Chapter Eight

Post-War Research Program
Frank Dunnington (1946-1952)

Postwar Rutgers University

At the end of World War II, there was a dramatic transformation in the University. Rutgers had achieved its new status as the State University of New Jersey in April 1945, and was poised to become a major state university. Large numbers of veterans joined the student body. With the return of the veterans to Rutgers, the full-time enrollment rose from the prewar maximum of 7,000 to 16,000 in 1948. Excluding N.J.C., 70% of those enrolled were veterans. Rutgers suddenly became one of the 20 largest universities in the country. In the men's colleges, the student enrollment rose from 750 in September 1945 to over 4,200 in September 1947.[1]

There was a similar dramatic change in the size of the faculty at Rutgers. In 1940 there were slightly more than 100 faculty members in the College of Arts and Sciences. In September 1946 a total of 62 new faculty members were hired, and in September 1947 an additional 52 new appointments were made. In a very short period, the University was transformed from a small college to a large university.[2]

Postwar plans for the University projected a need for $40,000,000 for new buildings for chemistry, agricultural sciences, engineering, and biological sciences, for new libraries for the men's colleges and for N.J.C., and for several dormitories. In 1946 $965,000 was appropriated for the first unit of a new chemistry building, and in 1947 $1,000,000 was appropriated for an agricultural science building. In November 1948, a $50,000,000 bond issue for Rutgers, the state teachers colleges, and the welfare institutions, was placed on the ballot and defeated. Apparently there was continuing resentment of the special status of Rutgers in the State, since a subsequent bond issue for the teachers colleges and the

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[1]McCormick, *Rutgers: A Bicentennial History*, 271, 272.
[2]Ibid., 272.

welfare institutions was approved. The defeat of the Rutgers bond issue indicated a continuing need to consider the relationship of Rutgers University with the State of New Jersey. Meanwhile, the University expanded by absorbing the University of Newark in 1946 and the College of South Jersey at Camden in 1950.[3]

In June 1949, the Trustees created the new position of Provost. Mason Gross became the new Provost, and under the President, had general charge of the administration of the University in all its branches. As the large number of returning of veterans passed through the University, the full-time undergraduate enrollment dropped from 8,656 in 1948 to 6,318 in 1951. There followed a period of retrenchment and consolidation at the University, along with an increased emphasis on research and graduate study. In 1951 President Clothier retired from the Presidency after holding that office at Rutgers for 19 years. As he retired, he continued to advocate the partnership relations with the State that had been created in 1945, and argued, in the strongest possible terms that the Trustees should not yield control of the University to the State.[4]

Lewis Webster Jones was chosen to replace Clothier as President. A native of Nebraska, Jones had received a Ph.D. in economics from the Brookings Institution, and later became President of Bennington College. He left Bennington to become President of the University of Arkansas, where he was successful in gaining the respect of legislators. When Jones came to Rutgers in 1951, many in the University community were concerned about the steady decline in enrollments, the uncertainty about support from the State, and the slow pace of physical development. Jones indicated that he was prepared to abandon the emphasis on partnership that had been the policy of President Clothier's administration, and press to make Rutgers more truly the State University of New Jersey.[5]

Physics and Astronomy at Rutgers

Prior to World War II the Physics Department at Rutgers was hardly comparable to the physics departments of the other colonial

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[3]McCormick, *Rutgers: A Bicentennial History*, 282, 283.

[4]Ibid., 286-290.

[5]"Presidents," *Journal of the Rutgers University Library*, v. 53, June 1991; McCormick, *Rutgers: A Bicentennial History*, 291.

colleges (e.g., Harvard, Yale, Princeton, and Columbia), which became great private universities, or of the great Midwestern state universities (e.g., Michigan, Wisconsin, and Minnesota), or of the great California universities (e.g. Berkeley, and the California Institute of Technology). Across the country, the number of students studying for the Ph.D. in physics was quite small before World War II, but there were programs of great strength. The Physics Department at Rutgers was a small department, with a moderately good undergraduate curriculum, a rudimentary graduate curriculum, and very little active research, apart from Atkinson's work and some modest work by Winchester. The relative stature of the Physics Department at Rutgers reflected the relative stature of the University as a whole.

