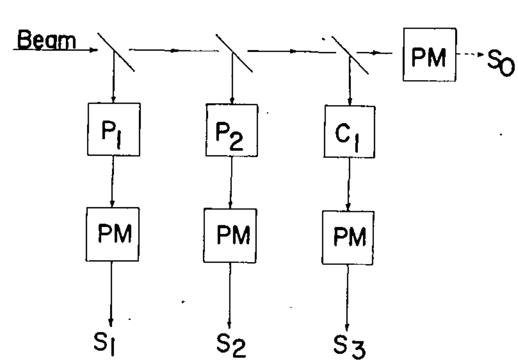
5. Fluorescence of optical materials by nuclear radiations.

Object: Find out if optical glass and other materials will fluoresce when bombarded by γ or β rays. For a start, just use a photomultiplier (and microammeter), specimen, and a radioactive source.

6. Measurement of interaction of polarized light with matter as a function of temperature, pressure, impurities, angle of incidence, etc.

7. Measurement of the degree of polarization of sources, i.e., Zeeman effect, Stark effect, bifluorescence, biemissivity, grazing emergence, etc. [W. A. Shurcliff, *Polarized Light* (Harvard Univ. Press, Cambridge, 1962), p. 161.]

8. The construction of a device to measure simultaneously the Stokes parameters (see Shurcliff in item 7 above) of a light beam is proposed using photomultiplier circuitry with beam splitting. It could be attempted using counting circuits rather than integrating currents so that statistical analysis could be used to increase accuracy. Schematically the device would appear as in the following figure:



P_1, plane polarizer at 0°; S_0, S_1, S_2, S_3, Stokes parameter; P_2, plane polarizer at 45°; PM, photomultiplier and counter circuit. A less expensive device could be constructed using only two channels, the S_0 channel with the P_1, P_2, and C_1 filter being placed in the second beam.

9. Study the Faraday effect.
10. Study the effects of polishing and grinding on the structure of the surface of optical materials. It may be interesting also to study the effect on other features.
11. Mechanical properties of optical materials (glasses, glues, etc.):

(a) Elastic modulus.
(b) Thermal effects in nonequilibrium situation when apparatus is being externally illuminated in a vacuum (satellite in space).

(c) Coefficient of thermal expansion.
(d) Thermal conductivity.
(e) Emissivity.
(f) Homogeneity of optical elements.
(g) Hardness.

12. Study of mirror-support structures.

13. Measurement of thermal waves in optical materials by observing the spatial change in the index of refraction as a function of time.

14. With the introduction of gratings, commercial infrared spectrometers have increased spectral range from 4000 cm^{-1} to 250 cm^{-1} or 200 cm^{-1}. The only clear window materials are CsBr or CsI, which are soft and very hygroscopic. It should be possible to coat these materials with a thin film of a material like MgF_2, which would make them moisture resistant yet not affect their transmission. B_2O_3 forms a glass which reacts with H_2O. It might be useful to see if the glass could be protected by thin film coatings.

15. Transmission and absorption in filters as a function of temperature.

16. Measurement of anisotropic properties of films (or anything else for that matter, e.g., birefringence).

17. Thin films. Determine the following:
(a) Dispersion curves for metals.
(b) Reflectance, transmittance of metallic films, and semiconducting films.
(c) Reflectance and transmittance of dielectric films.
(d) Variation of the above with temperature of the sample.
(e) Variation with respect to temperature of the substrate during deposition of the film.
(f) Variation with respect to time (and pressure) following the deposition of the film.
(g) Variation with respect to rate of formation of film.
(h) Variation with thickness of sample.
(i) Investigate for possible relationships between the above optical properties of metallic films and their electrical properties.
(j) Try to determine why some metals such as zinc must bounce several times before they will stick to the surface.
(k) Measurement of n and k for thin films. As a reference for thin films see *Physics of Thin Films*, G. Hass, ed. (Academic, New York, 1963).
(l) Study of magnetooptic effects, e.g., the use of Voigt and Faraday effects to determine effective masses. (Variation of absorption with magnetic field, magnetoreflection, and study of intraband and interbond structures.)
(m) Study of behavior of the coefficients of nonlinear optical effects as a function of temperature, pressure, frequency, and impurity concentration using a laser.

Bibliography (*American Journal of Physics*)

1. "Studies of Transmission Zone Plates", by O. E. Myers, Jr., **19**, 359 (1951); use of Fresnel zone plate as a lens to focus wavelengths from infrared to soft x rays.
2. "Electronic Magnifier for Observation of Infrared and Ultraviolet", by Z. V. Harvalik, **18**, 151 (1950); use of spectroscope from 3000 Å to 11,500 Å.
3. "Caustics by Reflection in a Concave Spherical Reflecting Surface", by G. F. Herrenden-Hacker, **16**, 272 (1948); plotting caustic curves from derived formulas.
4. "Caustic Curves by Geometric Construction", by A. Newell and A. V. Baez, **17**, 145 (1949).
5. "Experimental Approach to the Paraxial Properties of Lens Systems", by F. D. Cruickshank, **17**, 204 (1949); good geometrical optics experiment involving virtual images.
6. "Experimenting with Virtual Images", by B. I. H. Scott, **17**, 209 (1949).
7. "Analysis and Synthesis of Optical Images", by J. E. Rhodes, Jr., **21**, 337 (1953); good starting point for a theoretical project using a double Fourier transform.
8. "Refractions by a Thick Lens Which Is Equivalent to a Compound Lens System", by M. E. Hufford, **14**, 259 (1946).
9. "Fresnel Diffraction Experiment", by L. A. Sanderman and R. S. Bradford, **17**, 514 (1949).
10. "A Correction to the Treatment of Fresnel Diffraction", by C. L. Andrews, **19**, 280 (1951).
11. "Optical-Lever Amplifier for Studying Brownian Motion of a Galvanometer", by K. W. White, **31**, 922 (1963); measure Boltzmann's constant.
12. "Construction and Use of a Fabry–Perot Interferometer", by W. A. Hilton, **30**, 724 (1962); measure index of refraction of gases and Zeeman effect.
13. "Photography-High Speed Using General Radio 1531-A Strobotac", by D. C. Eldridge, E. M. Skinner, and J. Tsepas, **30**, 921 (1962); could be the start for an interesting project.
14. "Experiments on the Laws of Light Absorption", by O. Bluh and H. Ko, **22**, 306 (1954); vary depth of liquid—absorption and half value layer.
15. "A Simple X-Ray Diffraction Camera", by W. C. Campbell, **15**, 409 (1947).
16. "Optical Methods for the Determination of Flame Temperatures", by S. S. Penner, **17**, 422 (1949); pyrometry and infrared work—two color and line reversal techniques.
17. "Photon Diffraction—Undergraduate Research Project", by R. H. Biser, **31**, 29 (1963).
18. "Physics of the Glassy State", by E. U. Condon, **22**, 310 (1954); thermoluminescence–phosphorescence, material heated–glows brightly, solarization—color change by sunlight on glass—photosensitive glass.
19. "Photosensitive Glass", by K. Riess, W. C. Bosch, and T. T. Reboul, **16**, 399 (1948); study of Corning photosensitive glass—expose by ultraviolet 310–340 m and develop by heat (565°C).
20. "Diffraction by Two Non-Coplanar Obstacles", by C. F. Ellis, **16**, 8 (1948).
21. "Diffraction by Two Non-Coplanar Straight Edges", by J. R. Heirtzler, **17**, 449 (1949); also see letter by H. A. Nye in same issue.
22. "C. V. Boy's Rainbow Cup and Experiments with Thin Films", by J. Satterly, **19**, 448 (1951); good qualitative experiment for starting thin film study.
23. "Velocity of Light Measurement through μ_0, ϵ_0", by W. E. Stephens, **31**, 105 (1963).

Recommendations of the Conference for Programs in Direct Support of the College Research Efforts

The support Groups A, B, and C and some of the research program groups made suggestions and recommendations for OSA action. There was also considerable discussion of the problems of the small college physics professor. Just prior to the Conference the May issue of *Physics Today* published a summary of the COPFIC (Committee on Physics Faculties in Colleges) report. The college faculty problems brought out in that excellent report are similar to those the Conference reported. Since the COPFIC report is widely available, this section is concerned only with possible action steps specific to optics.

1. Research Communication

A specific communication mechanism was proposed whereby the OSA could provide a linkage so that a member of any physics faculty desiring aid or advice in a specific area of optics could be recommended to a competent academic or industrial researcher in that field for such help. The linkage would consist of two groups—a *regional group* consisting of representatives of the college faculties which would coordinate the requests for aid, and a small *resource group* to be designated by the Board of OSA to seek out researcher aid in response to requests from the regional group. Once the arrangements are made, the communication between the college faculty member and the advisor would be direct.

The Board of OSA felt that such a communication mechanism should be tried, and it authorized J. H. Taylor, in continuation of Task IV, to form such a regional group and prepare proposals of philosophy and procedures. If this can be accomplished, the Board will institute the resource group.

2. Optics Research Newsletter

A common recommendation was the establishment of an *optics research newsletter* for distribution to faculty members, which would keep them aware of current developments in optics to aid their teaching and research studies. While the problem is not easy, it was the conclusion of the Optics Action Group that efforts to start such a newsletter should be made.

The reaction of the Board was that a more specific program and mechanism for accomplishment was required before further consideration was possible. It was further recognized that OSA is already participating in the AAPT–AIP resource letter project; further activity in the proposed area should reinforce and not interfere with this project. The Optics Action Program will continue an attempt to clarify this program.

3. Optical Handbook

The requirement of centralized availability or a handbook of *optical characteristics of materials* was strongly urged by the conference for the reasons of both its value to the scientific world and its indication of data gaps which might be a basis for college research programs. This requirement was also the greatest single item listed in answer to the question of the Task III postcard survey [see L. M. Biberman and V. Z. Williams, Appl. Opt. **4**, 205 (1965).] The question for the Optical Society would have two aspects—a philosophical one of its responsibility in the area and a practical one of what might be done about it.

The Board recognizes that this question is fundamental to the Society and has started consideration of it.

4. Research Grants and Contracts

It was agreed that the conference effort would produce a good summary of the present situations with respect to grants, contracts, and other financial aid from foundations or contracting agencies. The question of grants in the $500–$1,000 area for critical items recurred frequently. This proved too complex to be resolved at the conference.

On request from the Optics Action Group T. L. Porter *National Bureau of Standards* has prepared such material and it will be distributed to the conference participants and to others who were not able to attend. Additional copies are available from the Executive Office of OSA.

It is emphasized that the OSA cannot become a clearing house for handling contracts, or act as liaison in such regard, or aid in writing research contracts, or distribute surplus equipment.

5. Summer Employment

Although this problem was much discussed, no specific scheme appeared which offered great advantage over present mechanisms. For the benefit of the conference members, the following present mechanisms are listed:

(a) **Program in Government Laboratories**

This program for undergraduate student trainees is under the supervision of the U.S. Civil Service Commission. Announcements of examinations are available on request from the Commission or one of its regional offices. Appointments are made on the basis of performance in the examination: the Civil Service grade level and salary depend on the number of years of college completed. These and other details are described in the announcements of the examinations.

Applicants who hold a bachelor's degree (therefore, including faculty), or who expect to receive a degree in June of the summer in which they desire employment, are not required to take a written examination. They file an Application for Federal Employment, called Form 57, which is available at post offices, together with a list of courses completed and grades received.

These programs are nationwide and the types of work, the summer vacancies, and other details vary somewhat between laboratories. Specific information should be sought by correspondence with the Civil Service Commission or direct with a particular laboratory of interest to the student or faculty member.

(b) **NSF Programs**

NSF provides summer and part-time research programs for both undergraduates and college teachers. Details of these programs are available from the National Science Foundation, Division of Scientific Personnel and Education, Washington, D.C. 20550. Further information on these is given in the report of the preceding section.

(c) **AIP Program**

The American Institute of Physics, under recommendation of COPFIC, maintains two listings. One shows the institutions and industries which welcome inquiries about summer employment for physics students and teachers. The other listing gives the names of physics faculty members who would like to consider such employment. Data on this program are available from the American Institute of Physics, 335 East 45th Street, New York, New York 10017.

6. Education in Optics

The recommendations of the conference are being incorporated in the Task V program under M. E. Warga. In summary, the conference felt the present status of optics teaching should be better known. A questionnaire for this purpose was prepared and put through a dry run at the conference. It is being improved for distribution pending more accurate knowledge concerning this. The cognizant group recommended that:

(a) The introductory physics course include material on optics which is at the level and extent of the text *Physics for Students of Science and Engineering* by David Halliday and Robert Resnick (Wiley, New York, 1961).

(b) Further course work be offered such that the level of optics instruction be at least to the R-curriculum recommendations of the second Ann Arbor conference.

It was further felt that Task V and the OSA should act to increase the number of summer optics courses and institutes available.

7. Additional Manpower in the Executive Office

In subsequent consideration of this successful conference and its recommendations, it was realized that a most desired service is a means of informal and versatile communication in addition to the present communications via journals and meetings. The requirement is for newsy, pointed communications concerning new research progress, correlation of available surplus equipment, new grants or assistance programs, summer employment opportunities, new undergraduate experiments in optics, a study of mass purchase of lasers for price improvement, etc.

Many of these things, as well as aid in a program to meet the aims of (3), might be pursued if an education officer were to be added to the Executive Office staff. The Optics Action Group recognizes the difficulties of getting such a person and financing his expenses. On the other hand, the Society should give thought to all methods whereby it can better serve optics and its membership.

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Department of Physics

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Description of Item: Model Number:

Condition: Location: (Room Number)

Manufacturer:

Method of Acquisition (ie, direct purchase, gift, government surplus, grant, etc.):

Date Acquired and Purchase Order Number:

Cost:

Replacement Cost:

List on the back any modifications made on this item. Please list date of modification and name or names of persons making them.

Enclosure 21 - Copy of the Cards and Tags used in the Physics Department's Inventory System

Enclosure 22 - Journals Presently Subscribed to by the Physics Department

Advances in Geophysics

American Journal of Physics

American Scientist

American Society for testing and Materials

Annals of Physics

Annual Review of Astronomy and Astrophysics

Applied Optics

Applied Spectroscopy

Astronomical Journal

Astronomy and Astrophysics

Astrophysical Journal

Bulletin of the American Astronomical Society

Bulletin of the American Physical Society

Bulletin of the Astronomical Institution of the Netherlands

Canadian Journal of Physics

Communication of the Lunar and Planetary Laboratory

Contemporary Physics

Discussions of the Faraday Society

Electronics

IEEE Journal of Quantum Electronics

Infrared Physics

Irish Astronomical Journal

Journal of Applied Physics

Journal of Atmospheric and Terrestrial Physics

The Journal of Chemical Physics

Journal of Geophysical Research

Journal of Molecular Spectroscopy

Journal of Quantitative and Radiative Transfer

Journal of Research of the National Bureau of Standards

Journal of Scientific Instruments

Journal of the Accoustical Society of America

Journal of the Optical Society of America

Memoirs of the Royal Astronomical Society

Metrologia

Monthly Notices of the Royal Astronomical Society

Nucleonics

Optics and Spectroscopy

Optics Technology

The Physical Review

The Physical Review Letters

The Physics Teacher

Physics Abstracts

Physics Today

Planetary and Space Science

Proceedings of the IEEE

Publications of the Astronomical Society of the Pacific

The Quarterly Journal of the Royal Astronomical Society

Review of Modern Physics

Review of Scientific Instruments

Science

Science Abstracts

Science and Technology

Scientific American

Scientific Monthly

Scientific and Technical Aerospace Reports

Sky and Telescope

Solar Physics

Soviet Journal of Optical Technology

Space Science Review

Technical Abstract Bulletin

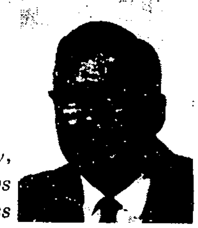
Transactions of the Faraday Society

U. S. Government Research and Development Reports Index

Enclosure 23 - Reprint from Applied Optics - "Optical Activities in the Universities" by Dr. Stanley S. Ballard in which he comments on the NSF supported Short Course In Optics For College Teachers held at Southwestern June 7-18, 1971

Applied Optics

Optical Activities in the Universities



reported by STANLEY S. BALLARD, Department of Physics and Astronomy, University of Florida, Gainesville, Florida. Professor Ballard hopes to receive news and comments for this column, which should be sent to him at the above address

Intensive "short courses" usually given on university campuses during the summer months, and of duration one or two weeks, have apparently become a permanent educational feature. I remember back a couple of decades when there were just a few of them given, first in spectroscopy and later in infrared physics. The early ones were designed for industrial scientists and technicians who needed updating in a specific subject and whose employers could pay the rather substantial fees that were charged. Often university-related people were able to attend the same courses at considerably smaller cost, and later on the National Science Foundation began to give support specifically for college and university teachers whose records showed that they would profit by the accelerated subject-matter treatment. I attended such a course in the broad area of optics at the University of Rochester in the summer of 1963. This was the first of a long series of such courses, I believe—the most recent one was at Rochester in late July and early August of 1971.

The Short Course in Optics for College Teachers at Southwestern at Memphis in mid-June 1971 deserves discussion because of its special nature. The NSF made a grant to Southwestern College which provided stipends for thirty college teachers to attend, as well as covering other costs of the course. A few of us old optics hands who could not qualify for NSF stipends were permitted to come on our own and participate as fully as we desired. It was an exceedingly worthwhile experience for me.

The Director of the course was Jack H. Taylor, Chairman of the Physics Department at Southwestern and a man well known in both educational and research optics circles. He had valuable experience as an optical physicist at the Naval Research Laboratory in Washington, and he has been active in working on research grants, astronomical eclipse expeditions, and the like, since going to Southwestern 15 years ago. Assisting him in planning and executing the course was John A. Sanderson, who retired shortly thereafter from his position as Research and Education Officer of the Optical Society of America. If the course were to be dedicated to any one person—and I am not sure this is ever done—that person would certainly have been John Sanderson.

Southwestern is an unusual collegiate institution indeed. It is an undergraduate college with somewhat more than 1000 students, about equally divided between men and women. It has a beautiful large campus in suburban Memphis, with several dormitories for out-of-city students. A most unusual feature is the new Science Center, which exemplifies the strong role that science plays in the curriculum. [See Appl. Opt. **8**, 197–202 (1969); photographs are included of the Physics Tower and some of its several laboratories.] What other school this size can boast a physics faculty of six? Support from Research Corporation and from research grants and contracts are important contributing factors. One result is that undergraduate physics majors, strongly oriented toward optics, astrophysics, and astronomy, because of the makeup of the physics faculty, ordinarily participate in sponsored research to an extent equaled on few other campuses in the country.

The selection of participants, from the many who applied, was made by Drs. Taylor and Sanderson on the basis of choosing persons who, it appeared, would receive the greatest benefit from the course. Apparently the resurgence of optics in college curricula means that optics is taught by a good many physics professors who are not specifically trained in this field. Thus they must build up a familiarity with and some competence in optics to do an effective teaching job. A short course like the one at Southwestern is an excellent mechanism for performing this updating. In my mealtime and other conversations with the participants, I found that in fact many of them were in this situation: they had specialized in other fields of physics but now found themselves teaching in a small college or other school where they were called upon to cover optics courses.

Features of the course that we found especially attractive were the rather relaxed pace and the fact that the local situation made possible maximum interaction among participants and between participants and the instructional staff. Most of us stayed in a fine new, air-conditioned (women's) dormitory just a short block from the physics building. The school refectory, where we took three meals a day, was located just another short block further on. Except when it was raining, it was pleasant to stroll back and forth among the buildings and for that matter all over the lovely tree-covered campus with its traditional Westminster-style buildings.

The standard schedule called for a lecture from 9:00 a.m. to 10:15 a.m., then a coffee break followed by another hour-and-a-quarter of lecture or discussion. After lunch there was a third lecture, or educational or research films were shown. Following the afternoon coffee break the participants were separated into small groups of six or seven to perform or observe experiments that had been prepared. These were quite different from the usual optics laboratory experiments and dealt more with the subjects of special interest at Southwestern: radiation physics, stellar radiometry, measurement of atmospheric transmittance in the infrared, measurement of the near-infrared spectrum of a planet, measurement of the solar spectrum in the visible region, celestial photography. Some of these experiments were necessarily conducted at night, and a period after dinner was scheduled for them. One problem was that the days are long in June, and the daylight-saving routine made it all the later before the skies darkened and astronomical experiments could be carried out. One hardy group convened at 2:00 a.m. to conduct a stellar experiment!

The local faculty included Dr. Taylor and his colleagues E. A. Barnhardt, J. R. Beacham, J. L. Schmitt, and F. R. Stauffer. John L. Streete, the sixth member, was involved in an off-campus research project during the summer. All the instructors were eminently available for discussions at any time; they simply devoted two weeks of their life to this undertaking.

Talks by local staff members included such helpful subjects as how to get worthwhile pedagogical and research equipment through government surplus property channels, and ideas for honors projects. The more conventional lectures were on astronomical spectroscopy, stellar radiometry, Fabry-Perot interferometry, Fourier spectroscopy, and infrared radiometry. Four of these topics were carefully written up as reports and were distributed to the participants for their retention and subsequent study at home. This in itself represents a valuable contribution. Your columnist was asked to give a review of the present situation regarding infrared-transmitting optical materials and their properties.

In general, there was an invited lecture or two scheduled each day on which one of the local staff members did not speak. The guest lecturers (listed in alphabetical order) included such well-known opticists as Professors C. L. Andrews of the State University of New York in Albany, who spoke on microwave optics and gave some excellent demonstrations; E. Scott Barr of the University of Alabama, who described a number of useful items for the conventional optics laboratory and illustrated most of them; R. W. Gammon of Catholic University, who lectured vigorously on holography and nonlinear optics; M. P. Givens of the University of Rochester, who spoke on coherence and interferometry; T. H. Jeong of Lake Forest College, who showed some spectacular demonstrations on lasers and holograms; and H. W. Yates, now at the National Environmental Satellite Center of ESSA, who spoke on the role of optical physics in the problems of air pollution and remote sensing. Several laboratory supply houses had sent equipment, largely for the college optics laboratory, and this was on display for several days and could be examined at leisure by the participants.

President W. L. Bowden of the college invited us to his home one evening; President-emeritus P. N. Rhodes, himself a physicist, attended several of the sessions; Dr. and Mrs. Taylor had us all in for a most pleasant and hearty barbecue dinner in their spacious backyard.

Since one successful conference or short course often breeds another in a later year, it is reasonable to ask what changes or improvements might be made in the course being discussed. I found it so professionally interesting and intellectually invigorating that it is hard to be critical. Keeping in mind the general makeup of the group—physics teachers who need to know more classroom optics, as perhaps an oversimplification—one can wonder whether more time should not have been spent on the problems of the conventional optics laboratory. Other than for Professor Barr's excellent lecture and the commercial apparatus exhibit, very little indeed was said about this important part of most undergraduate physics curricula. Surely optics teachers should be aware of great borderline fields like radiometry, microwaves, and astrophysics. Surely they should have at least a speaking familarity with modern optics topics such as lasers, holography, nonlinear phenomena, and Fourier spectroscopy. Their bread-and-butter subjects in their home institutions, however, are the classical areas of geometrical and physical optics, in theory and experiment.

In conclusion, note should be taken of a conference at Southwestern at Memphis seven years earlier: a four-day conference on undergraduate research programs in optical physics in June 1964. This was within the general framework of *Optics—an Action Program*, which was then being vigorously pursued by the Board of Directors of the Optical Society of America. At OSA request, and with support from the National Science Foundation and the Office of Naval Research, Drs. Taylor and Sanderson, with the enthusiastic assistance of Dr. Van Zandt Williams, selected eighty participants, organized and directed an intensive four-day program. Unfortunately, I was not able to attend this conference; I refer you to a rather extensive report on it prepared by Drs. Williams and Taylor: Appl. Opt. 4, 617–625 (1965).

Meeting Reports

Information about future meetings should be sent to the Managing Editor, P. R. WAKELING WINC, 1613 Nineteenth Street N. W., Washington, D. C. 20009

First National Symposium on Solid Thin Films, Bangalore, 19–21 April 1971

Reported by M. Ramakrishna Rao, Indian Institute of Science, and K. L. Chopra, Indian Institute of Technology

Research and development activity in the science and technology of thin films is growing very fast in many countries. A number of groups in various laboratories in India have also been working on different aspects of solid thin films. These activities cover the instrumentation connected with equipment for the preparation of thin films, experimental techniques to produce the specified films, basic investigations on nucleation, growth and structure of metallic and nonmetallic films, and studies of applications of these films in technology related to optics and electronics. It was felt that it would be beneficial if all these groups came together periodically for mutual discussions and exchange of experiences. Hence the Central Instruments & Services Laboratory of the Indian Institute of Science in Bangalore, which has pioneered in thin film technology in India organized this Symposium together with an exhibition covering all aspects of thin film.

The response was encouraging, and ninety-five delegates took part, thirty-two scientific papers were presented. Twelve academic institutions, twelve national and defense research laboratories, nine industrial organizations, and two foreign corporations participated in the program. The papers presented were broadly classified into five categories: (1) instrumentation and experimental techniques, (2) properties, (3) measurement techniques, (4) fundamental aspects, and (5) technology. Only a few of the papers given—for reasons of space—can be mentioned in this report.

The session on instrumentation and experimental techniques was presided over by **P. K. Katti** (Instrument Research and Development Establishment, Dehra Dun) who pointed out the need for thin film devices in defense laboratories. **K. L. Chopra** (Indian Institute of Technology, Delhi) surveyed unusual thin film materials for solid state and electronic applications. **A. Goswami** (National Chemical Laboratory, Poona) presided over the second session in which **Heinz Walter** (Leybold-Hereaus, Germany) reviewed the company's progress in the manufacture of thin film equipment, components, and devices.

The session on properties was chaired by **V. Ramakrishna Rao** (Andhra University, Waltair). **M. Ramakrishna Rao** (Indian Institute of Science, Bangalore) surveyed recent advances in hybrid dielectric films, highlighting how the desirable physical and mechanical characteristics of thin films could be obtained by suitable combinations of dielectric materials. In the session dealing with measurement techniques, **P. Vijendran** (Bhabha Atomic Research Centre, Bombay) presided, during which **B. S. Ramprasad** presented a review of instrument design and evaluation of abrasion resistance. The session on fundamental aspects was presided over by **K. L. Chopra** (Indian Institute of Technology, Delhi), and **V. V. Shah** (National Physical Laboratory) reviewed the work done on thin films in his laboratory in Delhi.

The final session, on technology of thin films, was under the presidency of **R. P. Wadhwa** (Bharat Electronics, Bangalore). **A. Goswami** (National Chemical Laboratory, Poona) surveyed the contributions made by his group to the studies of the crystal

AMERICAN INSTITUTE OF PHYSICS

335 EAST 45 STREET, NEW YORK 17, N.Y. MURRAY HILL 5-1940

February 2, 1962

Dr. J. H. Taylor, Chairman
Department of Physics
Southwestern at Memphis
Memphis 12, Tennessee

Dear Dr. Taylor:

The American Institute of Physics Committee to Designate Student Sections has acted favorably on the application of Southwestern at Memphis for status as a Student Section of the American Institute of Physics and I am pleased to welcome your group to the list of other AIP Student Sections.

These Sections are proving to be a very useful stimulant to young physicists, and the number of Sections is growing rapidly.

With good wishes to the Officers and the Members of the new Section, I am

Cordially,

Elmer Hutchisson

Elmer Hutchisson

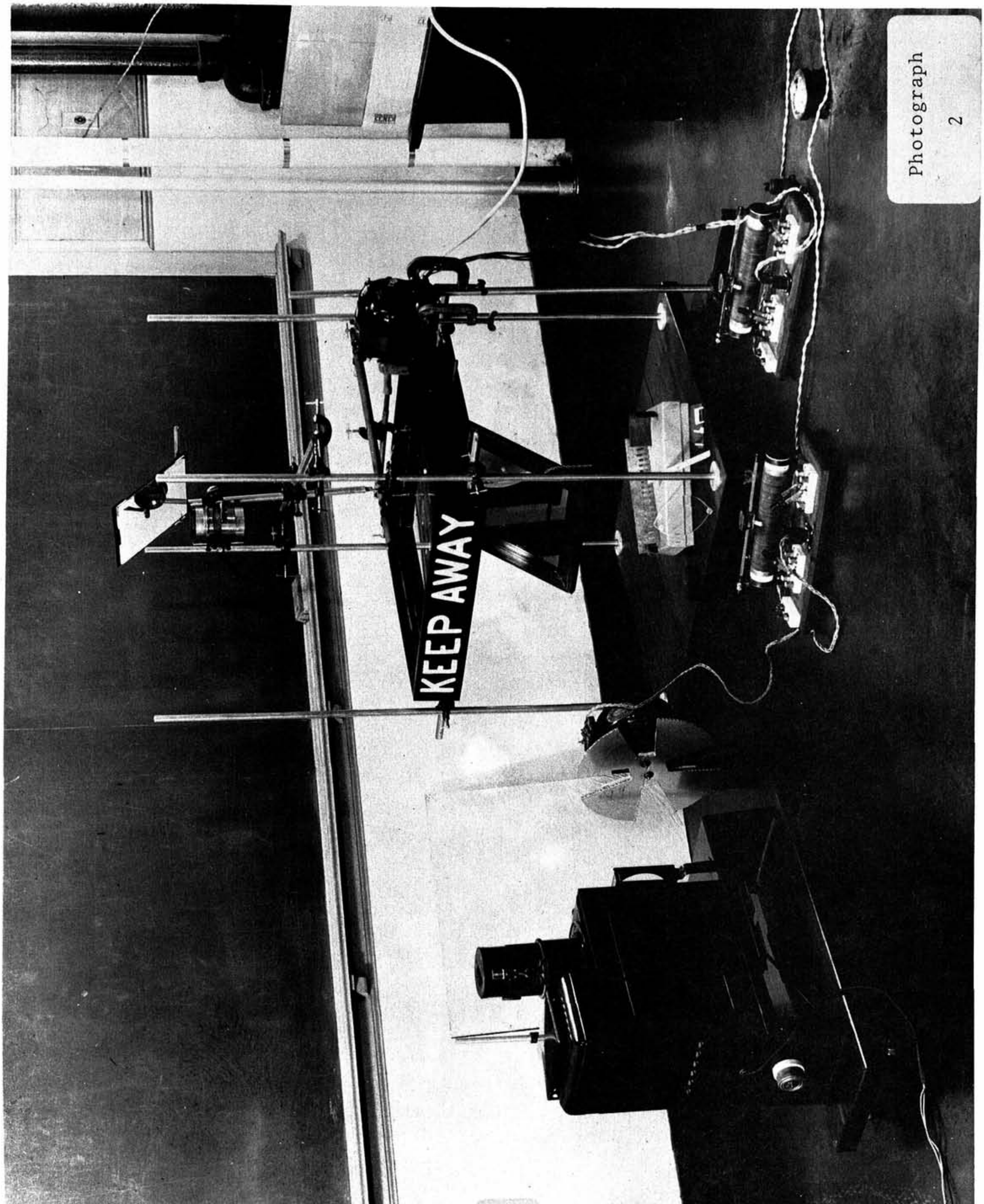
EH:bd

cc: Professor R.M. MacQueen, Student Section Advisor
Mrs. Ethel E. Snider, National Secretary, Student Sections

Enclosure 24 - Letter from the American Institute of Physics (February 2, 1962) concerning the AIP Student Section at Southwestern

Photograph 1

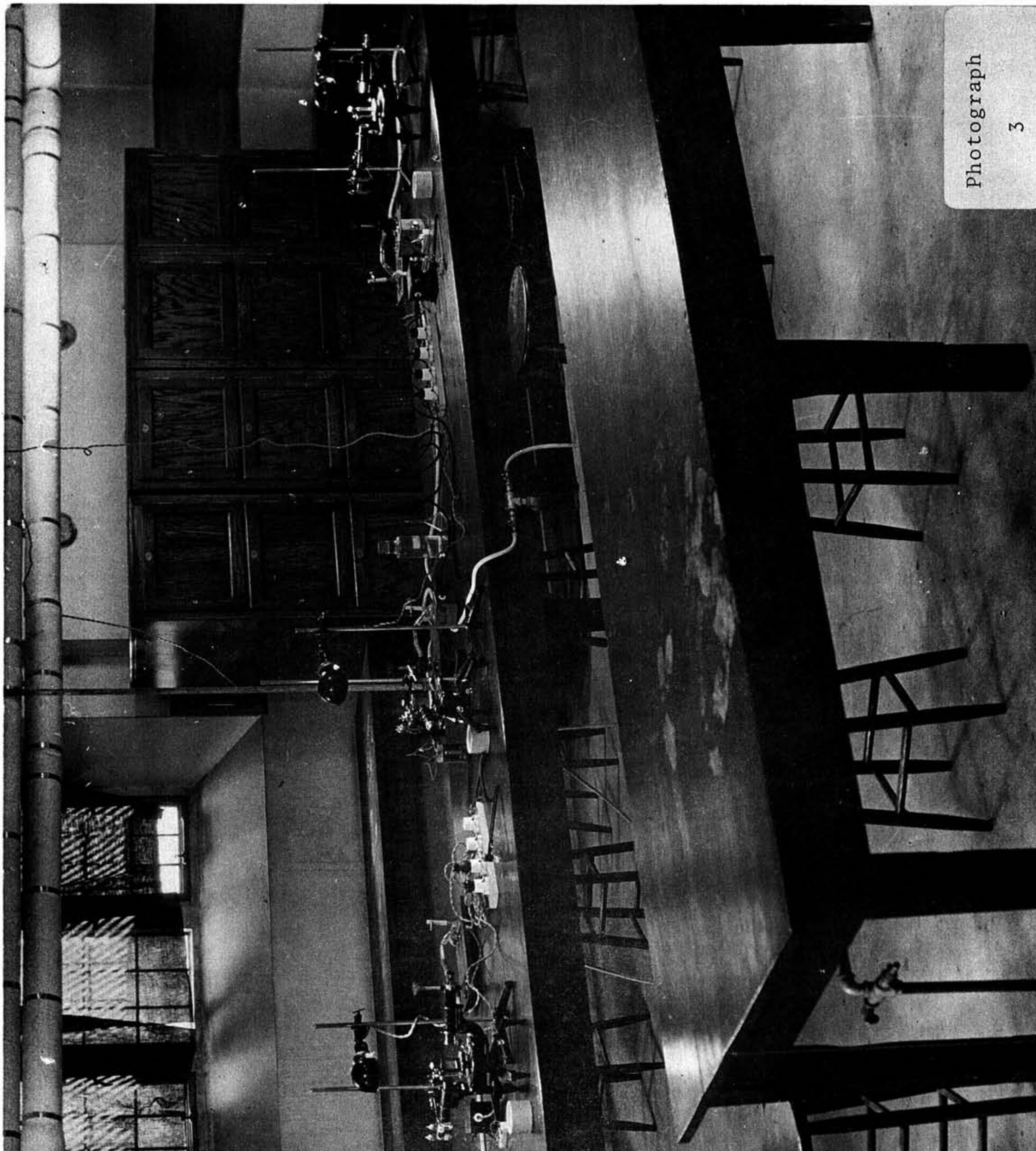
Photograph 1 - Dr. P. N. Rhodes during a lecture demonstration to a General Physics class. (Date - about 1927)



Photograph 2

Photograph 2 - Equipment in one of the physics laboratories.

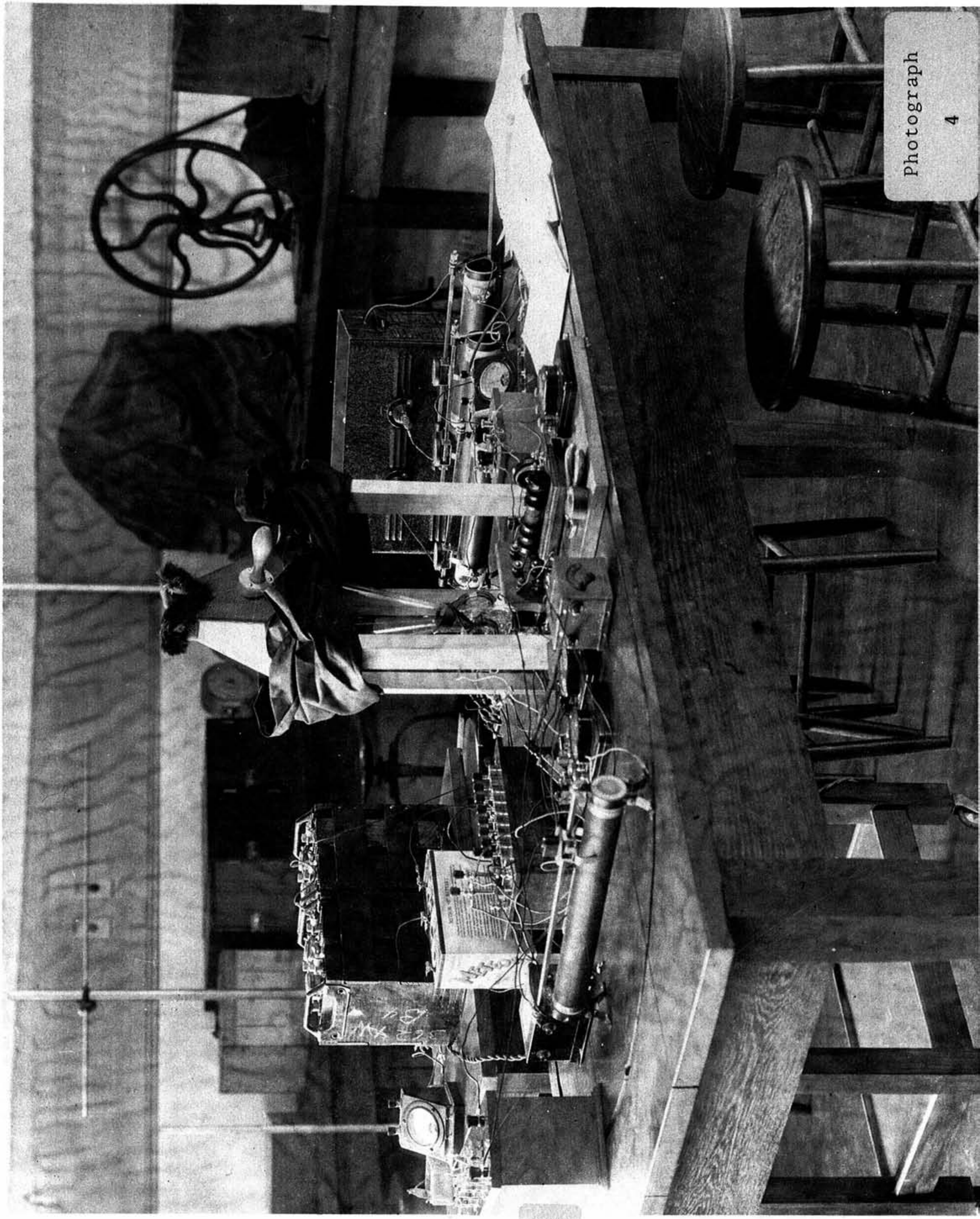
Dr. Rhodes built this ripple tank shortly after he came to Southwestern. Those of you who have followed the development of the Physical Science Study Committee (PSSC) and Harvard Project Physics programs will recall that ripple tanks play a very important part in the laboratory phase of these programs.



Photograph 3

Photograph 3 - Equipment in one of the physics laboratories.

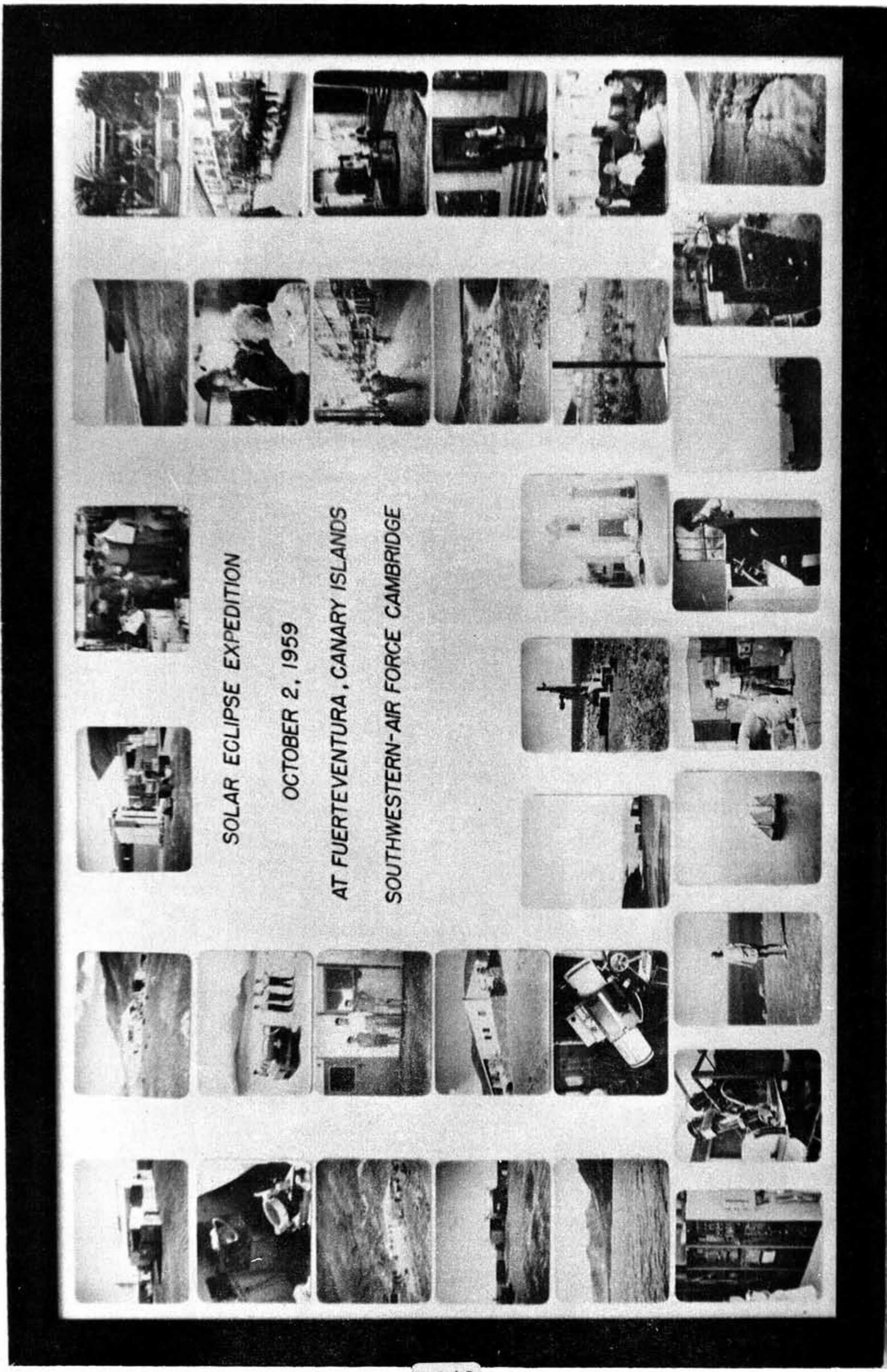
This is the General Physics laboratory located in the basement of the old Science Building. The cabinets shown in the background are still in use in the Physics Tower. This room is now part of Southwestern's Computer Center.



Photograph 4

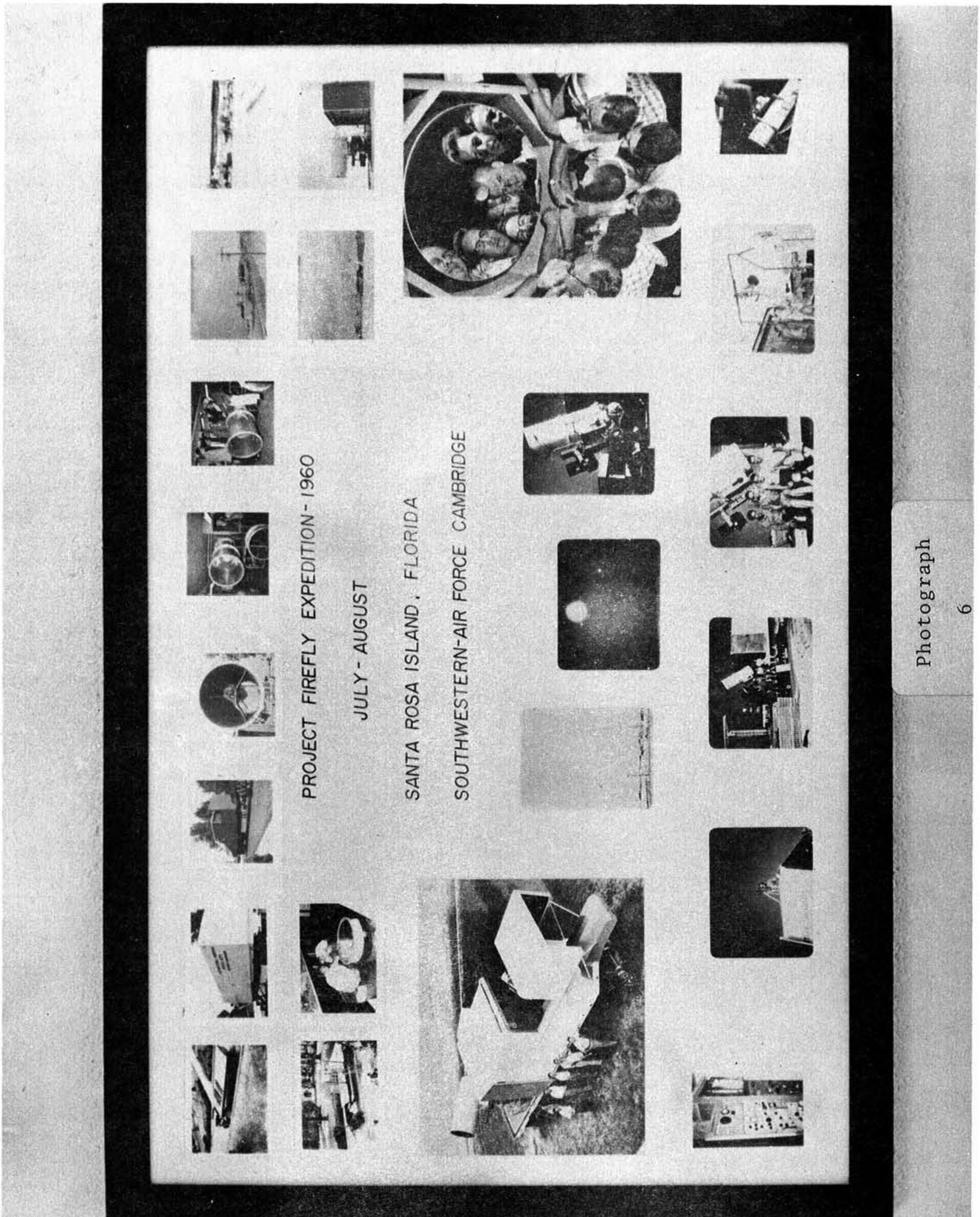
Photograph 4 - Equipment in one of the physics laboratories.

This photograph was taken in the old Science Building.



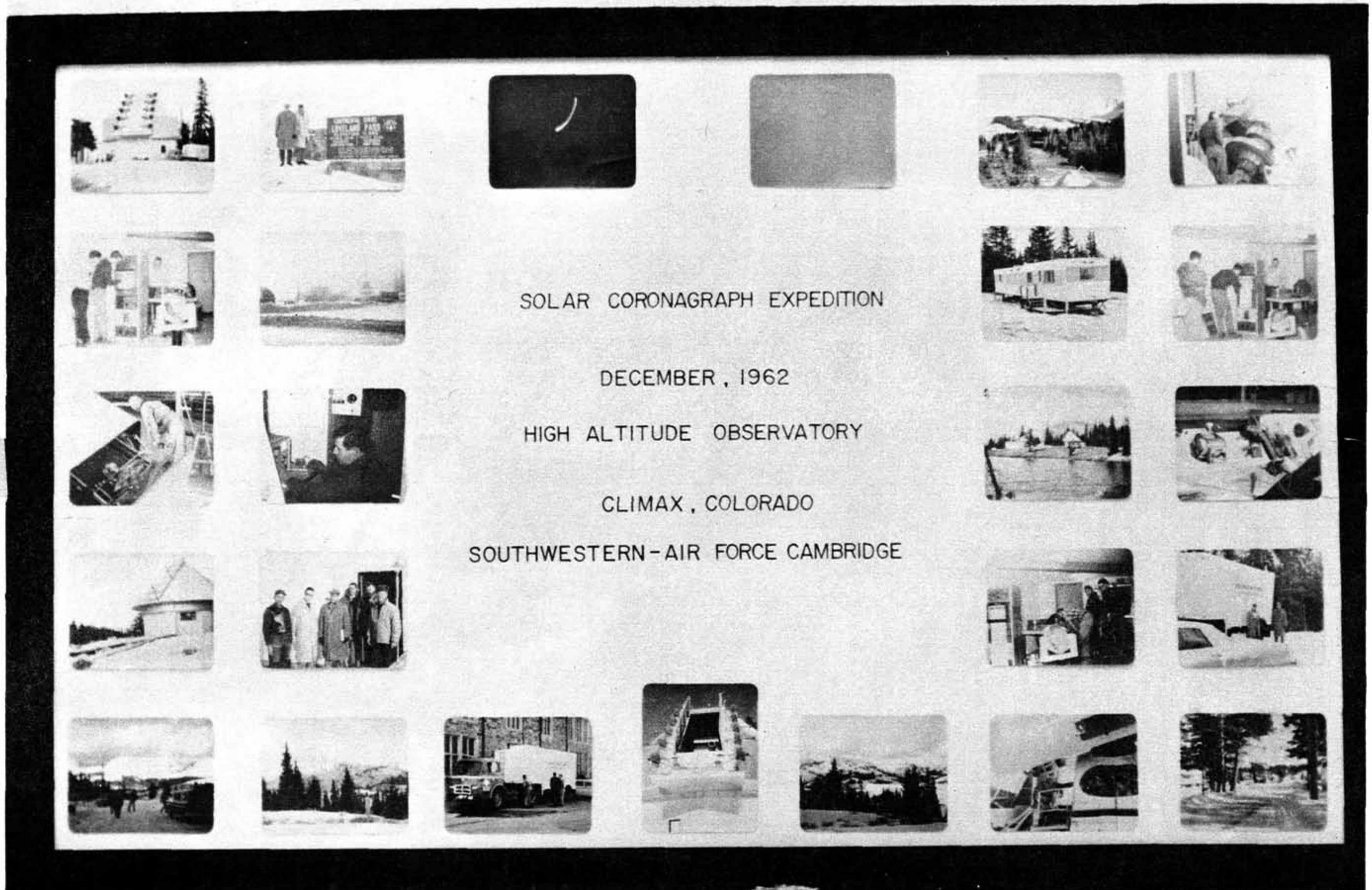
Photograph 5

Photograph 5 - Mural of the 1959 total solar eclipse expedition to the Canary Islands



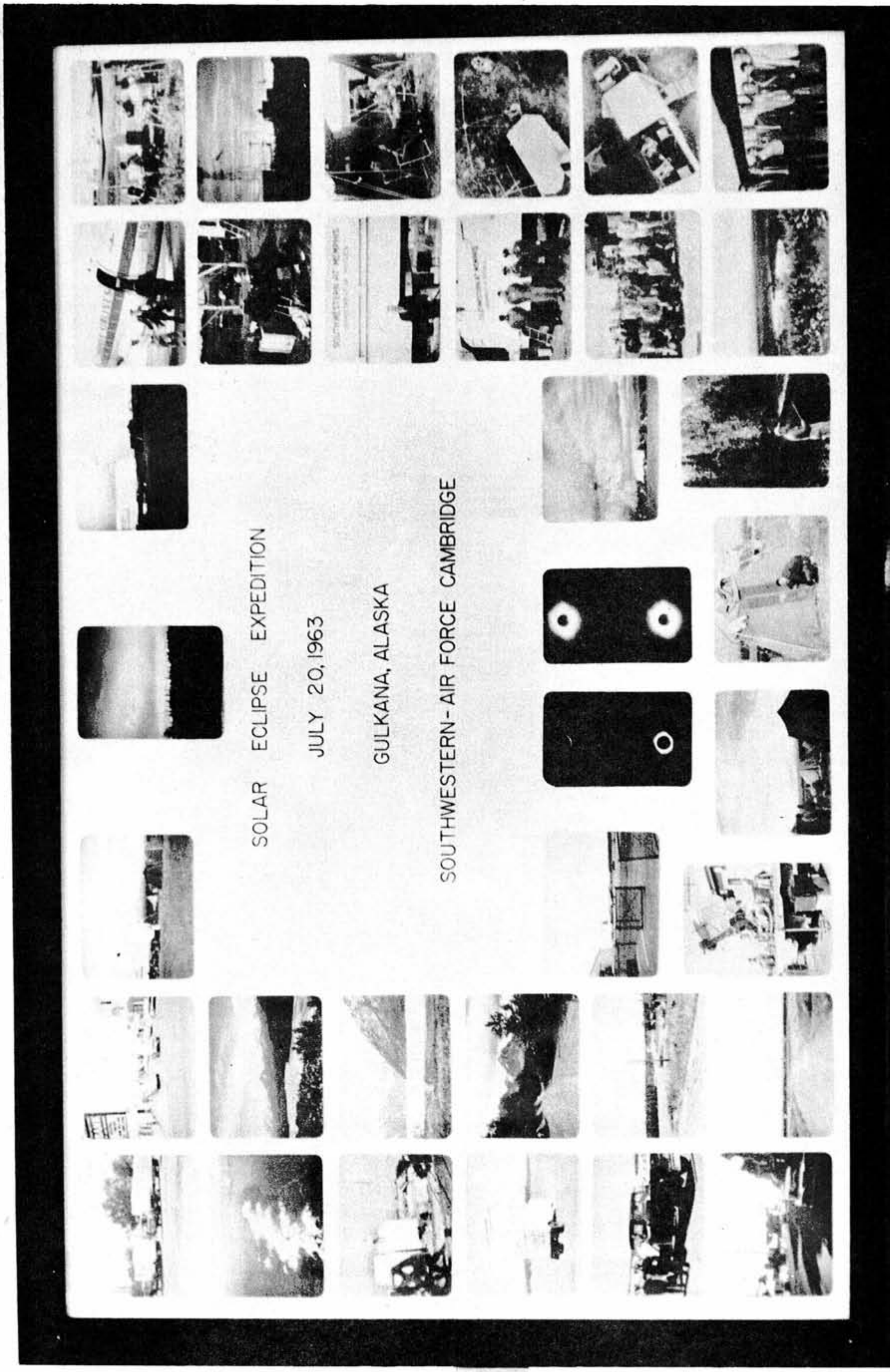
Photograph 6

Photograph 6 - Mural of Project Firefly - 1960



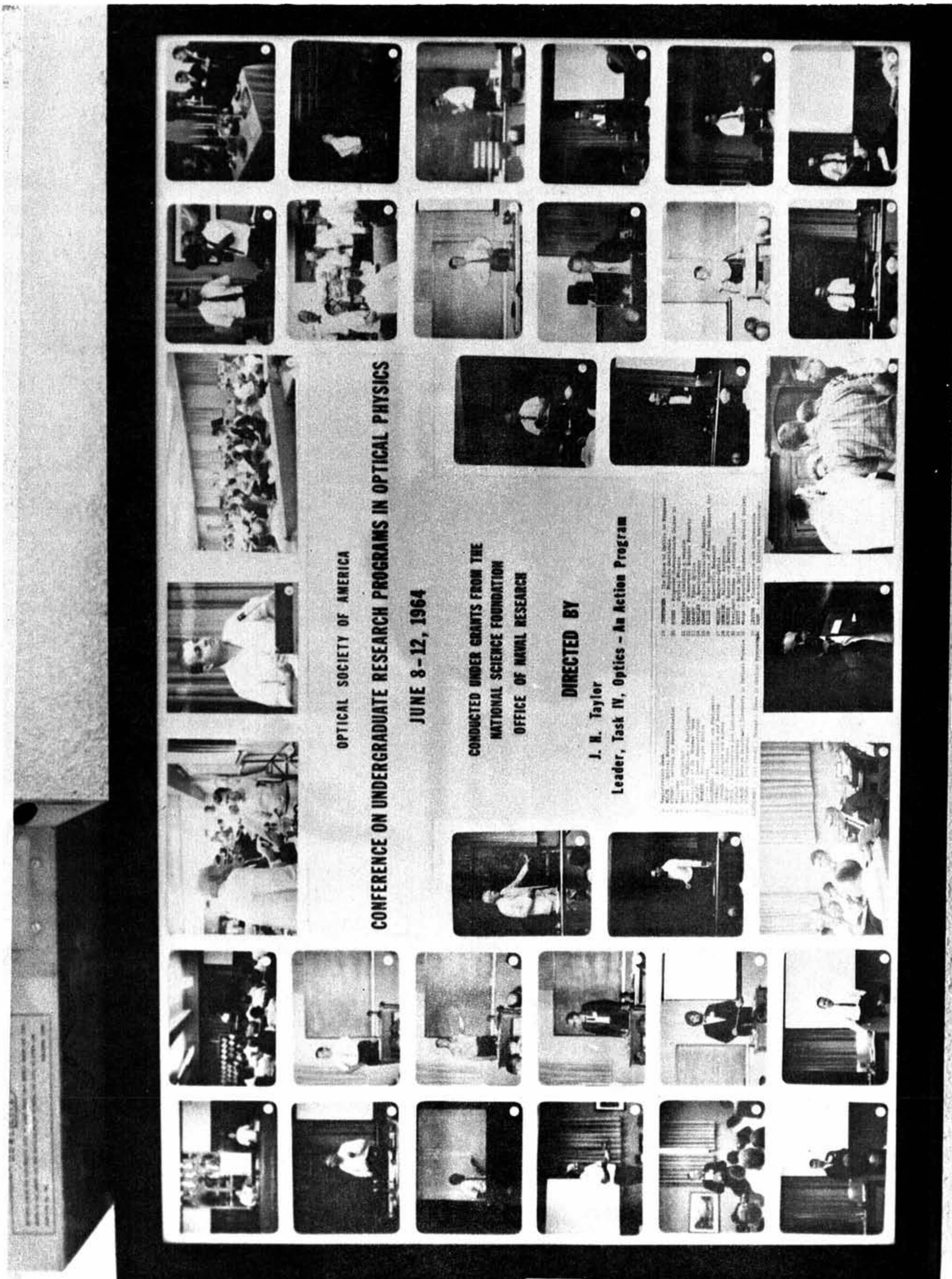
Photograph
7

Photograph 7 - Mural of expedition to Climax, Colorado - 1962



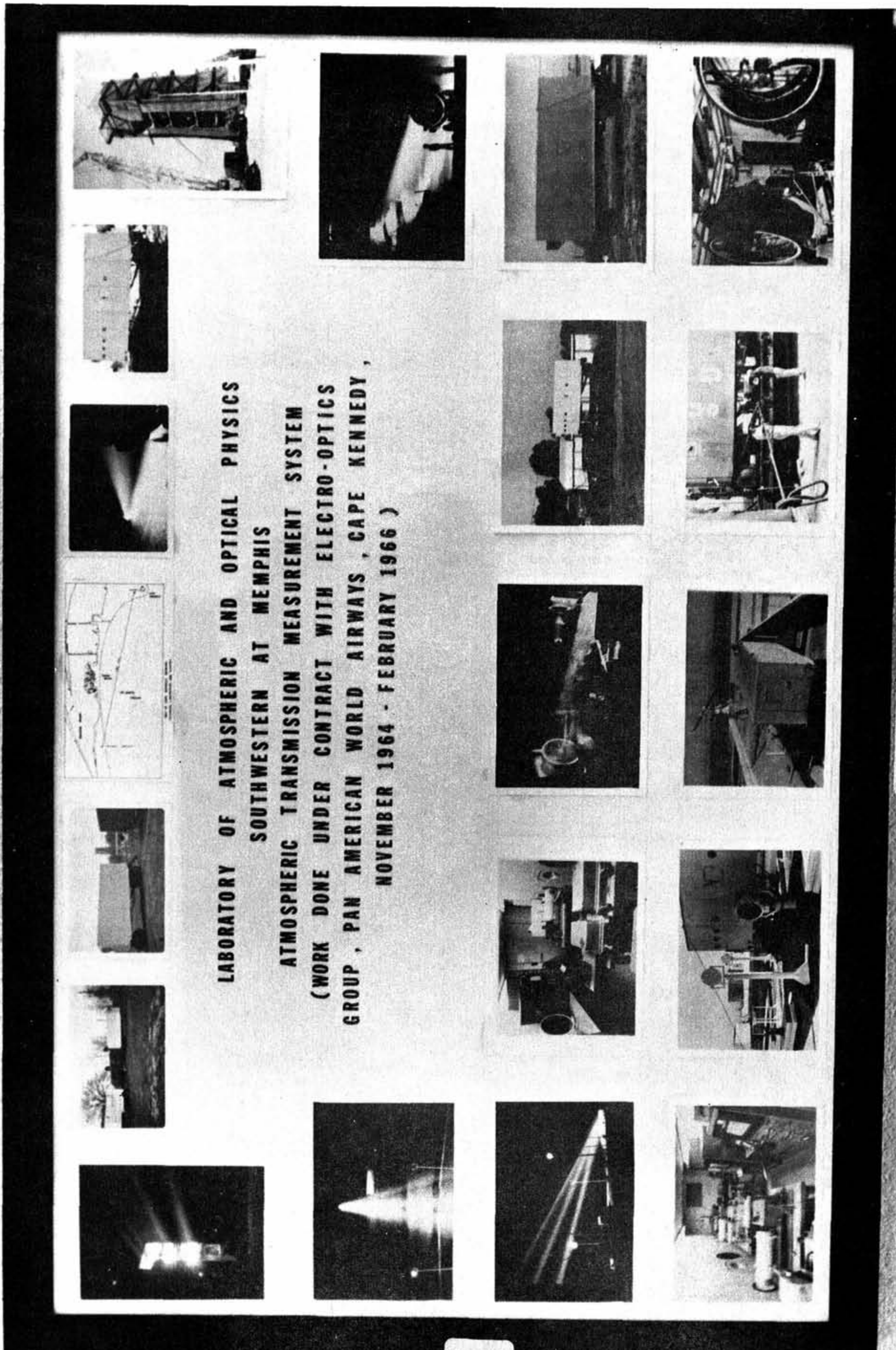
Photograph 8

Photograph 8 - Mural of the 1963 total solar eclipse expedition to Alaska



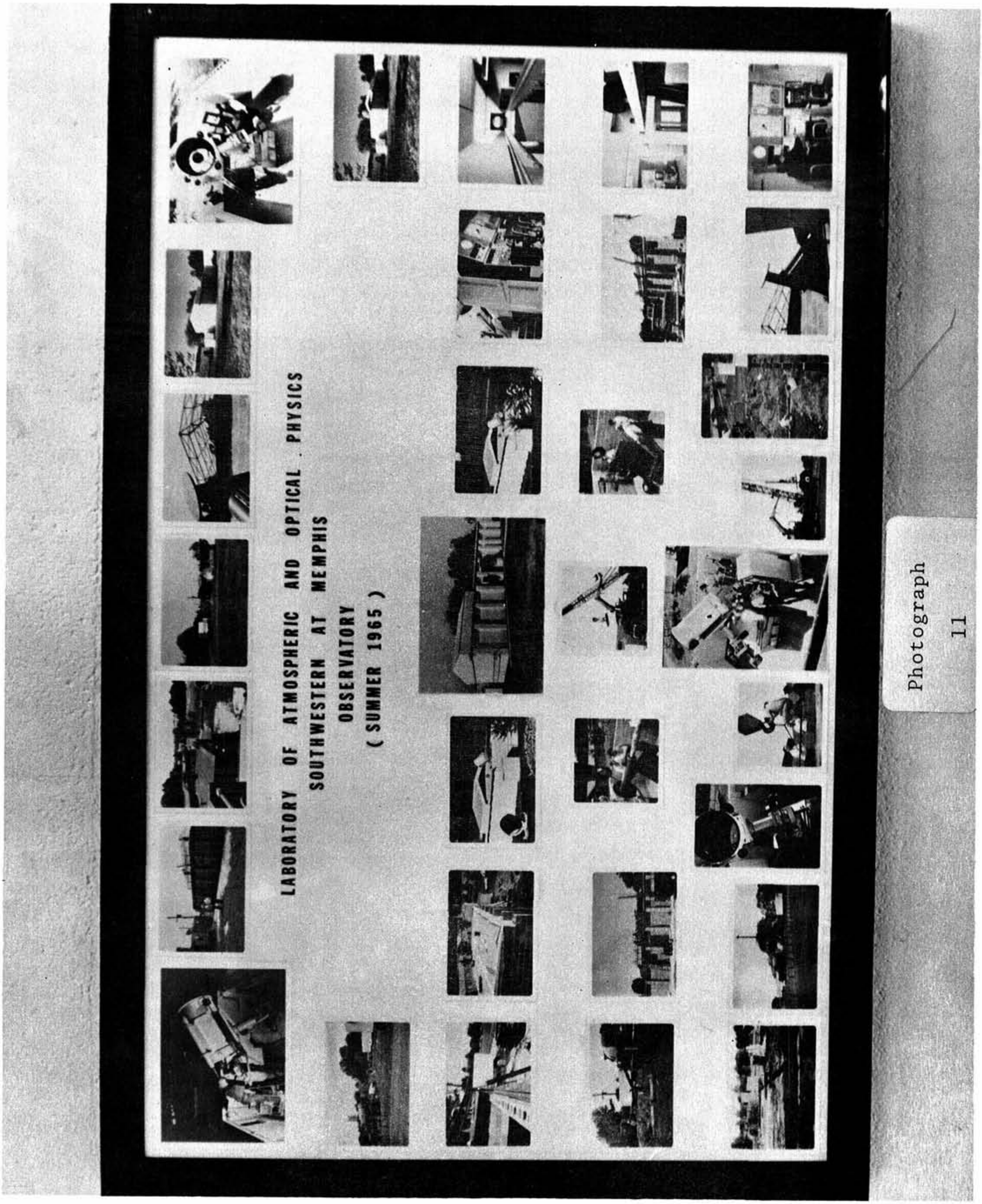
Photograph 9

Photograph 9 - Mural of the 1964 Conference on Undergraduate Research Programs in Optical Physics



Photograph 10

Photograph 10 - Mural of the Cape Kennedy project
(November 1964 - February 1966)



Photograph 11

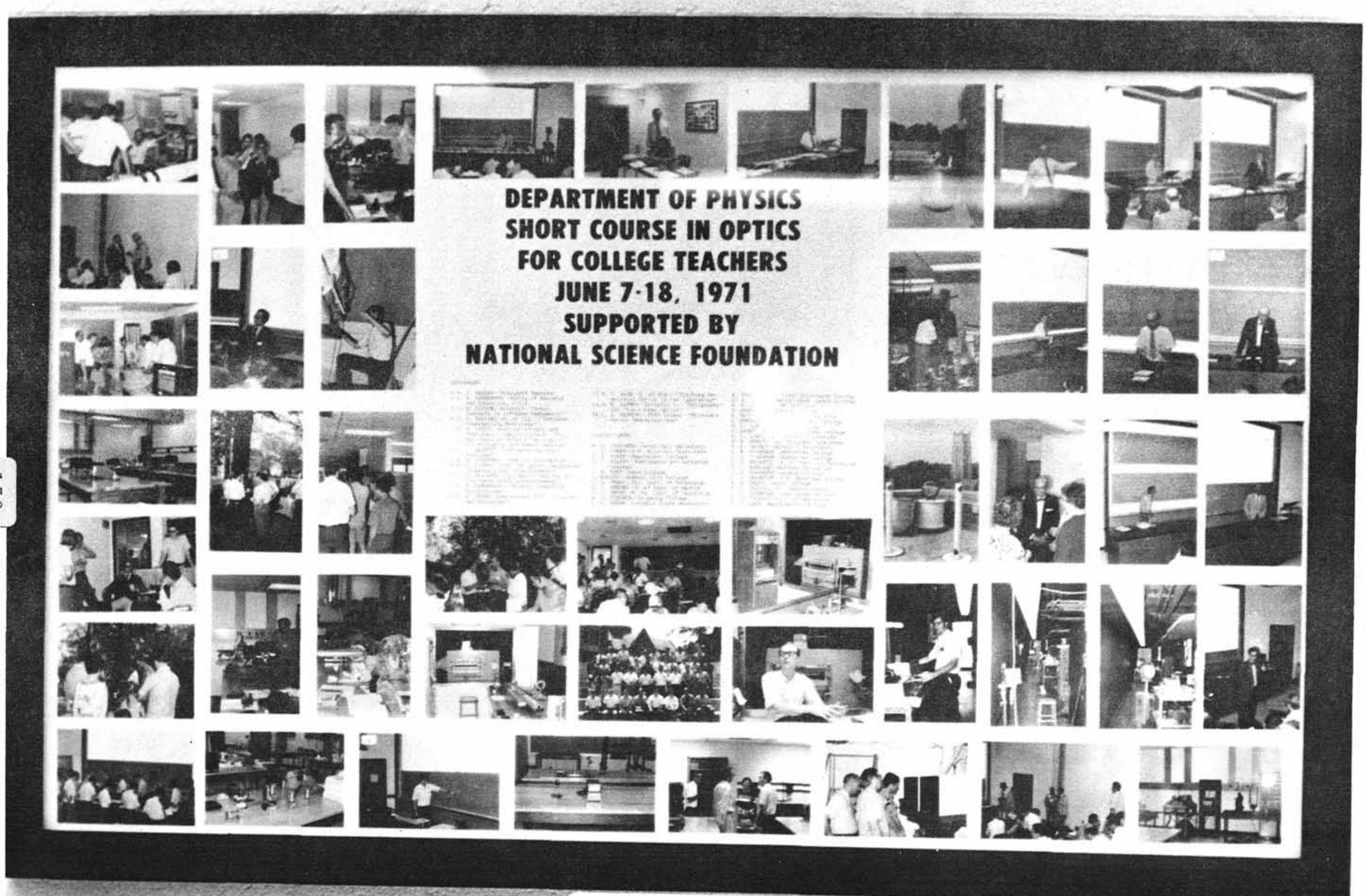
Photograph 11 - Mural of the Department's first Observatory
(Summer 1965)

Photograph 12

Photograph 12 - Mural of the construction of the Physics Tower (1966 - 1968)

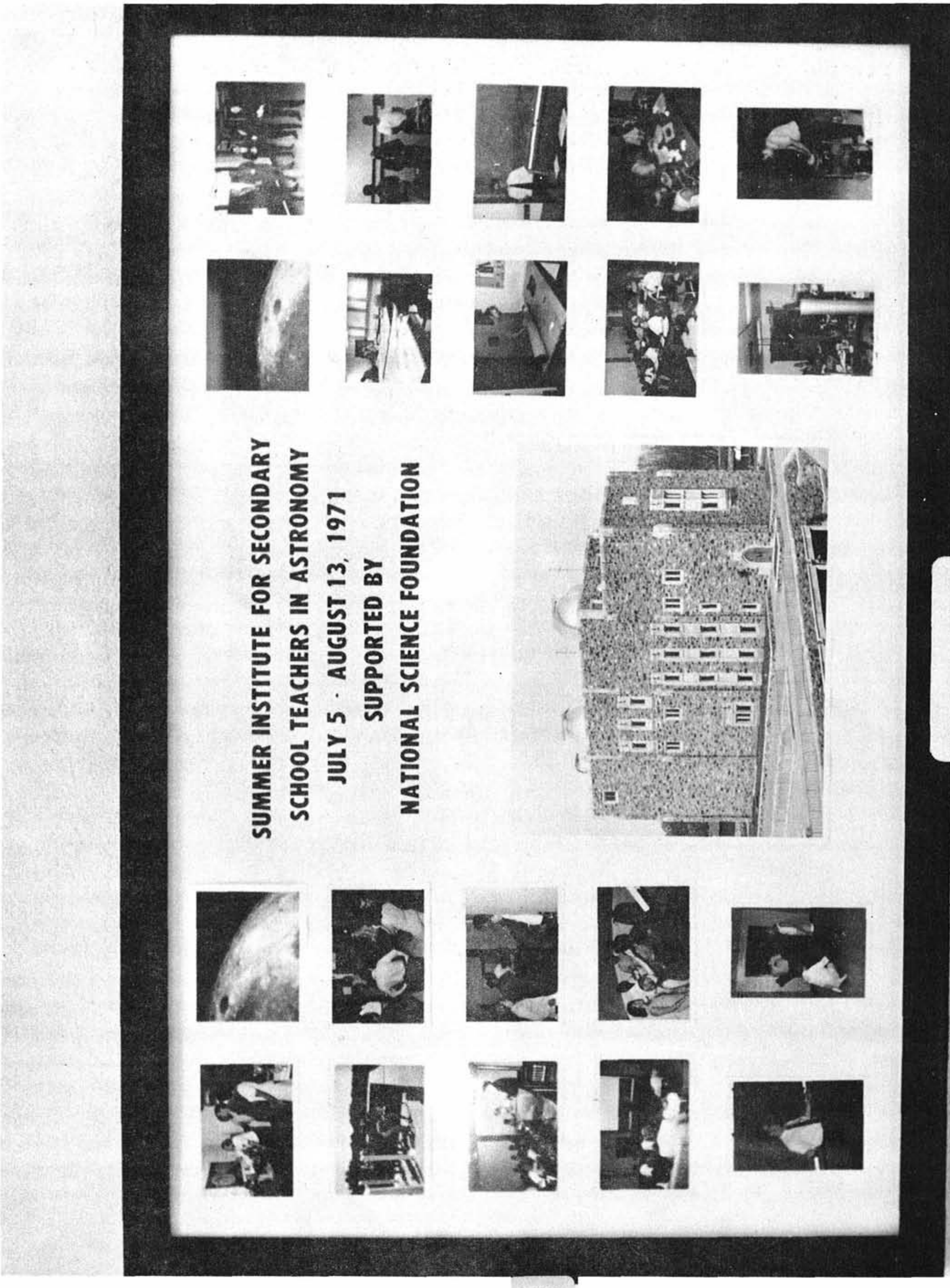
Photograph 13

Photograph 13 - Mural of the 1970 total solar eclipse expedition to Florida



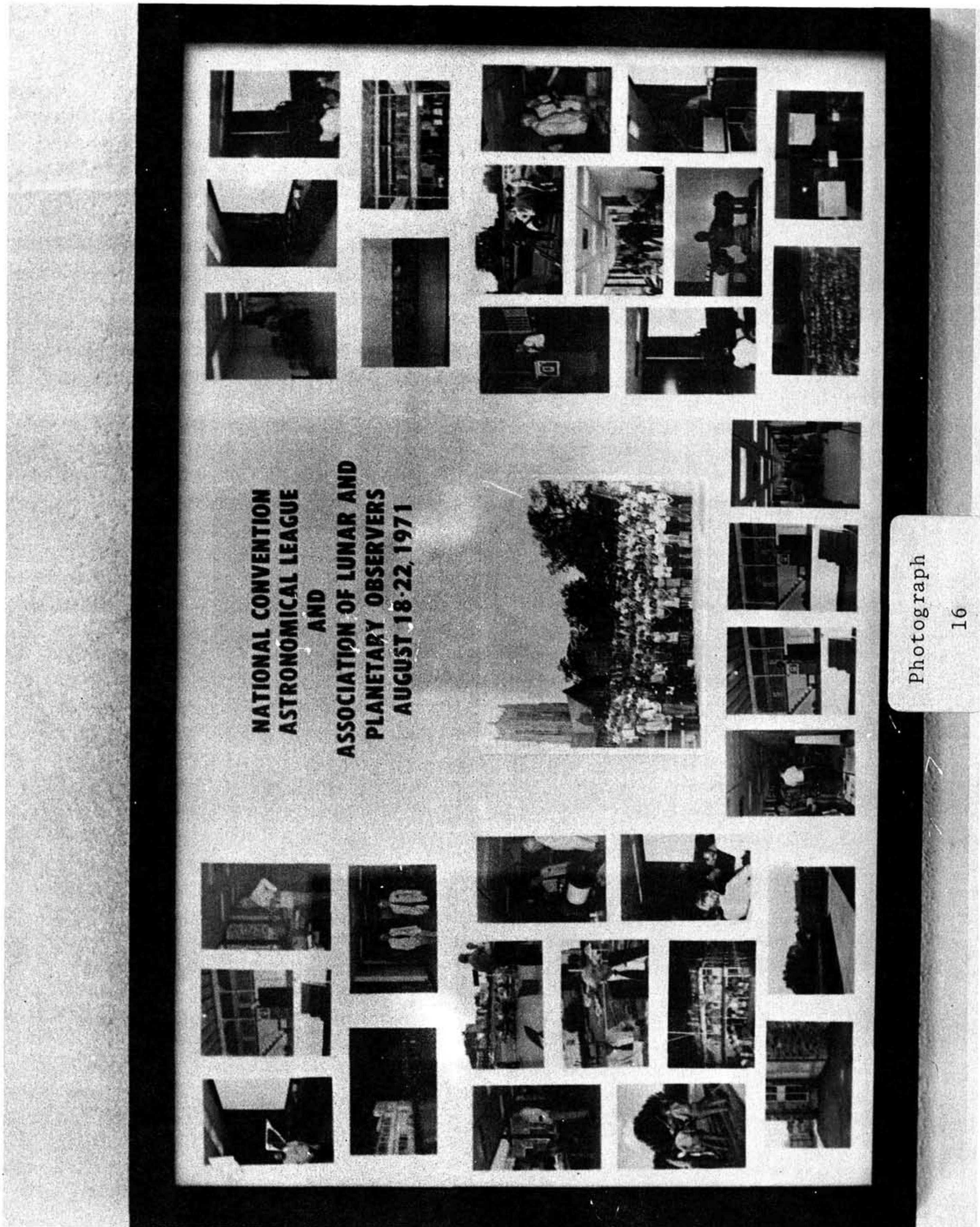
Photograph
14

Photograph 14 - Mural of Short Course in Optics for College Teachers - 1971



Photograph 15

Photograph 15 - Mural of Summer Institute for Secondary School Teachers in Astronomy - 1971

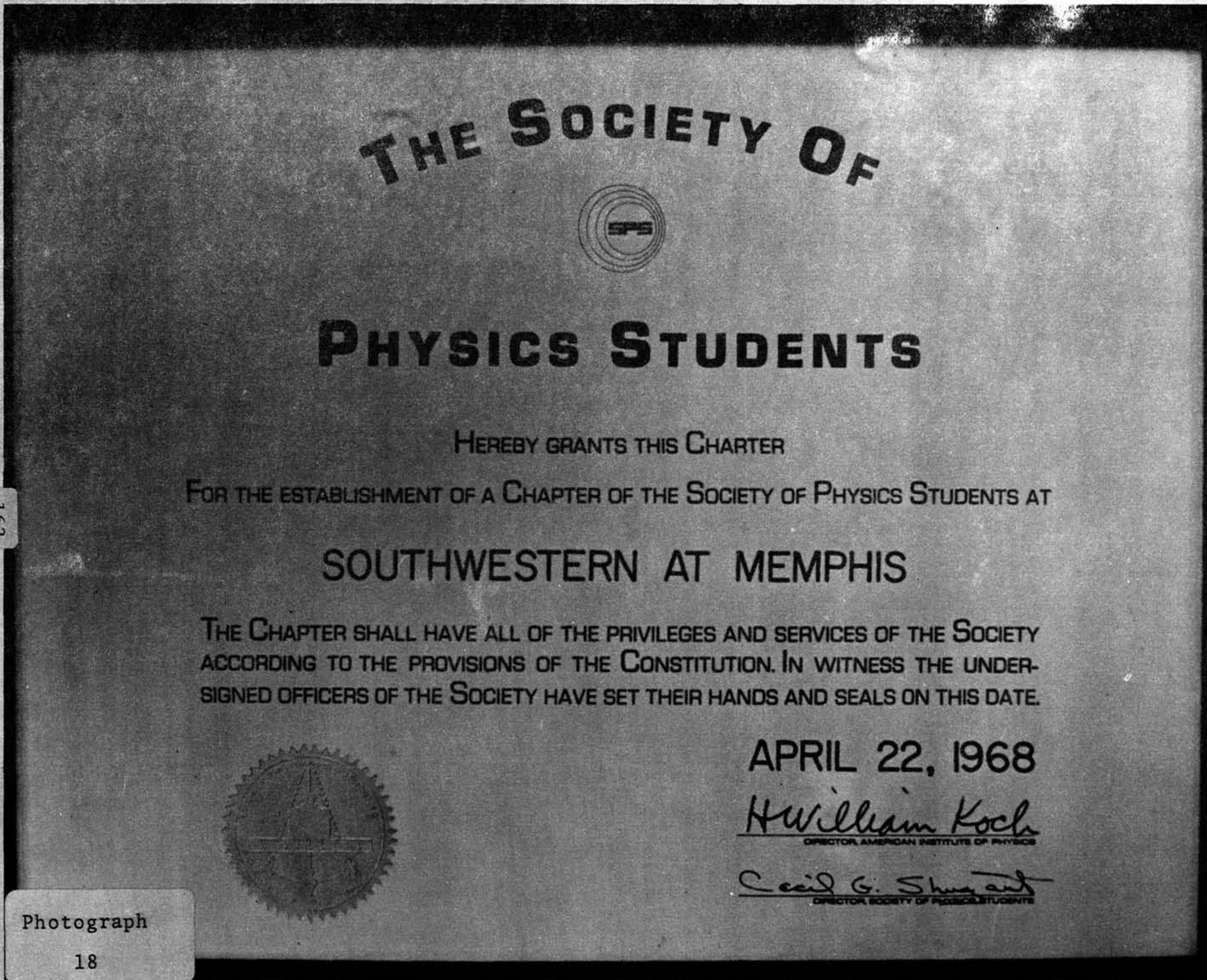


Photograph
16

Photograph 16 - Mural of National Convention of the Astronomical League and Association of Lunar and Planetary Observers - 1971

Photograph 17

Photograph 17 - President Rhodes receiving check for $25,000 from Dr. Alfred Kelleher and Dr. Marcy of Research Corporation to assist in the formation of the Laboratory of Atmospheric and Optical Physics



THE SOCIETY OF

PHYSICS STUDENTS

HEREBY GRANTS THIS CHARTER

FOR THE ESTABLISHMENT OF A CHAPTER OF THE SOCIETY OF PHYSICS STUDENTS AT

SOUTHWESTERN AT MEMPHIS

THE CHAPTER SHALL HAVE ALL OF THE PRIVILEGES AND SERVICES OF THE SOCIETY ACCORDING TO THE PROVISIONS OF THE CONSTITUTION. IN WITNESS THE UNDERSIGNED OFFICERS OF THE SOCIETY HAVE SET THEIR HANDS AND SEALS ON THIS DATE.

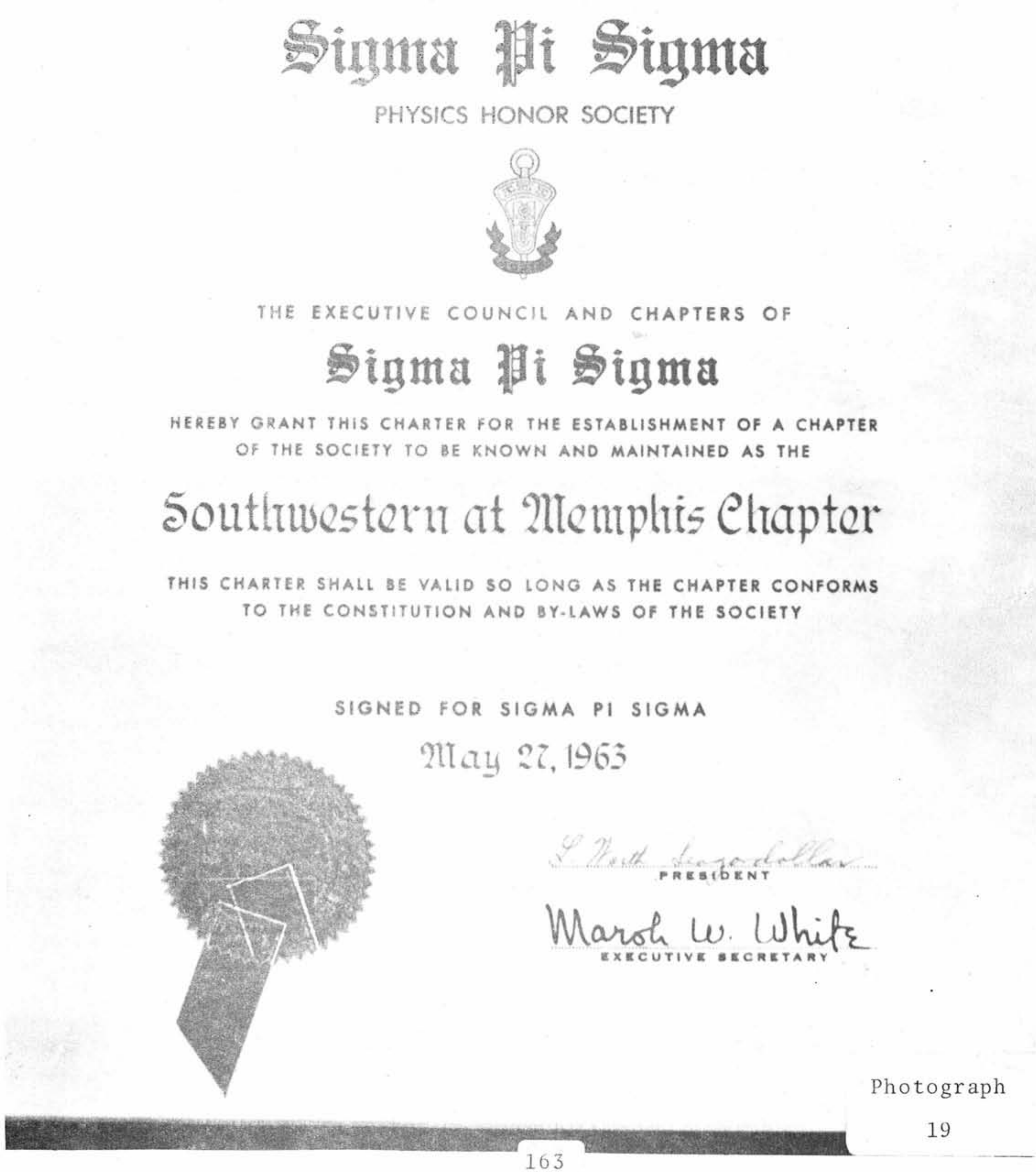
APRIL 22, 1968

H William Koch
DIRECTOR, AMERICAN INSTITUTE OF PHYSICS

Cecil G. Shugart
DIRECTOR, SOCIETY OF PHYSICS STUDENTS

Photograph 18

Photograph 18 - Plaque received by the Department at the installation of the Student Section of the American Institute of Physics



Sigma Pi Sigma

PHYSICS HONOR SOCIETY

THE EXECUTIVE COUNCIL AND CHAPTERS OF

Sigma Pi Sigma

HEREBY GRANT THIS CHARTER FOR THE ESTABLISHMENT OF A CHAPTER OF THE SOCIETY TO BE KNOWN AND MAINTAINED AS THE

Southwestern at Memphis Chapter

THIS CHARTER SHALL BE VALID SO LONG AS THE CHAPTER CONFORMS TO THE CONSTITUTION AND BY-LAWS OF THE SOCIETY

SIGNED FOR SIGMA PI SIGMA

May 27, 1963

L. Worth Seagondollar
PRESIDENT

Marsh W. White
EXECUTIVE SECRETARY

Photograph 19

Photograph 19 - Plaque received by the Department at the installation of the Southwestern Chapter of Sigma Pi Sigma

Photograph

20

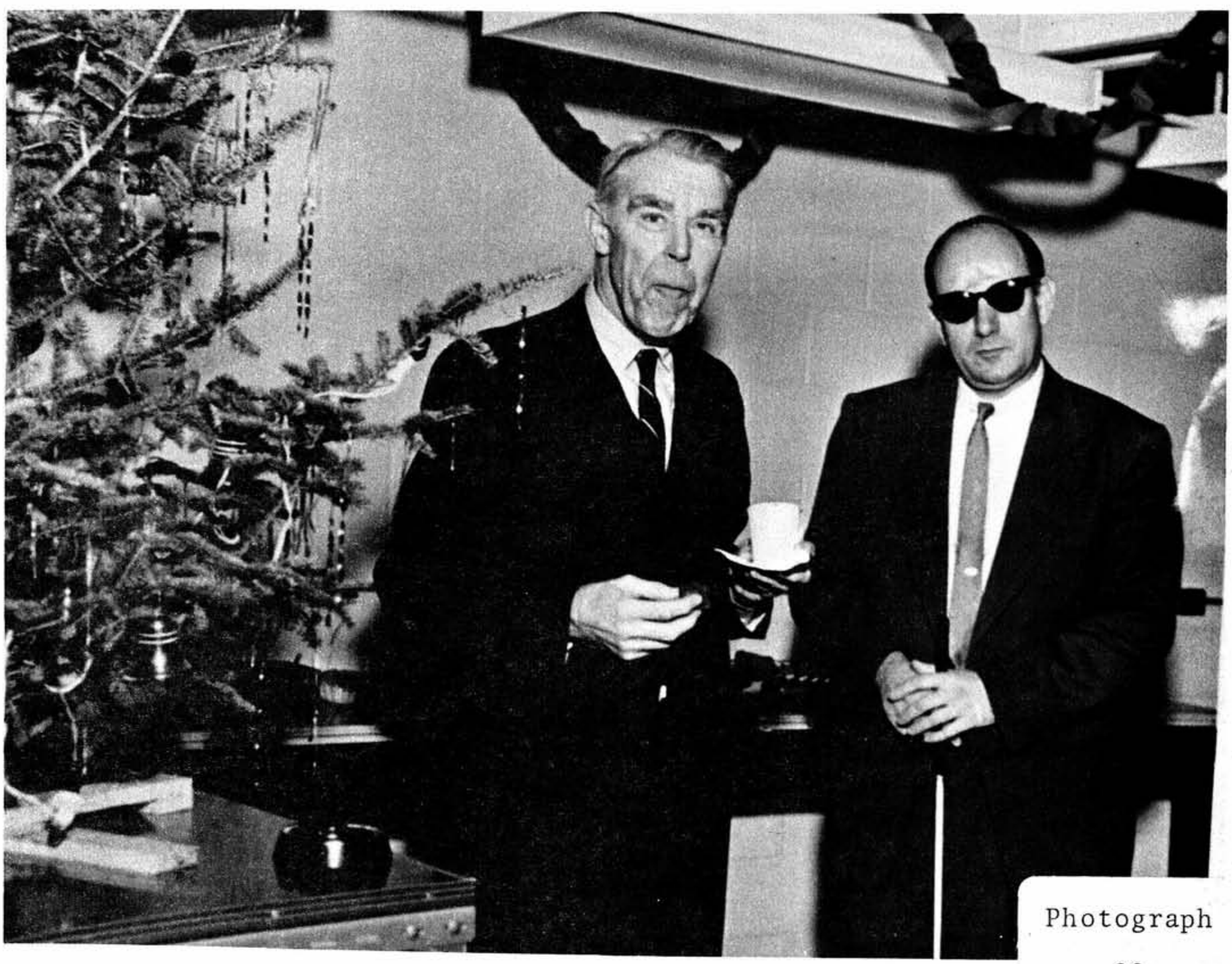
Photograph 20 - November 13, 1964 Meeting of the Southwestern Chapter of Sigma Pi Sigma

It was during this meeting that Dr. Walter Orr Roberts was taken into the Chapter. Reading left to right: Charles Brandon, Professor Hanson, Charles Robertson (President of the Chapter at that time), Professor Stauffer (Corresponding Secretary of the Chapter), Dr. Roberts, Professor Taylor and President Rhodes.

Photograph 21

Photograph 21 - A. C. Emery grinding a mirror in the Schulte Optics Shop

This photograph was made when the Department was housed in the old Science Building. The equipment for this Optics Shop was given us by Mr. George Schulte. Mr. Emery joined the Department in 1961. He is in charge of our Electronics Shop as well as the Optics Shop. Also, he is in charge of our Radio Sciences Laboratory, Station WA4-HTB.



Photograph

22

Photograph 22 - Physics Department Christmas Parties of 1964 and 1965 ,

Until the Department moved into the Physics Tower the annual Christmas party was certainly one of the social highlights. These photographs were taken in the basement of the old Science Building. One year we had purchased an oil can for the Machine Shop and before it had ever been used Mr. G. P. Ruffin suggested we break it in by using it as a cream dispenser for use with the coffee. It worked beautifully. Displayed on the wall are photographs of some of the graduates of the Department since 1956. In the photograph showing President Rhodes standing next to the Christmas tree, the gentleman on his left is Mr. Claude Bass, who played an important role in connection with our 1963 expedition to Alaska. Shortly after we moved into the Physics Tower Southwestern changed from the semester system to the three term system. Under this calendar system the first term is over by the time the students leave for the Christmas holidays and the week or so preceding the date college is out is completely taken up with examinations and with studying for exams. Under these adverse conditions we decided to dispense with the Christmas party tradition.

Photograph 23

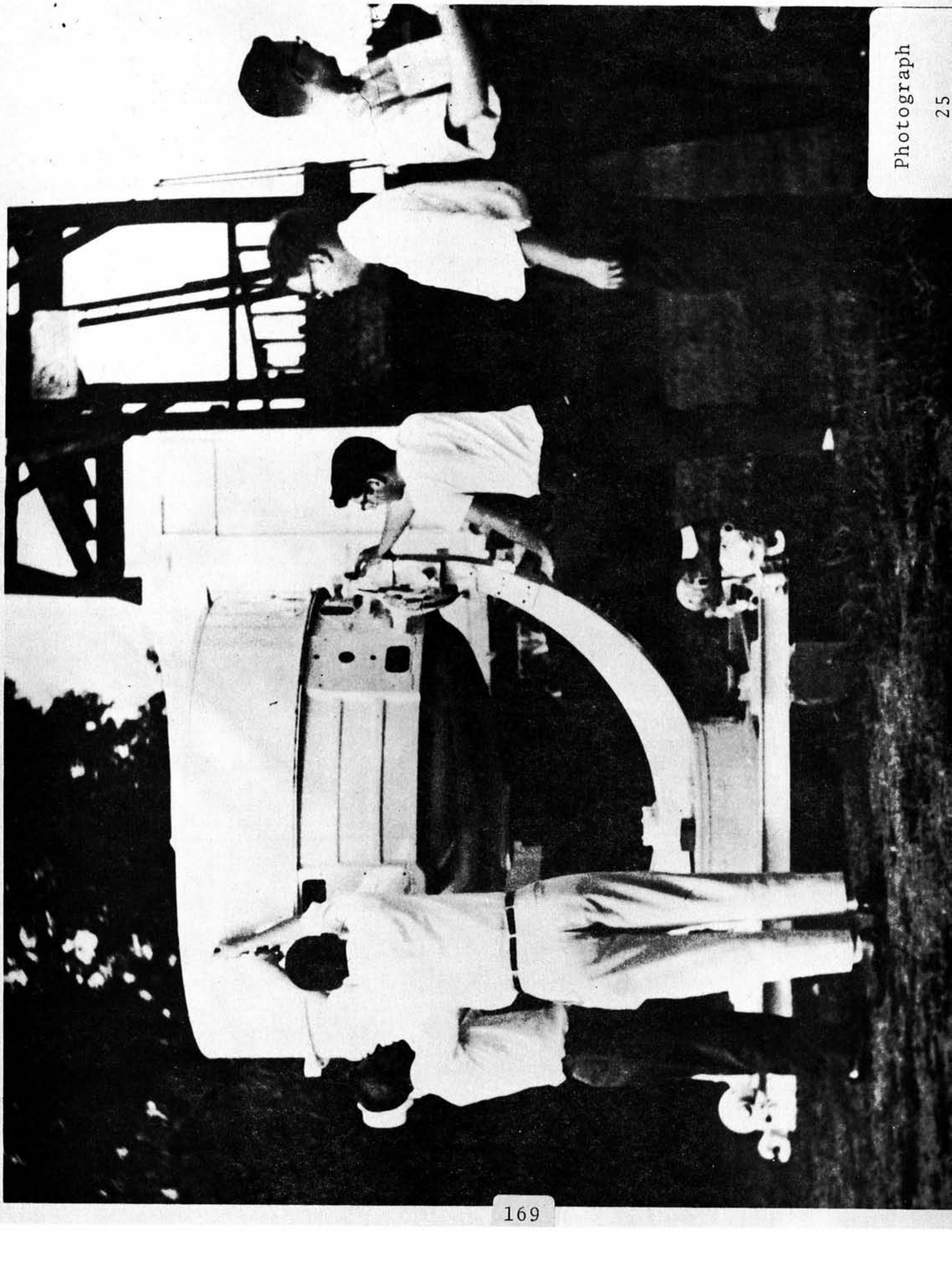
Photograph 23 - Chairman's Office in the old Science Building

This photograph was taken about 1964. To the right is J. H. Taylor and to the left is Viviene Guest, student secretary for the Department at that time. This office is one that had formerly been occupied by John A. Rollow '26 (Superintendent of Buildings and Grounds). The cane shown against the wall in the background was necessitated by a leg injury I received playing tennis.

Photograph 24

Photograph 24 - The Department's First Coelostat

This coelostat was built by Mr. G. P. Ruffin and was located about fifty feet to the east of the old Science Building. On the left is Bob MacQueen (now Dr. MacQueen and associated with the High Altitude Observatory) and on the right is Enloe Ritter (now Dr. Ritter and associated with the Atomic Energy Commision). They are shown directing solar radiation into the optics laboratory. In the background is the old football field (Fargason Field).



Photograph 25

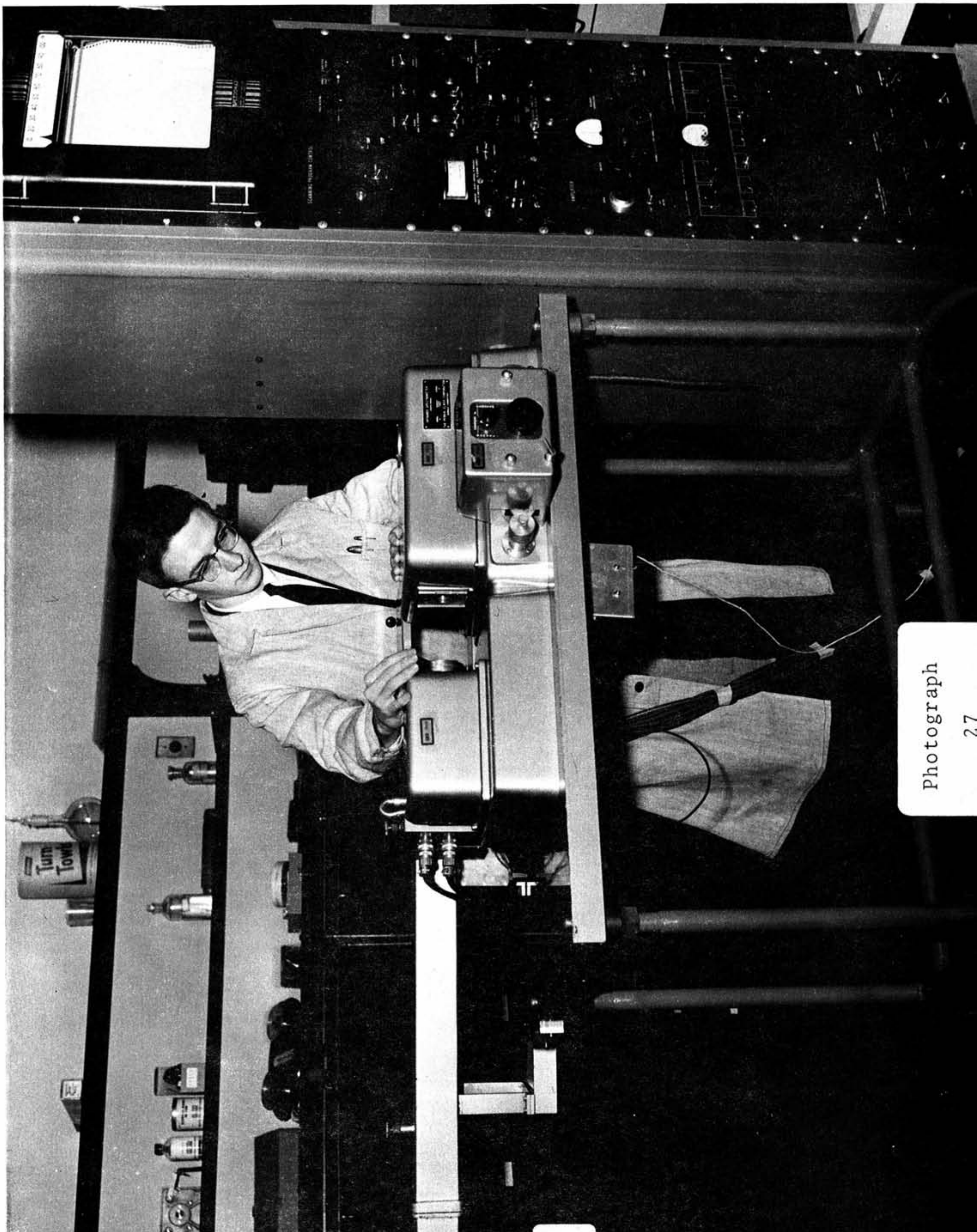
Photograph 25 - Getting students involved in planetary radiometry

Shortly before this photograph was taken the Air Force Cambridge Research Laboratories had sent us a 60 inch diameter antiaircraft searchlight mirror. We needed a housing for this mirror and Mr. Charles Oswald of Memphis kindly gave us the one shown in this photograph. In addition to using this large aperture mirror for planetary studies in the infrared it makes an excellent solar furnace and is used for that purpose from time to time. If pointed at the sun a piece of wood (say a 2 x 4) located in the focal plane will burst into flame rapidly. Reading left to right: G. P. Ruffin, Bob MacQueen, unidentified student, Professor Hanson and Charles Brandon.

Photograph 26

Photograph 26 - A fine looking group of youngsters

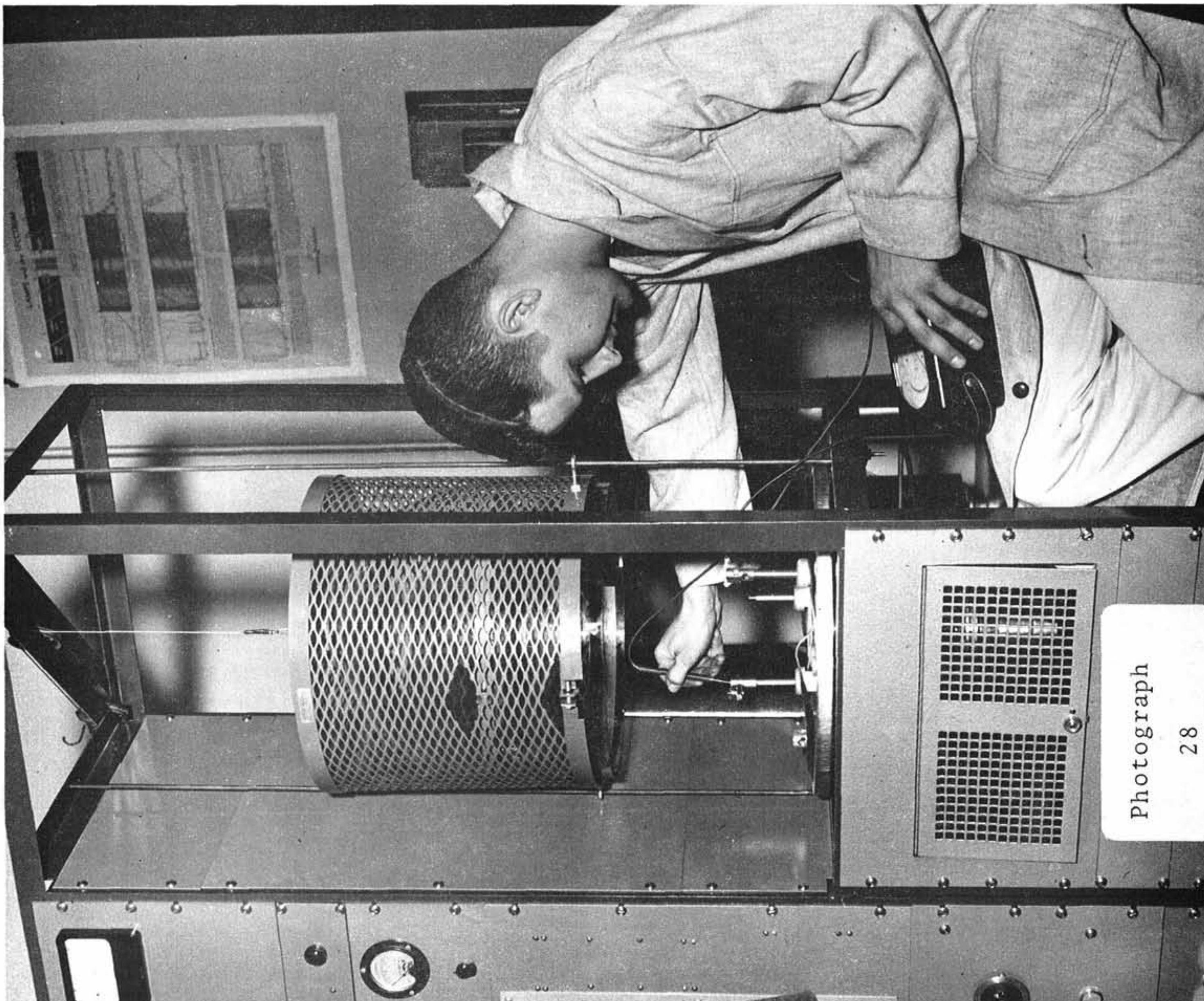
This photograph was taken in the old Science Building and shows some of our majors inspecting an infrared spectrometer that was being prepared for the 1963 expedition to Alaska. Reading left to right: Bill Boyd (now Dr. Boyd), Charles Robertson (now Dr. Robertson), Sally Hoffman (the only girl in the history of Southwestern as of this date to graduate with Honors in Physics), Charles Brandon and Jack Aldridge.



Photograph 27

Photograph 27 - Dr. J. L. Streete

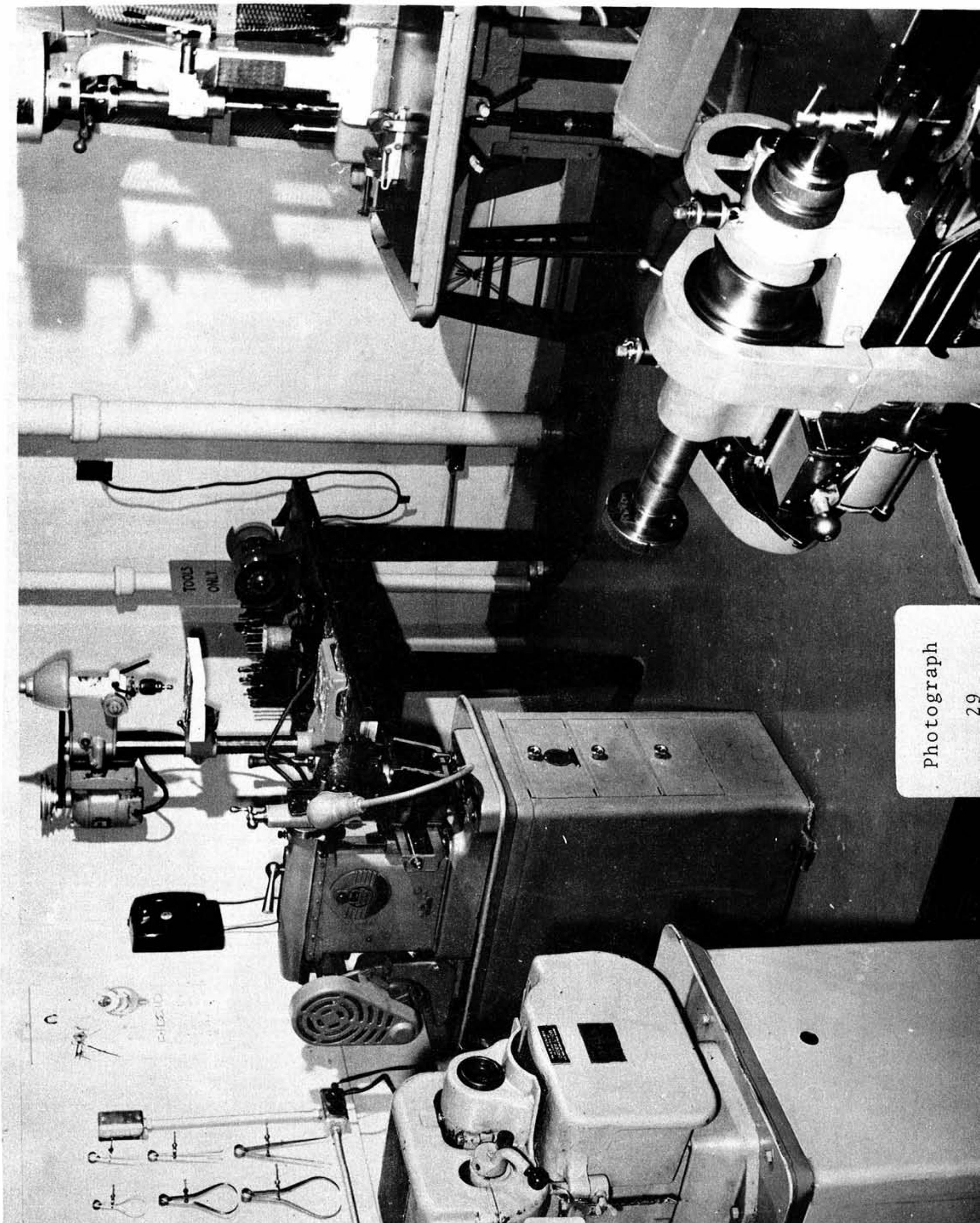
This photograph of Dr. Streete was taken during his student days at Southwestern. In this photograph, taken in the old Science Building, he is working with an infrared spectrometer.



Photograph 28

Photograph 28 - Thermal Evaporation Unit

This is the first thermal evaporation unit we had and it was built in the Department. One of the uses for such a piece of equipment is in coating mirrors. Shown using this system are Bill Hackleman (left) and Allen Barnhardt (now Professor Barnhardt).



Photograph 29

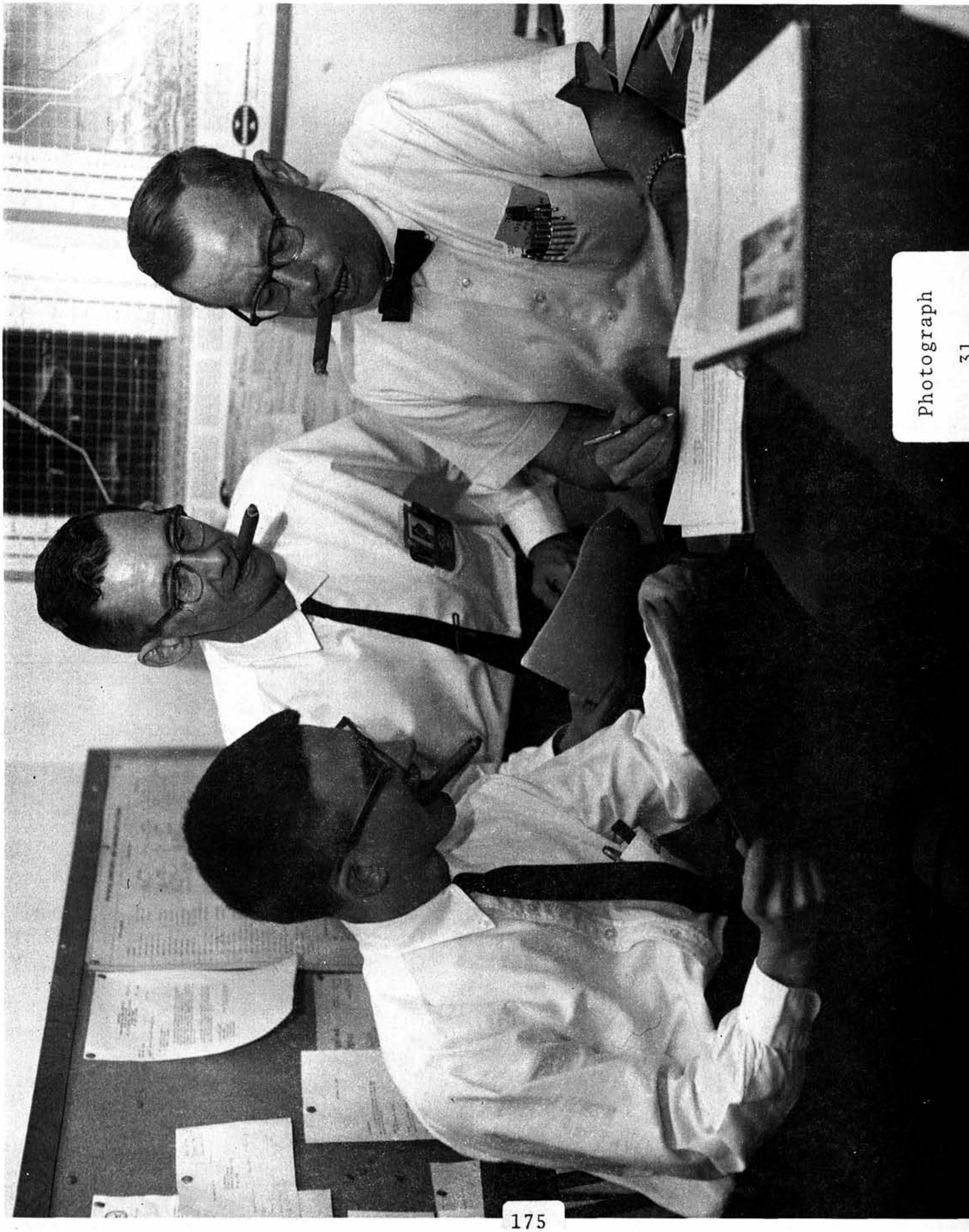
Photograph 29 - The Machine Shop in the basement of the old Science Building

This photograph shows part of the first Machine Shop. Later this Machine Shop was transferred across the hall into what had previously been John Rollow's wood shop used by Buildings and Grounds. The room shown in this photograph had been initially designed in 1925 for use in Biology. Across the end of the room not shown in this photograph was a large concrete tub (or aquarium). Needless to say, we had a large undertaking on our hands when be began to break out this concrete tub. After the tub was removed we repaired the damaged walls and floor and ended up with a room that was quite respectable.

Photograph 30

Photograph 30 - Mr. G. P. Ruffin

This photograph, taken in the old Science Building, shows Gardner Ruffin inspecting one of the pieces in a Fabry-Perot interferometer he built. Gardner was in charge of the Machine Shop until he was forced to resign in 1970 because of illness. He was the second person hired by President Rhodes after I joined the Department. His services are being sorely missed. After Gardner joined the Department he began offering a course in machine shop theory and practice for the students. This filled a very definite need and this type of instruction was continued by Bill Johnson and Ernie Goad.



Photograph 31

Photograph 31 - Three Cigars

For this occasion we broke out the cigars. It pictures the signing of the contract with the Electro-Optics Group at Cape Kennedy on November 25, 1964. Under the terms of this contract the Laboratory of Atmospheric and Optical Physics designed and constructed an atmospheric transmission measuring and monitoring system. Reading left to right: J. L. Streete, F. R. Stauffer (Associate Director of L.A.O.P.) and J. H. Taylor (Director of L.A.O.P.). This photograph was taken in my office in the old Science Building.

Photograph
32

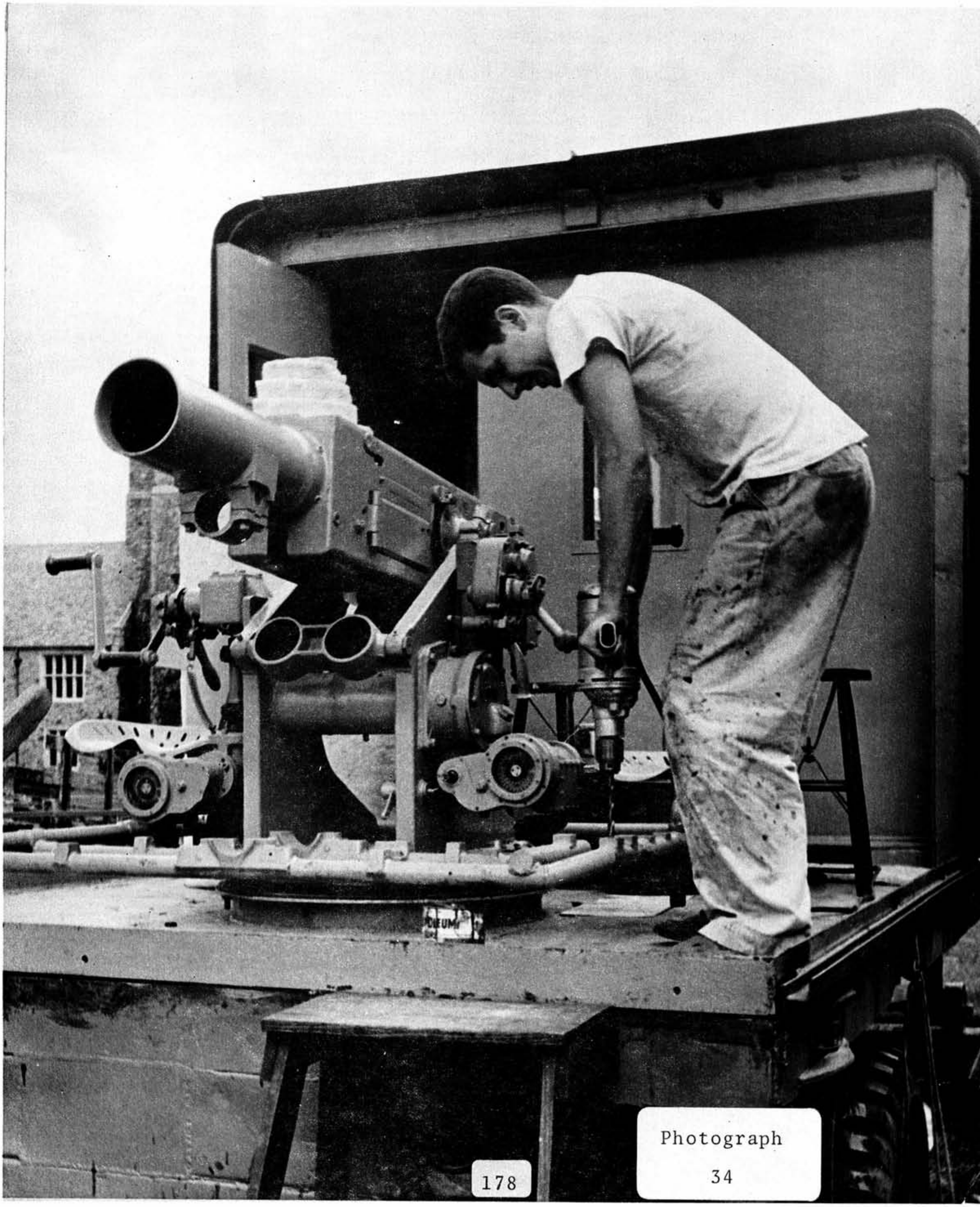
Photograph 32 - Off to Climax, Colorado

This photograph shows one of our trailers loaded with equipment. We are on our way to Climax to be the first scientific group invited to use the then recently completed 16 inch diameter coronagraph built by the High Altitude Observatory. We made near infrared measurements on the solar corona. This photograph was taken in December, 1962. In the background is the north side of the old Science Building. Reading left to right: Driver for Carl Carson Company, Inc., Bob MacQueen (now Dr. MacQueen and a member of the staff of the High Altitude Observatory, Boulder, Colorado) and J. H. Taylor. Mr. A. C. Emery, not shown in the photograph, also accompanied us on this expedition.

Photograph 33

Photograph 33 - Flatbed Trailer

This trailer was obtained in 1960 from our state outlet for government surplus property. My recollection is that the cost was $100. It is shown here located between the west side of the old Science Building and the Refectory. It was left in this location for several months while we built on it a Mobile Infrared Observatory. At this time we were desperately trying to get ready for Project Firefly. 80 hour work weeks plus generous help from the students "for free" enabled us to meet the deadline. I shall never forget an incident that happened while we were building this observatory. It was during the winter about 5 P.M. one day. I had been working on it (in particular, the central section) for several hours when one of our majors, Fred Bertrand (now Dr. Bertrand and associated with the Oak Ridge National Laboratory), came out of the old Science Building on his way to his dormitory. He stopped by to see if he could assist me in any way. I immediately accepted his kind offer and told him what I needed to do next. The task involved was one of climbing up a ladder to get on top of the central section in order to secure some vertical studding in the walls. While Fred was on top of the observatory I leaned over to pick up a hammer from the floor. About this time Fred accidentally hit a piece of 2 x 4 (about three feet long) that was lying on top of the observatory and it fell, striking me on the head. As is the case usually with head wounds, there was profuse bleeding. The blow stunned me and as I tried to straighten up I passed out but recovered almost immediately. My first reaction was to grab my head which I did only to find it completely covered with blood and it was also running down my face. You can imagine what this did to Fred. He immediately helped me get to the Infirmary (located about 300 feet away). The protuberance on my head made me look more disreputable than normal and I was unable to comb my hair for days. I overcame this difficulty by wearing my cap to lectures until I became more presentable.

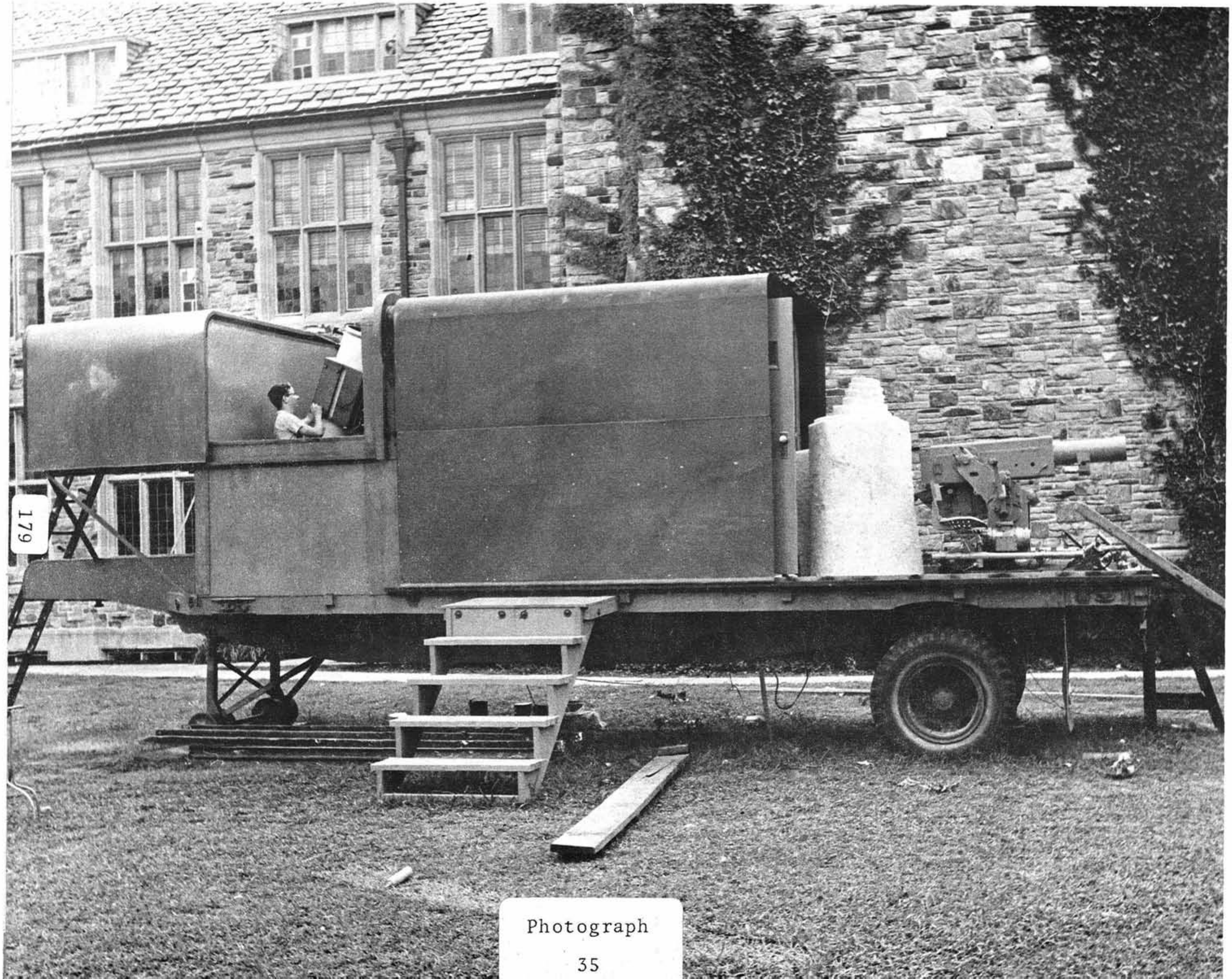


Photograph

34

Photograph 34 - Theoretical Physics !!

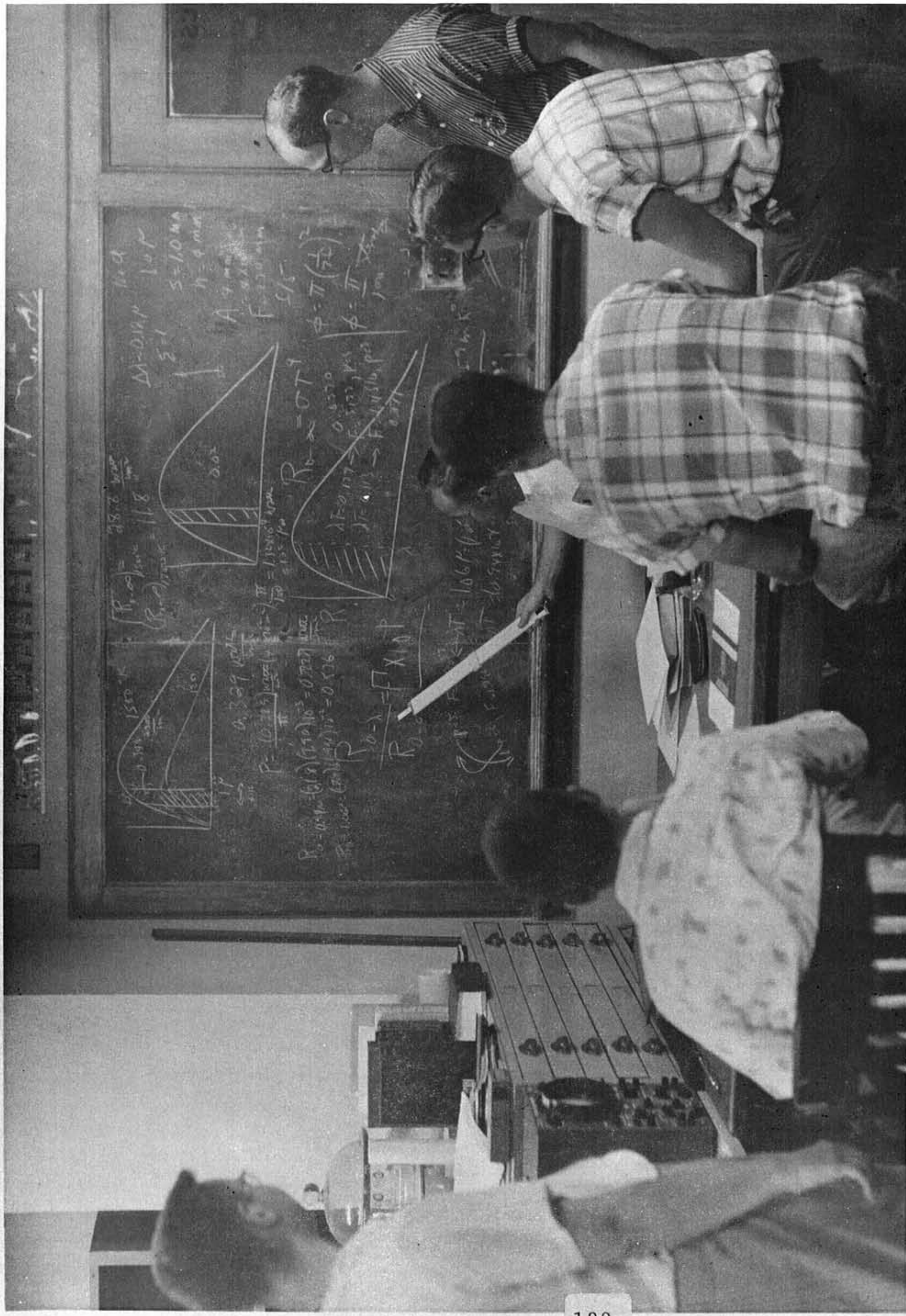
Photograph showing Joe Ajello (now Dr. Ajello) working on the Mobile Infrared Observatory. In this photograph the Observatory is located east of the old Science Building and Joe is working on the 40 mm antiaircraft gun mount we used to support and point the 31 inch diameter telescope (which in this case was used as a radiometer). Joe obtained his Ph.D. in astrogeophysics from the University of Colorado.



Photograph 35

Photograph 35 - Mobile Infrared Observatory Nears Completion

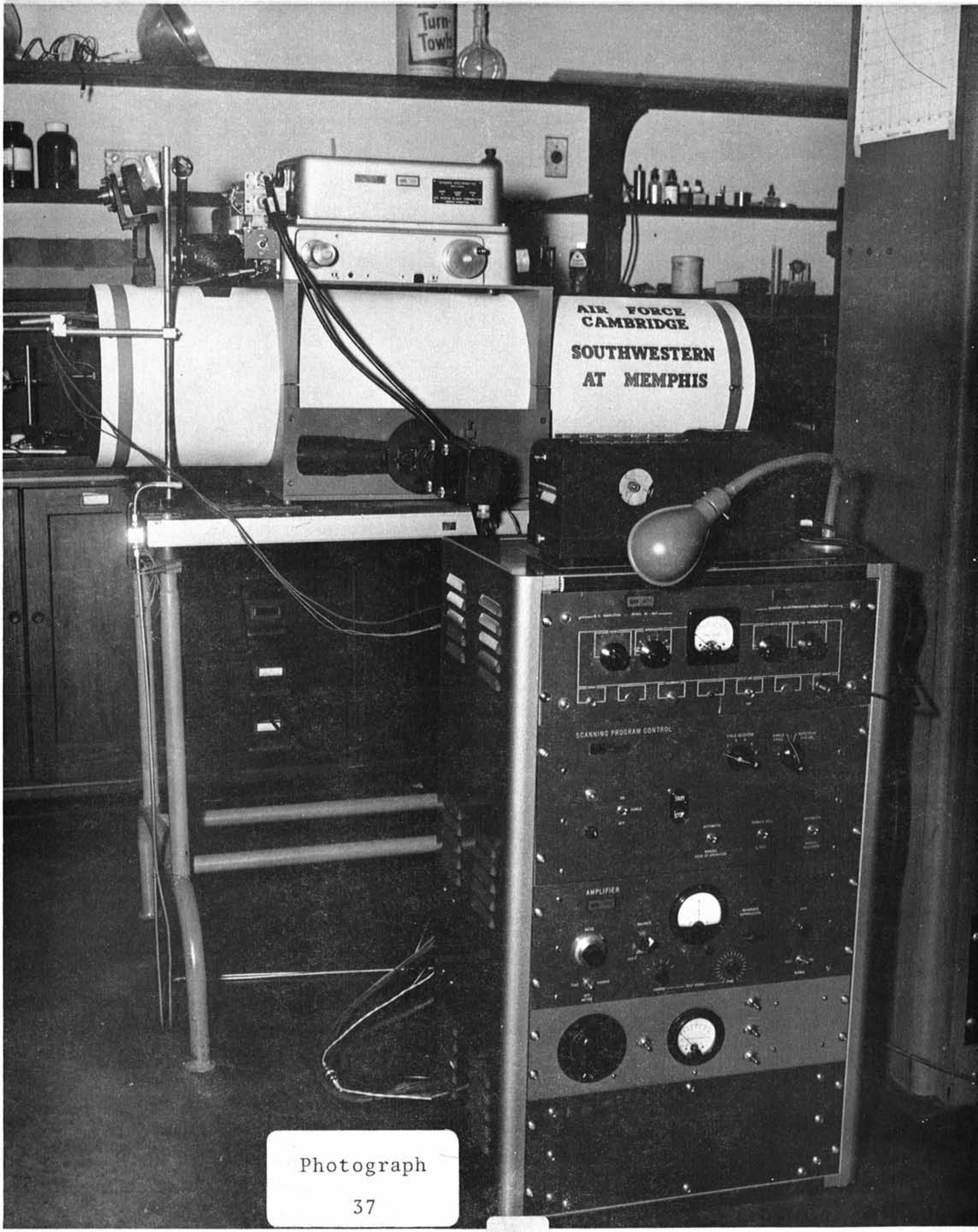
In this photograph of the Mobile Infrared Observatory made from the east side of the old Science Building Bill Mankin (now Dr. Mankin and a member of the staff at the High Altitude Observatory, Boulder, Colorado) is shown installing a 10 inch diameter reflecting telescope of the Newtonian type that was used to feed an infrared spectrometer mounted on the telescope. The infrared spectrometer cannot be seen in this photograph. This photograph was made a few months before our expedition left for Project Firefly. In early 1963 we extended the length of the Mobile Infrared Observatory about 8 feet to the left over the section that can be seen touching the ladder.



Photograph 36

Photograph 36 - A Discussion on Radiometry

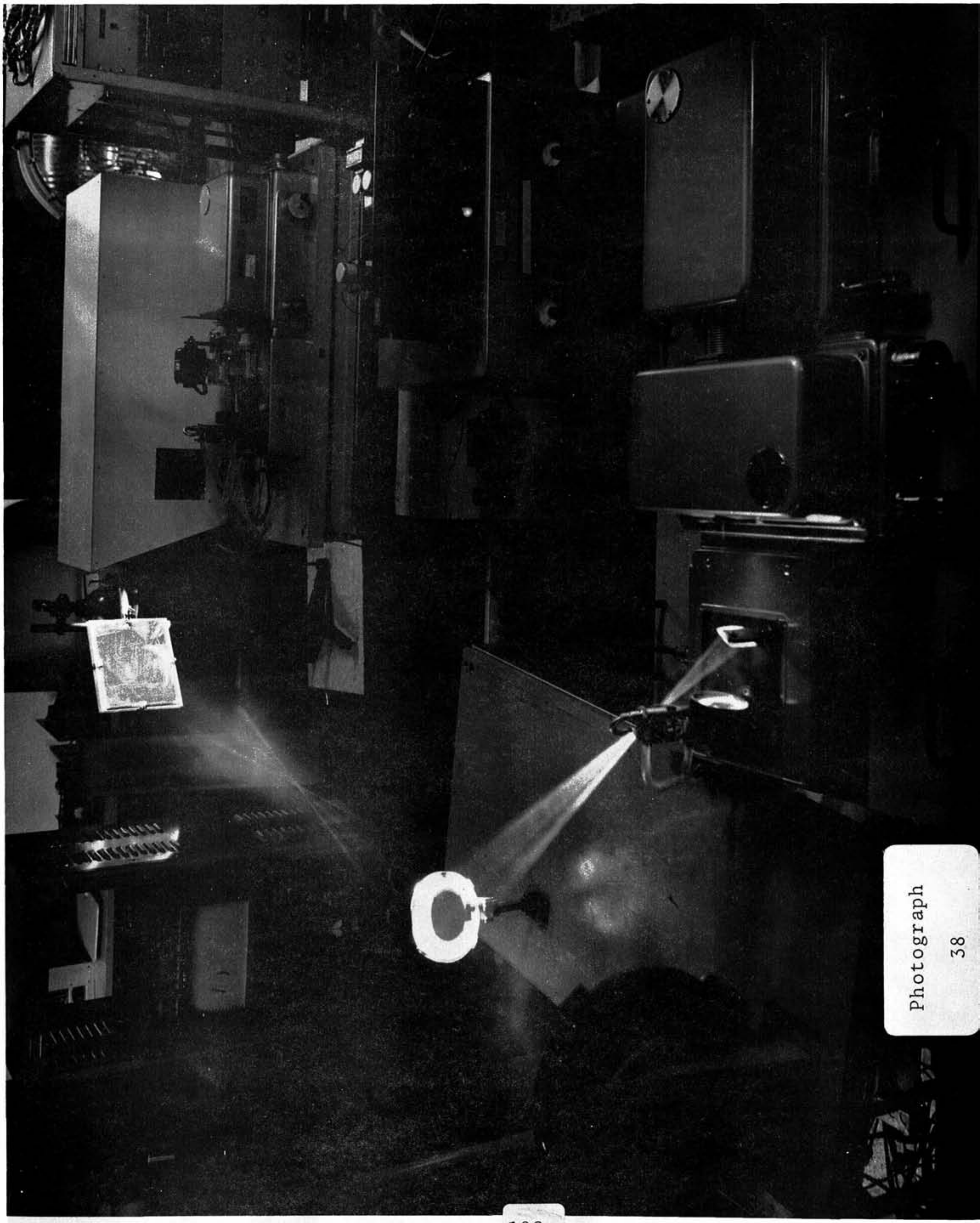
This photograph was taken in the old Science Building about 1959 or 1960. Reading left to right: Bill Raine (obtained a Master's degree in astronomy from Harvard), Bob MacQueen (now Dr. MacQueen), Professor J. H. Taylor, Enloe Ritter (now Dr. Ritter), Harry Swinney (now Dr. Swinney and a member of the physics staff at New York University) and Professor J. J. Freymuth.



Photograph 37

Photograph 37 - A Real Workhorse

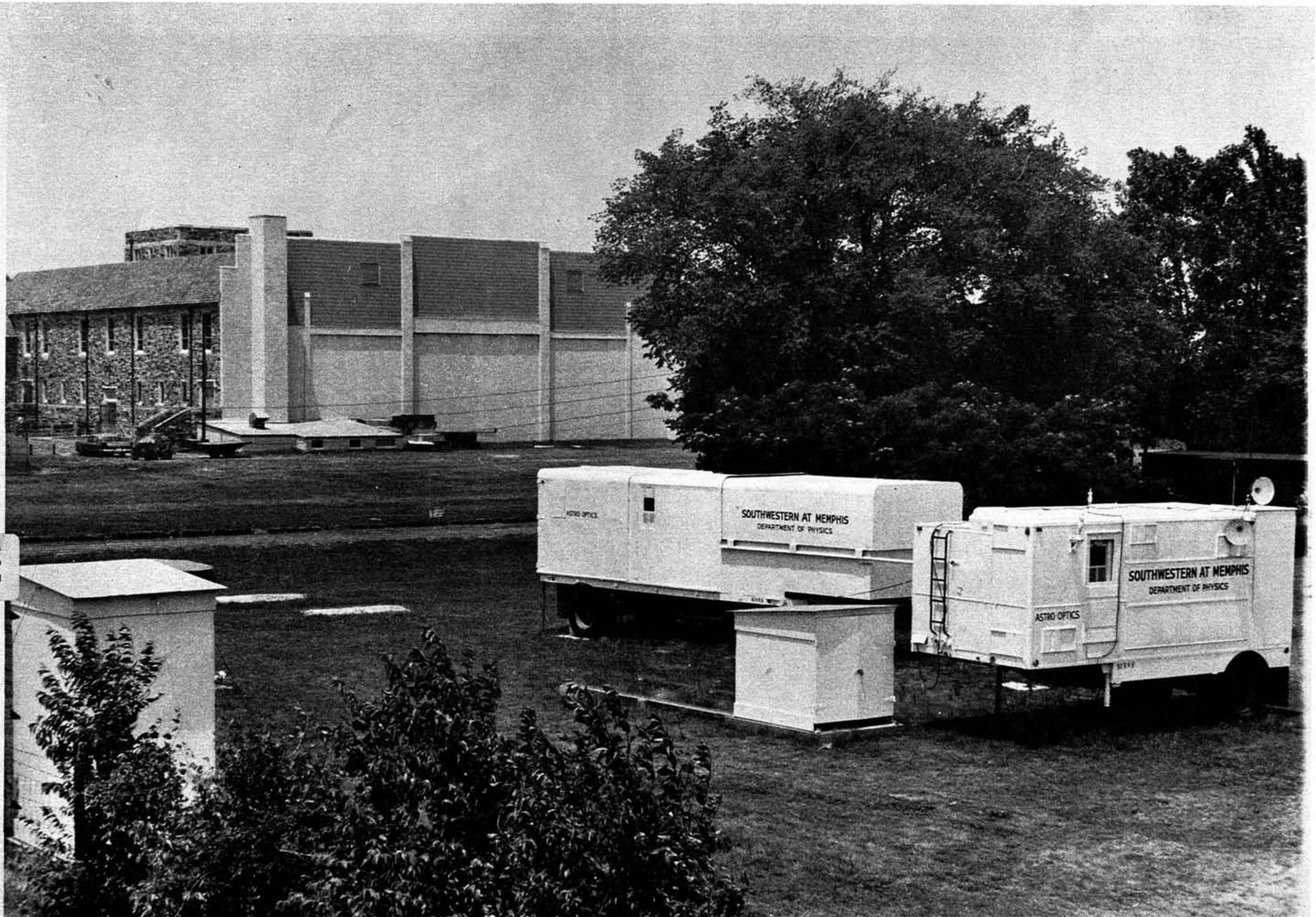
This photograph shows the "Hasty Scan" infrared spectrometer sent us by the Air Force Cambridge Research Laboratories in connection with our first contract. In this photograph the spectrometer is shown mounted "piggy back" on a reflecting telescope (10 inch diameter) of the Newtonian type in preparation for our first total solar eclipse expedition to the Canary Islands (Island of Fuerteventura) in 1959. This spectrometer has been on many expeditions and we were sorry when we finally had to relinquish it in 1968.



Photograph 38

Photograph 38 - Apparatus used by students to obtain high resolution studies of atmospheric absorption

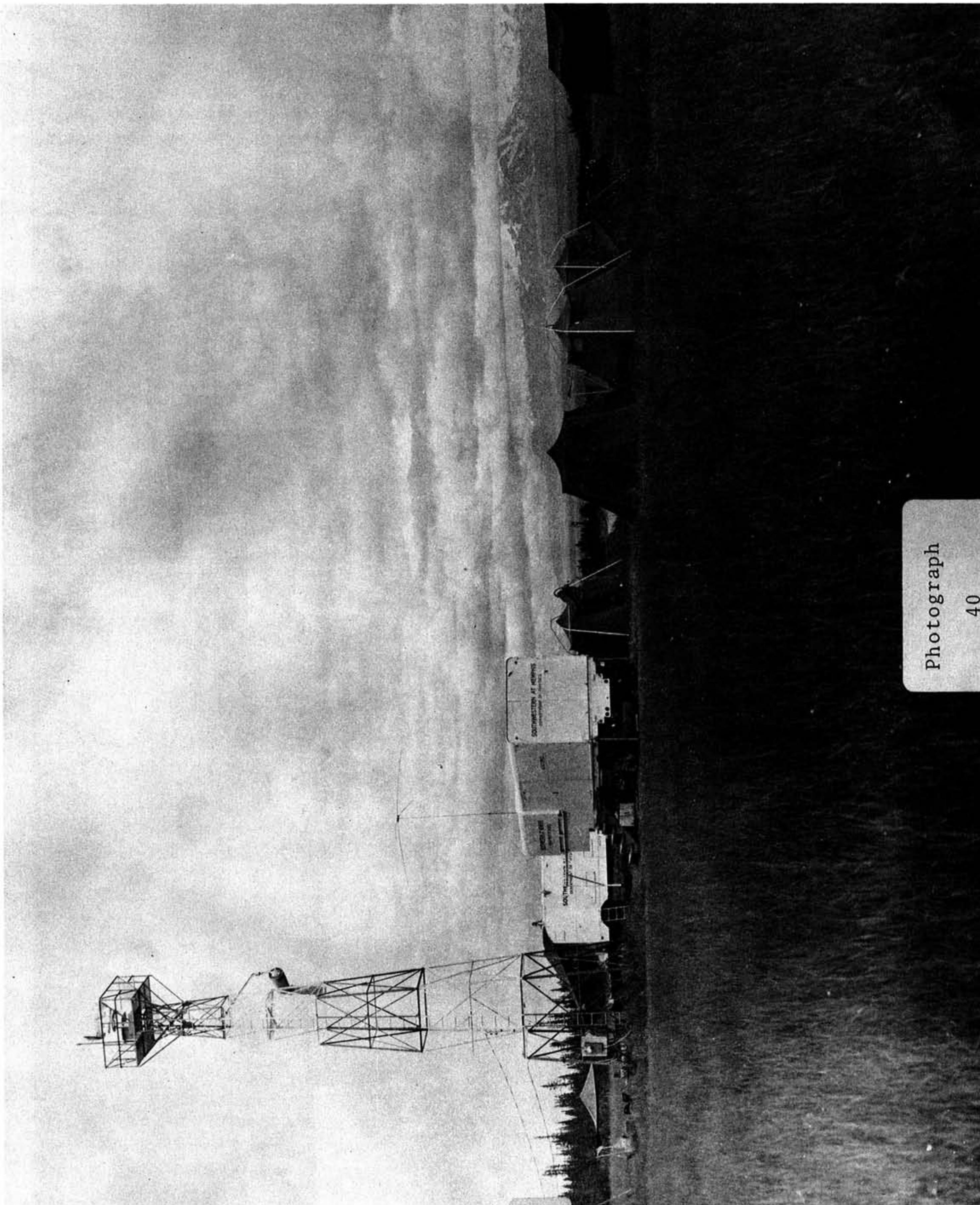
This photograph was taken in the old Science Building. Radiation from the sun is being directed into the laboratory by means of a coelostat.



Photograph 39

Photograph 39 - Preparing for the 1963 Expedition to Alaska

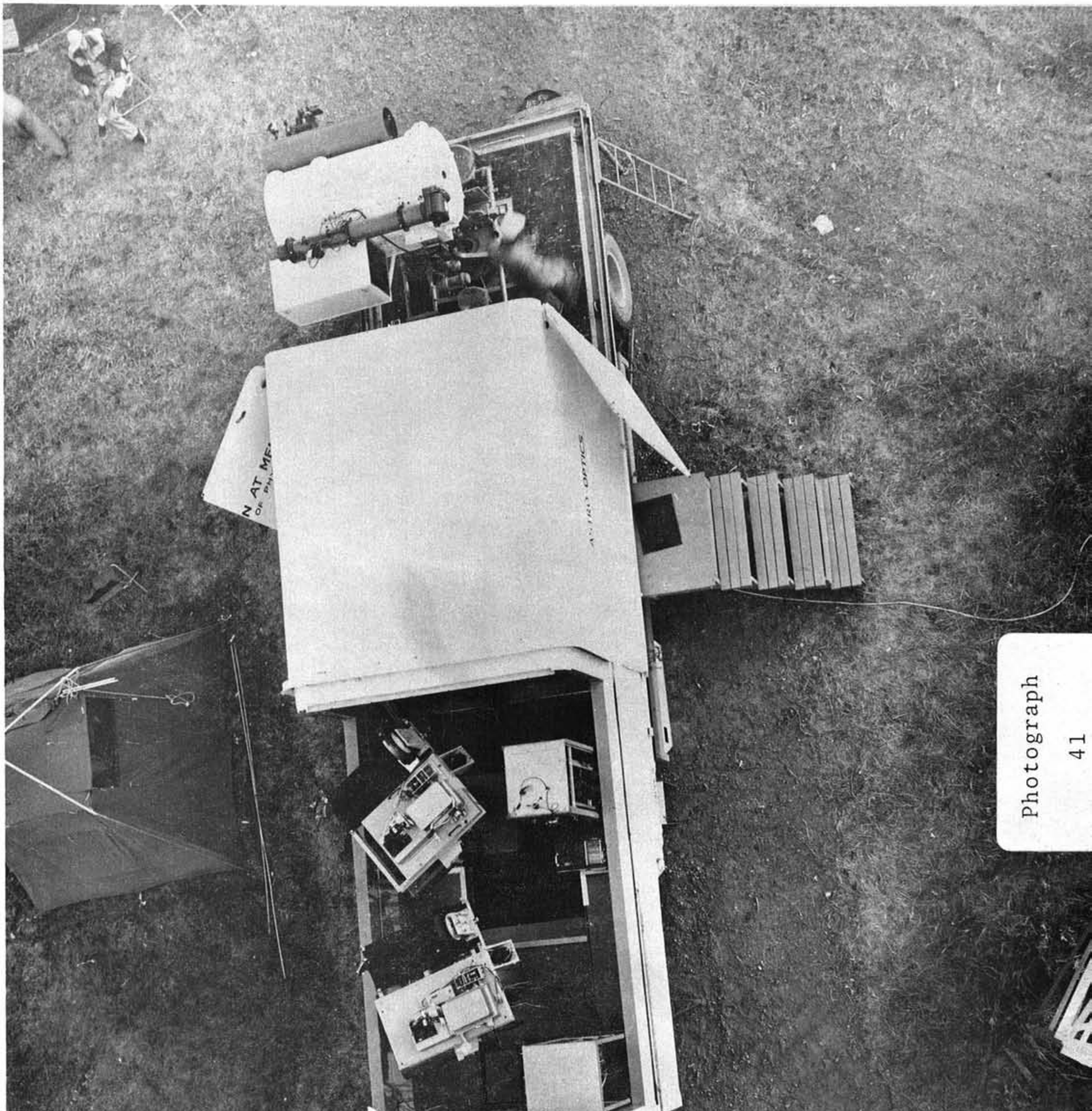
The two small white houses provide covers for the coelostat primary and secondary mirrors. Off to the right and not shown in the photograph is the Department's first Observatory. The long trailer to the left is the Mobile Infrared Observatory. We had the equipment located in this arrangement so we could make daily runs on the sun in preparation for the eclipse. The building off to the far left is the Mallory Gymnasium.



Photograph 40

Photograph 40 - The Campsite located at the Federal Aviation Agency Airstrip at Gulkana, Alaska

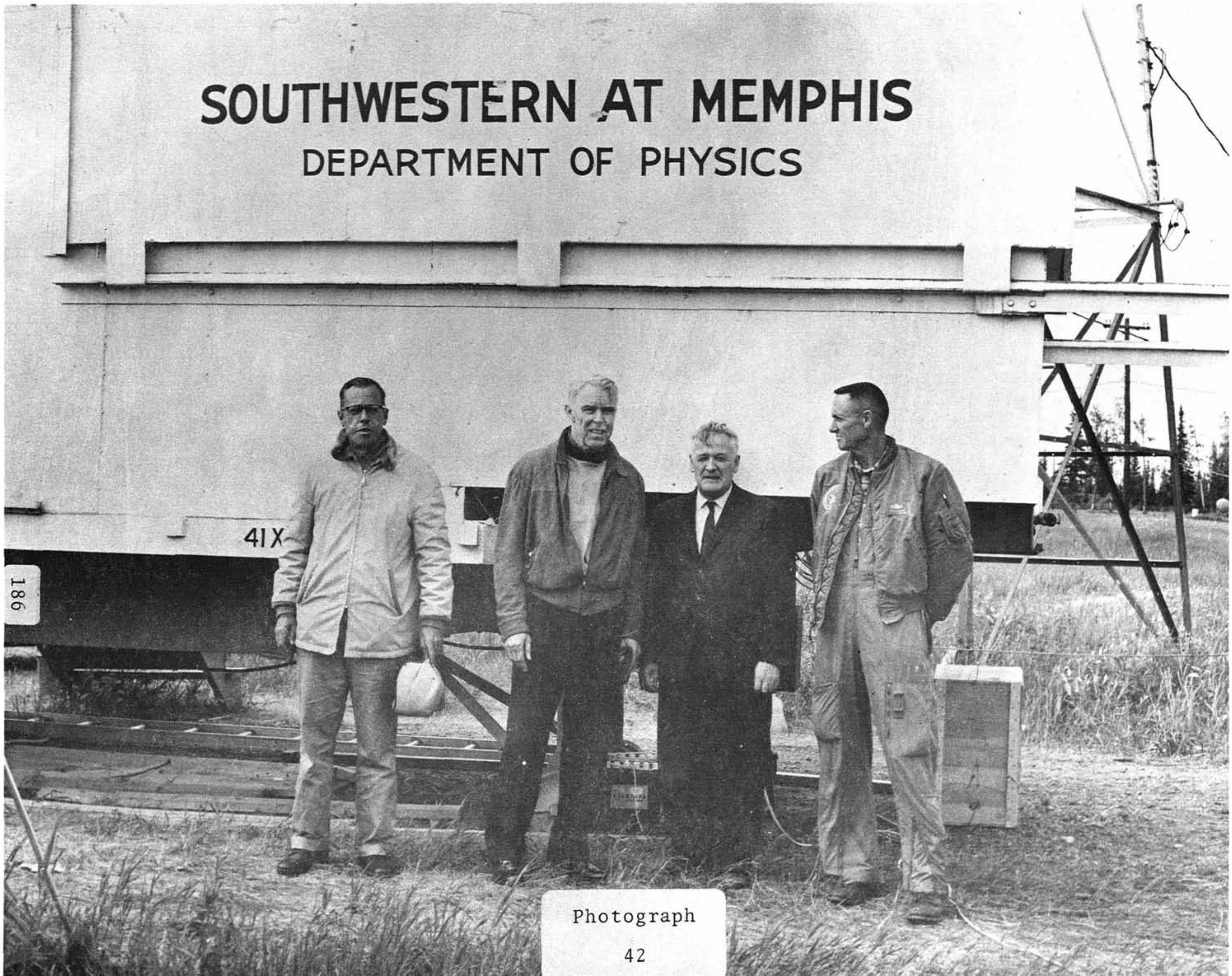
The expedition lived in the tents about a month before totality. The eating area is shown on the left under the canvas extending off the white trailer on the left



Photograph 41

Photograph 41 - Mobile Infrared Observatory in the Open Position

This photograph was taken from the Federal Aviation Agency tower at Gulkana. The infrared spectrometers are mounted on Mark 51 gun directors on the left end of the Observatory and the infrared radiometers are mounted on a 40 mm antiaircraft gun mount on the right end of the Observatory. The central section of the Observatory houses the electronics control center.



Photograph 42

Photograph 42 - Visit From The Governor of Alaska

Governor Bill Eagan dropped by to wish the Southwestern expedition clear skies and to pay a social call. Reading left to right: J. H. Taylor, President Rhodes, Governor Bill Eagan, Governor Eagan's personal pilot.

Photograph 43

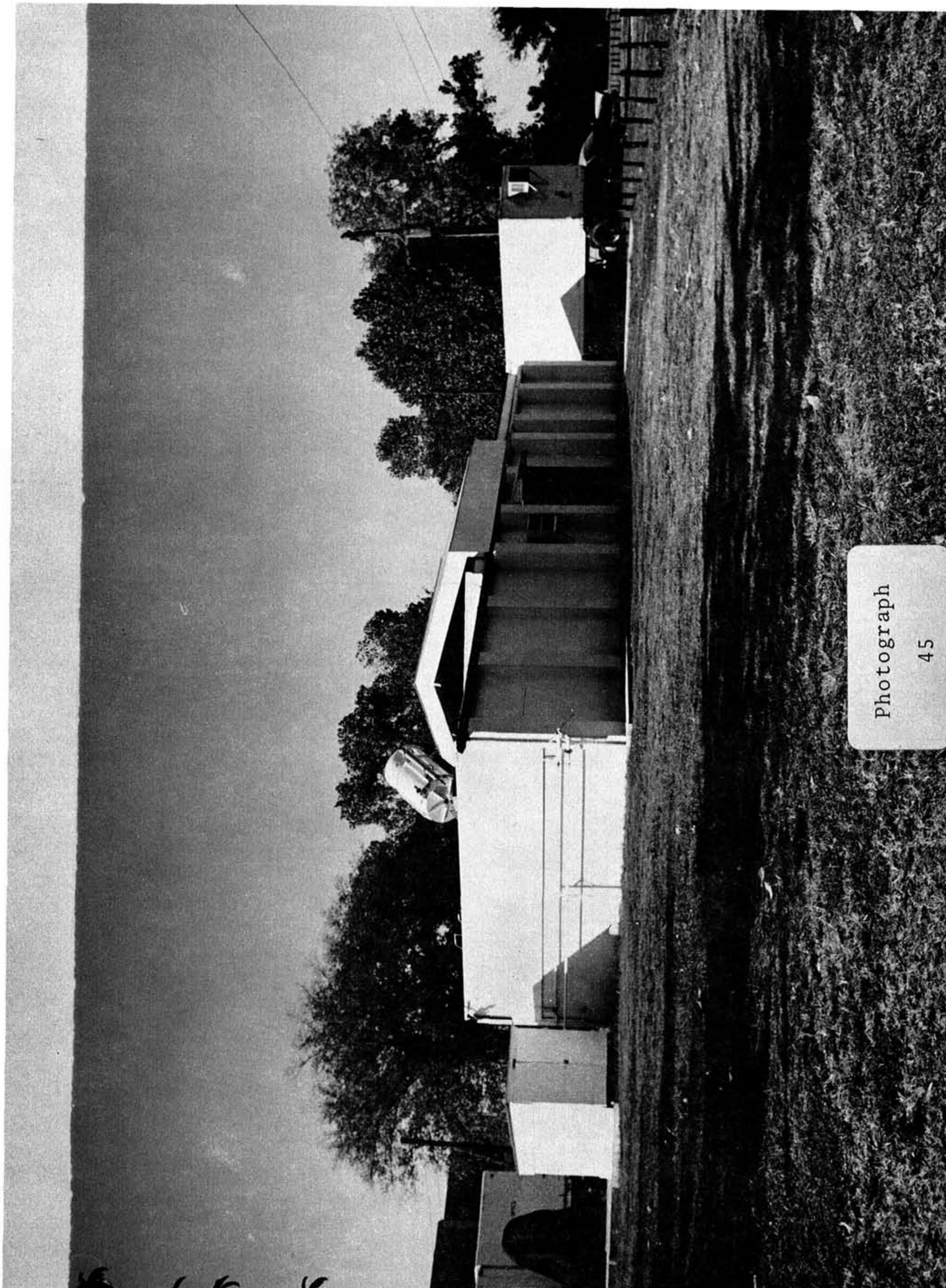
Photograph 43 - Southwestern's 1963 Expeditionary Group to Alaska

Back row standing, left to right:
J. L. Streete, R. M. MacQueen, H. M. Hanson, G. P. Ruffin, J. H. Taylor, P. N. Rhodes, A. C. Emery, D. K. Watson (Chief Observer, High Altitude Observatory).
Front row kneeling, left to right:
C. W. Robertson, C. W. Brandon III, W. S. Boyd, J. D. Aldridge, S. L. Ball.

Photograph 44

Photograph 44 - The First Observatory

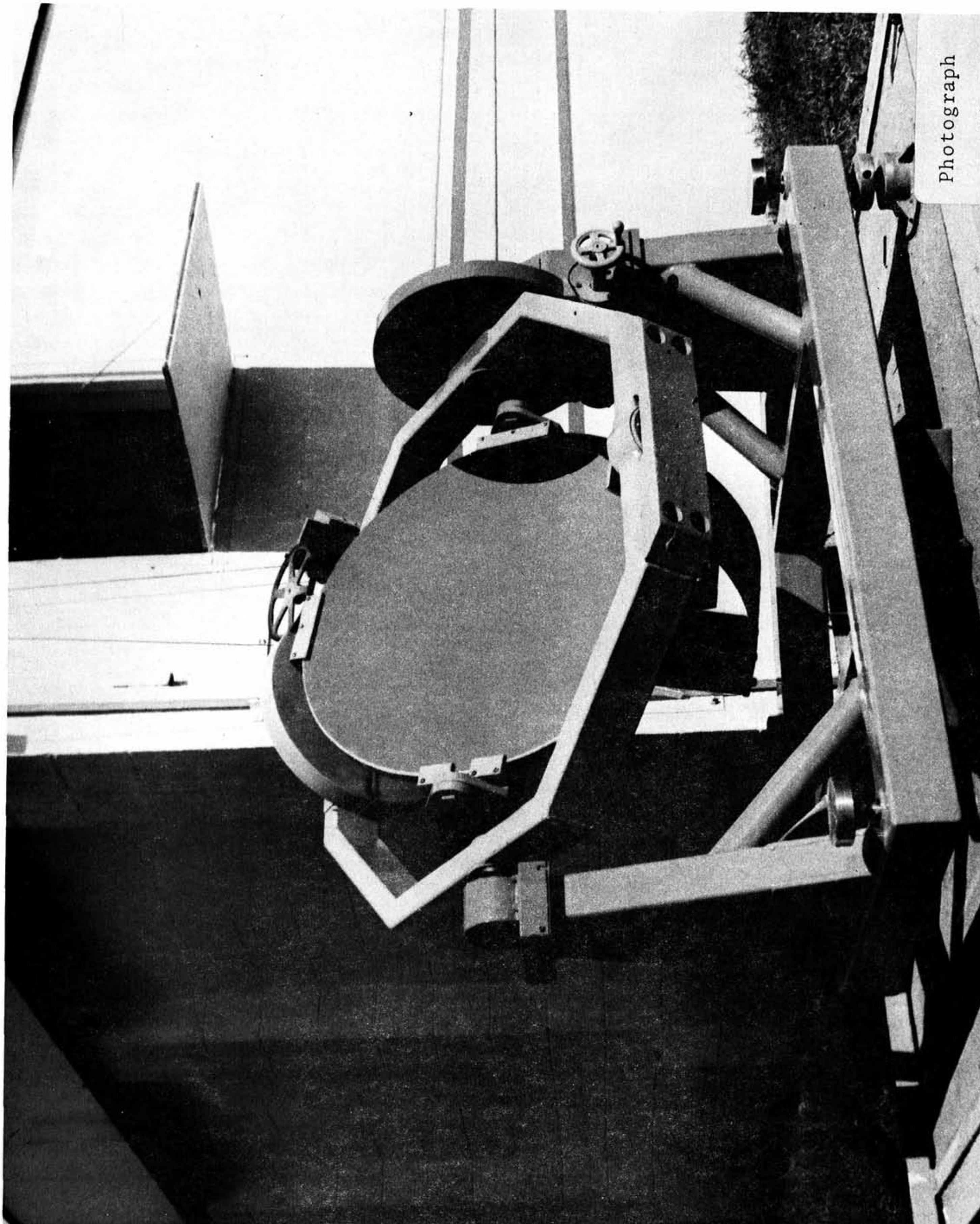
The Observatory is divided into three sections with a roll-back roof over one section. In this photograph the roof is back and the 31 inch diameter reflecting telescope is in the raised position. To the left of the Observatory are four trailers. On the extreme left is the Mobile Infrared Observatory. The two vans that are not painted white are T-33 Fire Control Radar Vans we obtained through our state outlet for government surplus property. The optical tracker from one of these T-33 vans was designed into the northernmost dome of the new Physics Tower. Between the fixed and mobile observatories can be seen two pieces of equipment underneath canvas. The one in the foreground is an antiaircraft searchlight and behind it is a tracking pedestal. In the distant background and off towards the right is an antiaircraft searchlight loaned us by the Electro-Optics Group at Cape Kennedy to be used in connection with the atmospheric transmission measuring and monitoring system we built for them. This photograph was taken about 1965. The pile of stone in the foreground was for use in the construction of the Science Center.



Photograph 45

Photograph 45 - Another View of the First Observatory

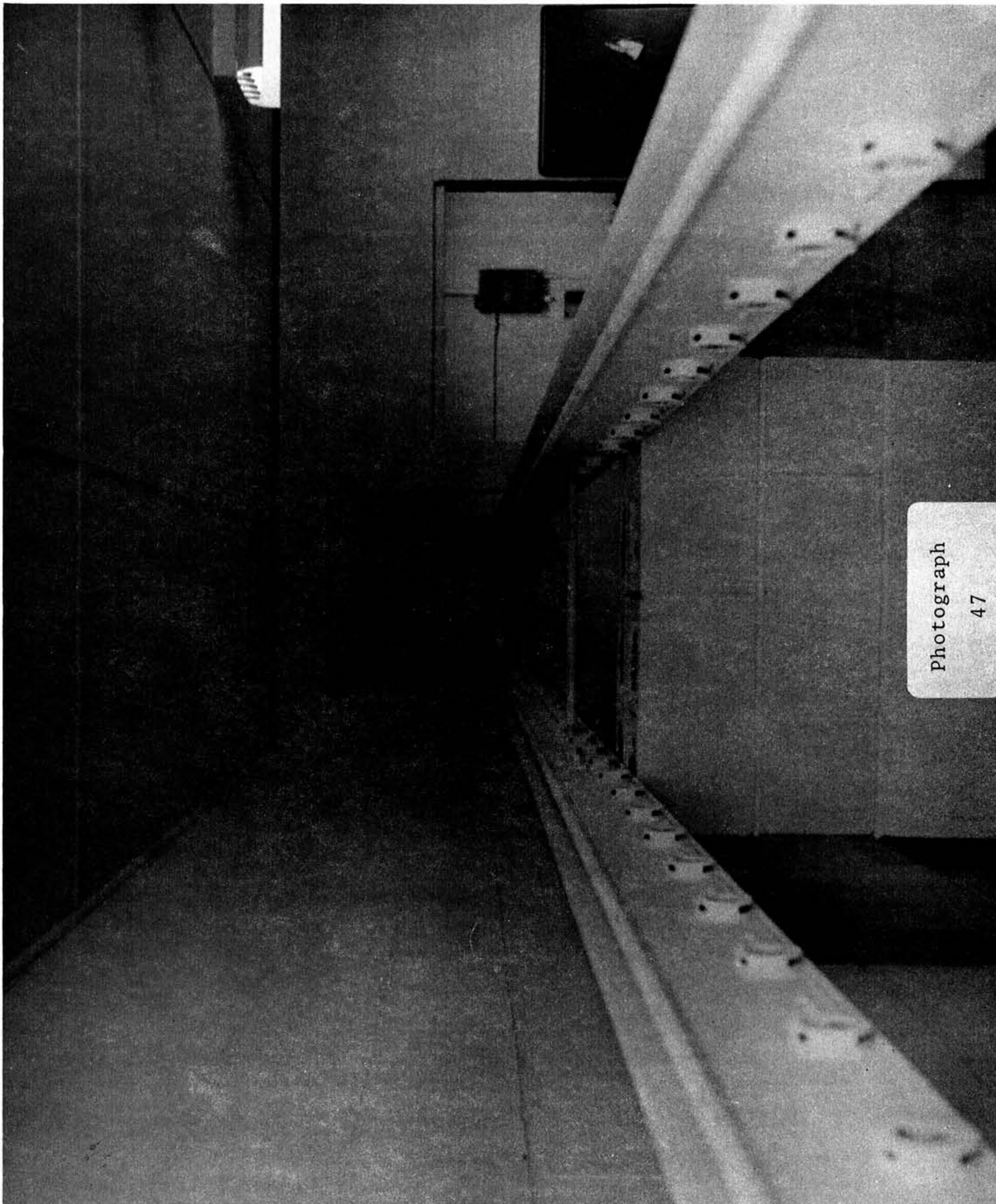
Past the right end of the Observatory can be seen a white trailer (a Nike-Ajax Work Van) that was sent to us by the Electro-Optics Group at Cape Kennedy to be outfitted for atmospheric transmission measurement and monitoring work.



Photograph 46

Photograph 46 - Large Coelostat

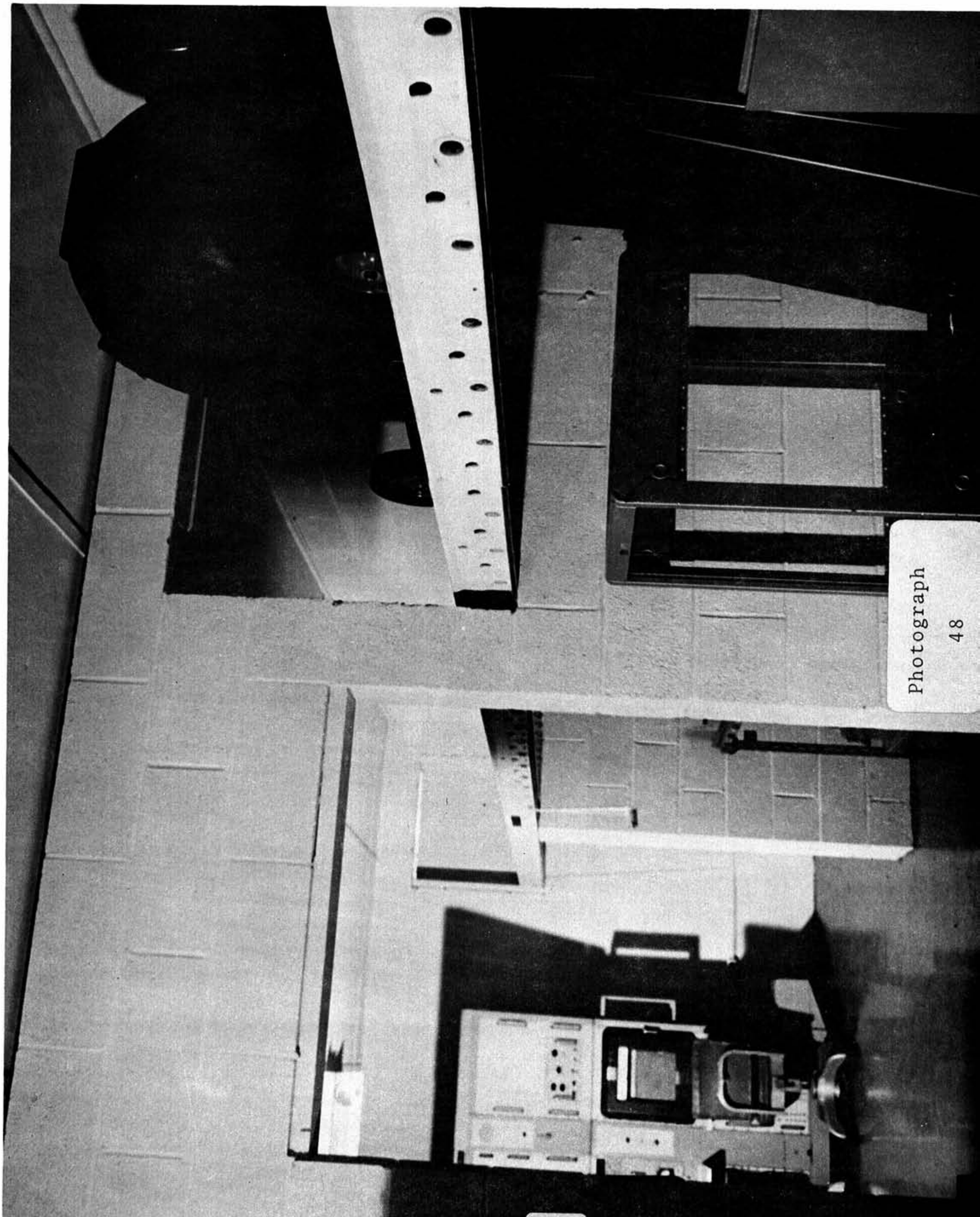
This coelostat was built around a very elaborate piece of equipment we obtained from our state outlet for government surplus property. After slight modification in the Machine Shop we had an excellent coelostat. The mirror is 30 inches in diameter and about one inch thick. It is high quality plate glass and has been front surface aluminized. To the right of the coelostat primary can be seen an opening leading into the Observatory. Not shown in this photograph is the secondary mirror (same size as the primary) that receives the beam of radiation from the primary and directs it into the Observatory to the Sun Telescope (24 inches in diameter with a 24 foot focal length).



Photograph 47

Photograph 47 - Sun Telescope located in the First Observatory

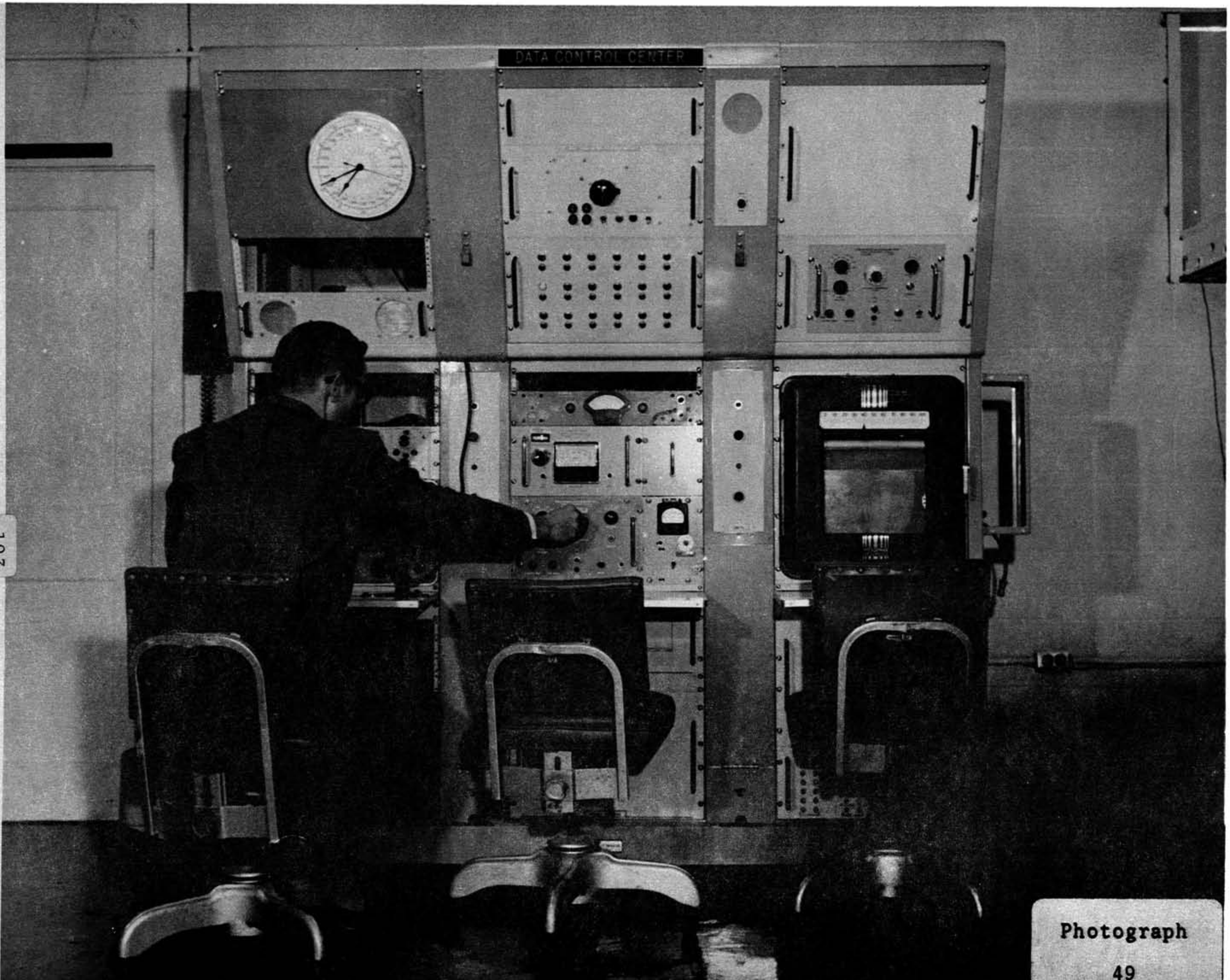
This paraboloid was obtained from our state outlet for government surplus property for $5.00. It is 24 inches in diameter and has a 24 foot focal length. The mirror is fed solar radiation by means of the coelostat system located outside the Observatory. The Observatory is divided into three sections. The 31 inch diameter reflecting telescope is located in Section 1. This Sun Telescope can be located in either Section 2 or Section 3 by rolling it along the tracks shown in the photograph. These tracks are aluminum and were obtained through our state outlet for government surplus property.



Photograph 48

Photograph 48 - Another View of the Sun Telescope

In this photograph the Sun Telescope is located in Section 3 of the Observatory. In Section 2 one can see part of the control console used with the 31 inch diameter telescope. I should point out that many of the ideas we developed on this Observatory were incorporated into the new Physics Tower.



Photograph 49

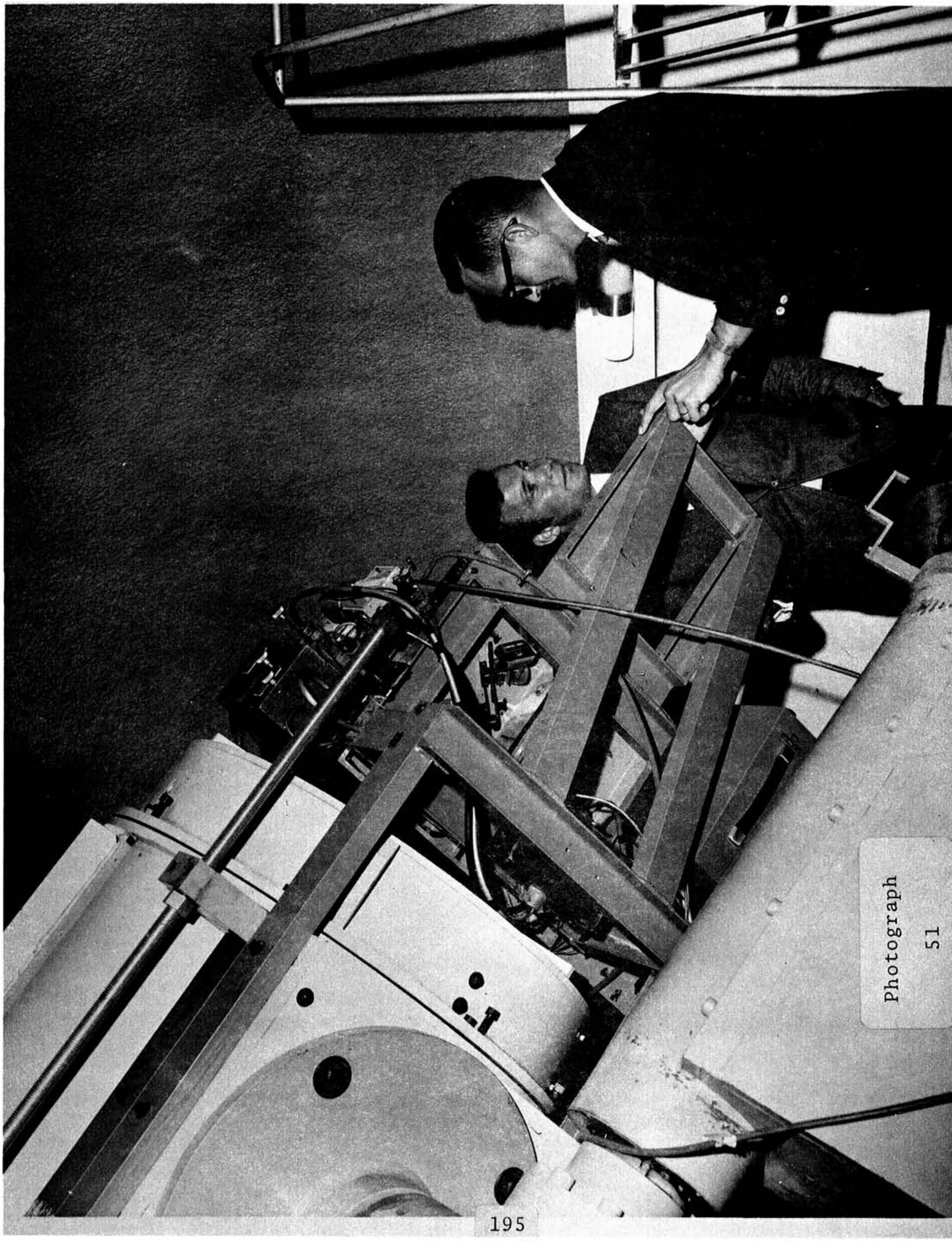
Photograph 49 - Data Control Center

This Control Center was located in Section 2 of the first Observatory and was used with the 31 inch diameter reflecting telescope. At the controls is Professor Allen Barnhardt.

Photograph 50

Photograph 50 - A Student Stops by to View The Heavens

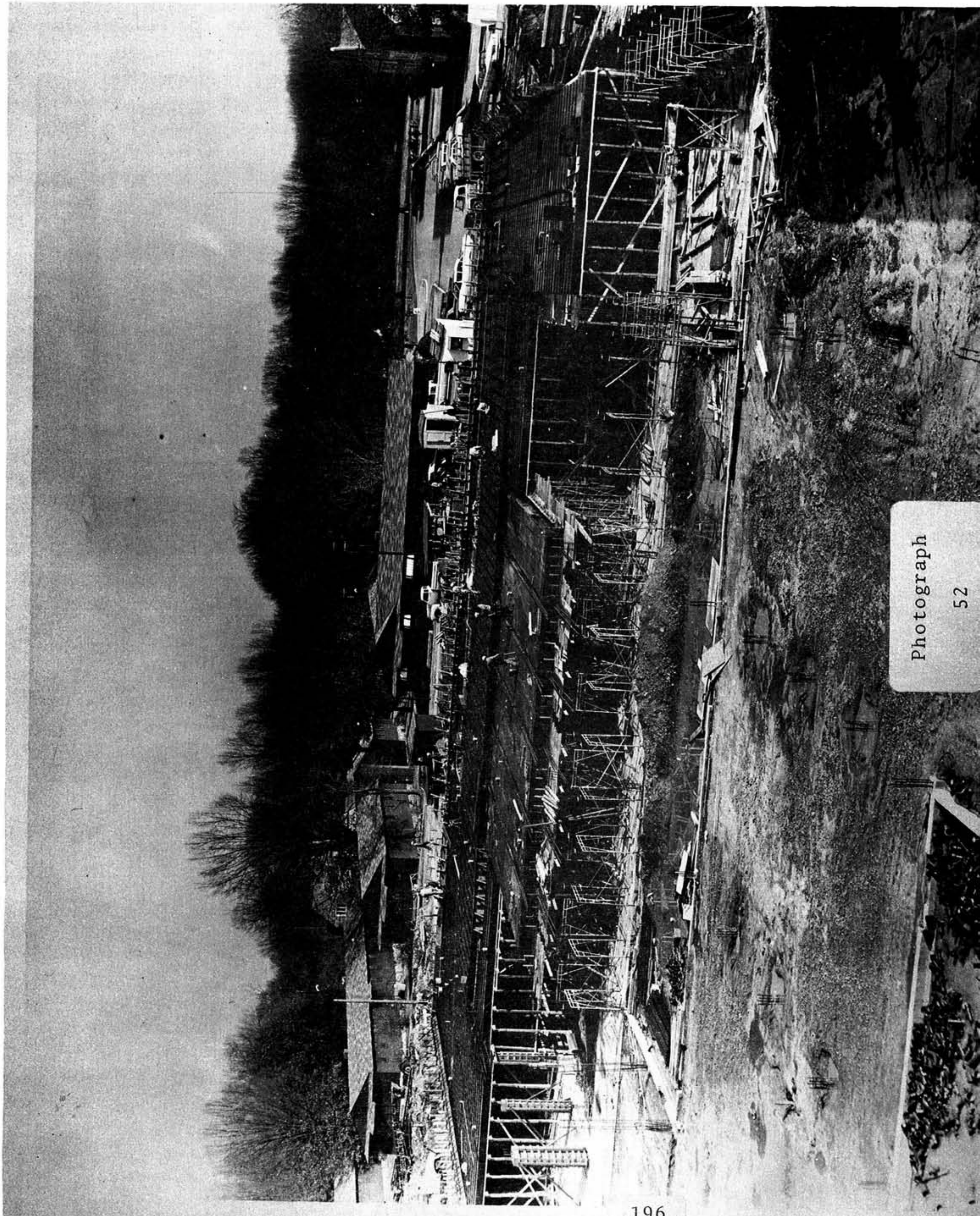
It is very interesting to observe the attraction of students to a telescope pointed skyward. This, incidentally, is a very worthwhile spin-off from work in astronomy. It has been our experience that most students have a built-in interest in astronomy. Here a student has dropped in to take a look. The guide telescope through which this young man is looking came with the College from Clarksville and is a 5 inch diameter refractor. We also used this 5 inch diameter refractor in a coronal camera on the 1963 Alaskan expedition. Haliburton Tower can be seen outlined in the background.



Photograph 51

Photograph 51 - From Galactic Stars to Television Stars !

In this photograph Professor Allen Barnhardt (right) is explaining the operation of the 31 inch diameter reflecting telescope to Mr. William Shatner (left), star of the television series "STAR TREK". This photograph was taken in the Physics Tower.



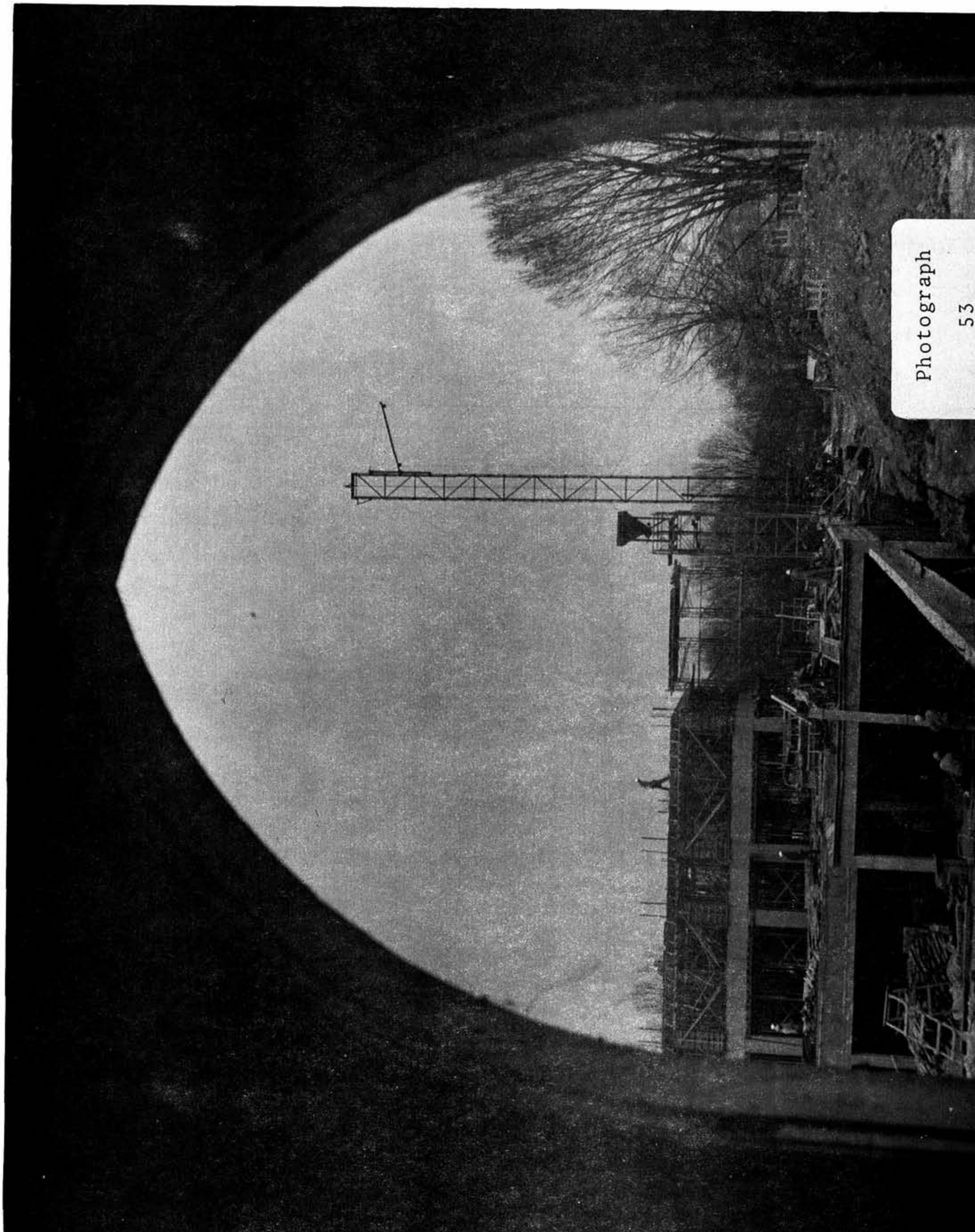
Photograph 52

Photograph 52 - Construction of New Science Center

Photograph taken looking east from the old Science Building

Some dates of possible interest:

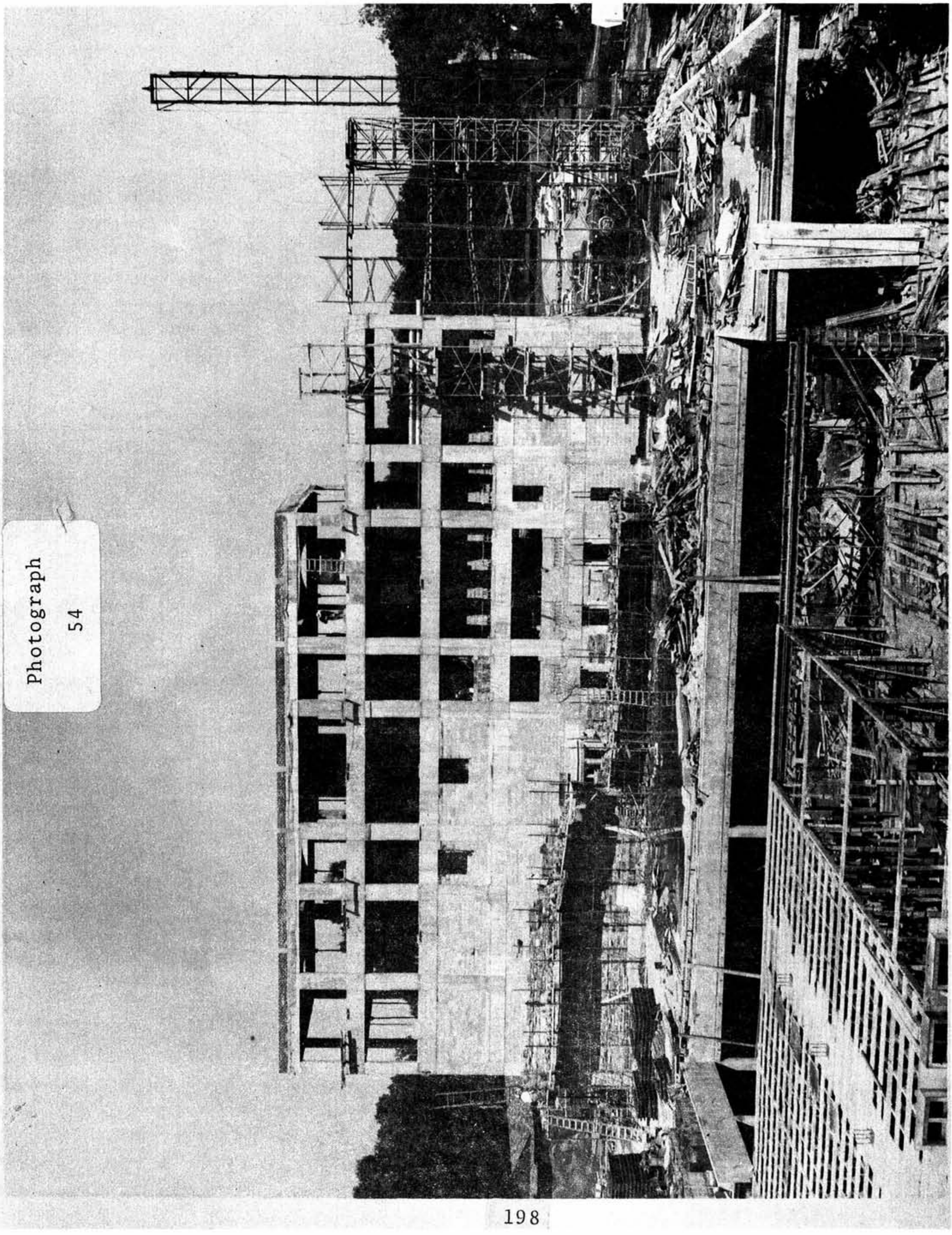
July 13, 1966	- Started digging on Science Center
October 24, 1966	- Began chipping of stone for Science Center
November 18, 1966	- Poured first floor slab under Physics Tower in the new Science Center
December 22, 1966	- Poured first floor ceiling in Physics Tower
January 12, 1967	- Second big pouring
January 24, 1967	- Footings for east walkway poured
January 26, 1967	- Poured columns in second floor of Physics Tower. It rained throughout the pouring. The pouring began about 1:00 P.M.
February 9, 1967	- Poured third floor of Physics Tower
February 13, 1967	- Stone masons began work on east side of Science Center
February 28, 1967	- Poured fourth slab in Physics Tower
March 3, 1967	- Began cement block walls in Physics Tower (second floor level)
March 16, 1967	- Poured fifth slab in Physics Tower
March 30, 1967	- Poured sixth slab in Physics Tower
April 14, 1967	- Poured seventh and final slab in Physics Tower
May 31, 1967	- The large domes arrived today
June 7, 1967	- Two large domes put on Physics Tower
August 1, 1967	- Began painting in Physics Tower
October 30, 1967	- First truck load of Sheldon furniture arrived for the Physics Tower
November 8, 1967	- Vertical antennas installed on Physics Tower
November 25, 1967	- Moved some equipment from the old Science Building to 5th floor of Physics Tower
November 27, 1967	- Started moving equipment to 6th floor of Physics Tower
December 23, 1967	- Moved Machine Shop from old Science Building to Physics Tower
December 28, 1967	- 29,000 pounds of steel shelving arrived
February 12, 1968	- Last of the furniture for the Physics Tower arrived from Sheldon
February 13, 1968	- Library furniture for Physics Tower arrived from Virginia Metal Products



Photograph 53

Photograph 53 - Physics Tower Begins to Take Shape

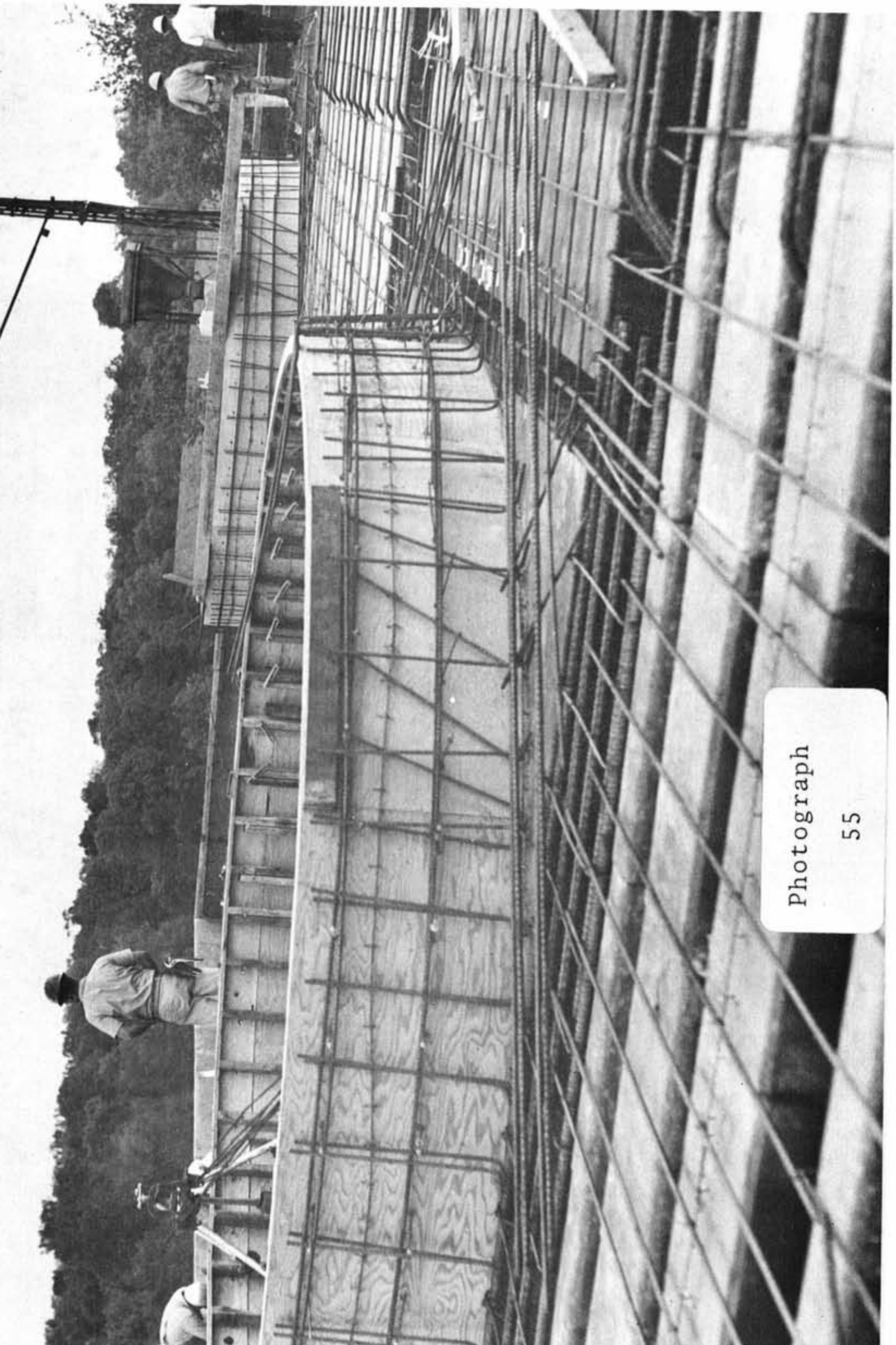
Photograph taken looking east from the old Science Building



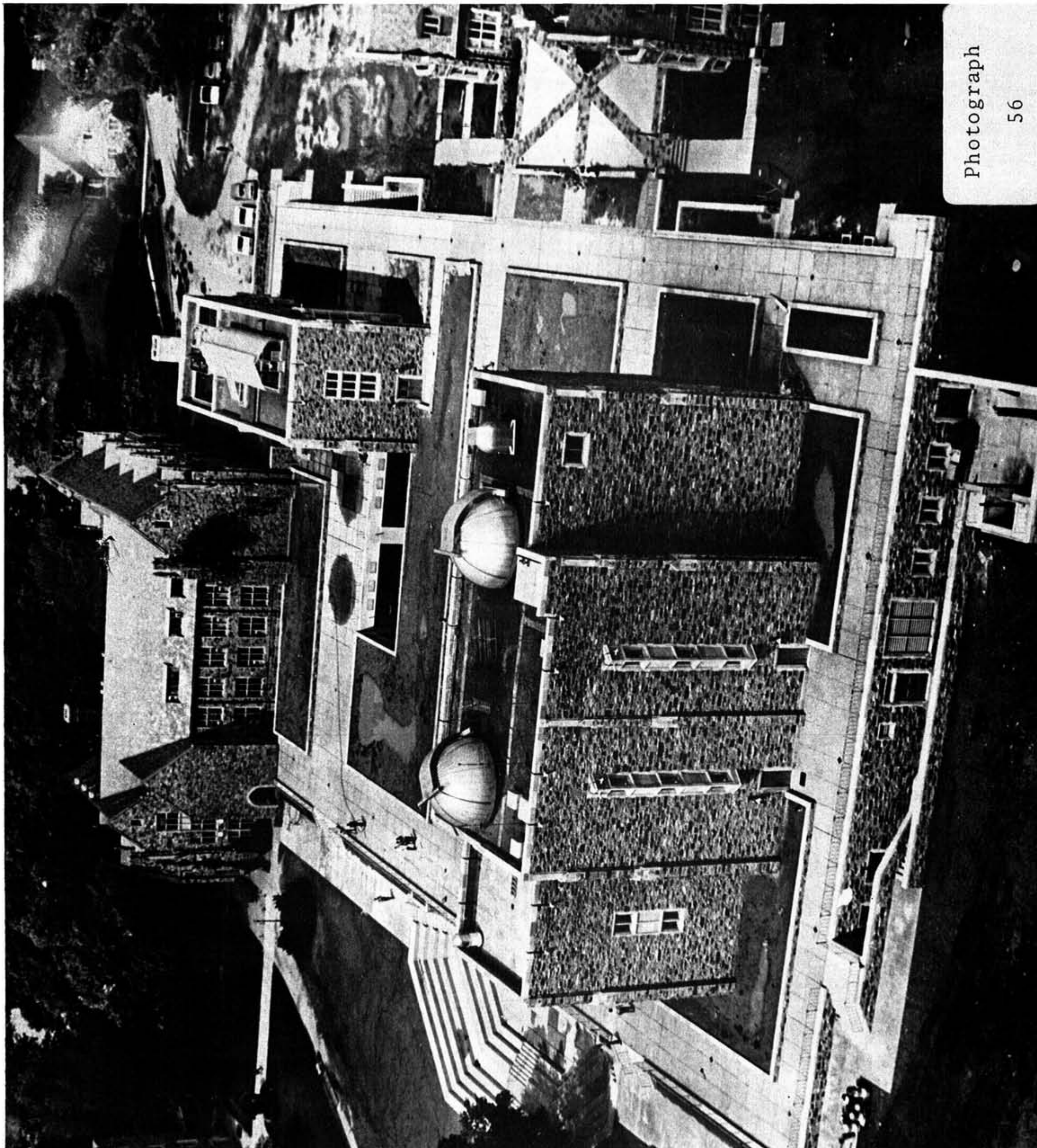
Photograph 54

Photograph 54 - Physics Tower Continues to Take Shape

The stone masons have begun.


Photograph 55

Photograph 55 - Bases for the two 18 foot diameter domes located on the roof of the Physics Tower



Photograph 56

Photograph 56 - Aerial View of Frazier Jelke Science Center

This photograph was taken shortly after construction was finished. In the background is the old Science Building (now Kennedy Hall) which houses the Chemistry Department and the Computer Center (located in the basement). To the right of Kennedy Hall is the Mathematics Tower with Biology's Greenhouse located on the top. In the foreground is the Physics Tower (only four of the five domes can be seen in this photograph). The Biology Department is located underground at level 1.