The factors that led to the transformation of the University at the end of World War II, together with a recognition of the special contribution of physics in the War, provided a climate for a dramatic buildup of the Physics Department. The atomic bomb, radar, sonar, and the proximity fuse were all military technical developments brought about primarily by physicists. It was widely recognized that physicists were likely to make similar important contributions in any future war, and that the government should support their research efforts.

George Winchester announced his intention to retire at the end of 1945-46. Frank Dunnington, who had left the Department to work at the MIT Radiation Laboratory during the War, was designated to become Department Chairman in 1946. While still at MIT, Dunnington exploited the eagerness of the U.S. government to support physics research as he prepared a plan to transform a second-rate physics department at Rutgers into a major university physics department. He proposed to hire a group of outstanding research physicists who would be leaving the MIT Radiation Laboratory. These physicists would be familiar with the new techniques in high-frequency and microwave electronics. He proposed that they be given time for research in the fundamental fields of nuclear magnetic resonance, electron paramagnetic resonance, and low temperature physics. He suggested that the University put up money for research, which would be matched by support from the Office of Naval Research. This money would be used for research equipment, including microwave equipment, a very large precision electromagnet, and a low temperature cryostat. Van

Dyck Hall, which had been built before the War, was available with sufficient space for the expanded research program in physics.[6]

Figure 22 Frank Dunnington

Albert Meder, Professor of Mathematics and Dean of Administration at Rutgers, supported this proposal, and President Clothier took the bold step of implementing the proposal to build a first-rate physics department at Rutgers. There was a view that if the special efforts in physics were successful at Rutgers, it might be possible to make similar dramatic improvements in other areas of the University. In addition to providing the necessary funds for research, President Clothier agreed that the new faculty members in physics would have a most unusual arrangement in which half of their salaries would be on a research budget, so that they could have reduced teaching loads and more time available for research. This arrangement was very important in building the physics research program. However, it produced two classes of faculty members in the Department, since there were some faculty members who did not have this special arrangement, and it sewed the seeds for later friction in the College because of the special treatment of the physics faculty.

In January 1946, Frank Dunnington returned to Rutgers from his war work at the MIT Radiation Laboratories, joining Winchester, Green-

[6]Interviews and Physics Department Archives.

lees, Porter, Miller, and Eisner. At the end of 1945-46, George Winchester retired after twenty-five years on the faculty at Rutgers, and Dunnington became Chairman of the Physics Department. The Department then doubled in size as seven new faculty members joined the Department. Five of these new faculty members came from the MIT Radiation Laboratory. They were Joseph Feldmeier, Henry Sommers, Henry Torrey, Peter Weiss, and Charles Whitmer. In addition to the physicists coming from MIT, James Stewart came to Rutgers from the Canadian Armament Research & Development Establishment, and Ellis Williams, an instructor, came to Rutgers with a M.Ed. degree from Duke. The new faculty members began a research program in nuclear magnetic resonance and paramagnetic resonance, and subsequently in low-temperature physics. They were successful in transforming the Physics Department into a major research department with a graduate program that grew in size and recognition. This was a major accomplishment for Rutgers University, and set a tone for later significant development in the Physics Department and in the University as a whole. A list of all the physics and astronomy faculty members at Rutgers College and the College of Arts and Sciences is given in Appendix 1.[7]

Perhaps the greatest of the new physicists was Henry Torrey, who contributed significantly to the building of the research program in physics at Rutgers. With Edward Purcell and Robert Pound, Torrey had carried out the first successful observation of nuclear magnetic resonance in bulk matter at Harvard on December 15, 1945. Within a month of the report of this fundamental work of Purcell, Pound, and Torrey, Felix Bloch published the independent discovery of nuclear magnetic resonance in solids. As a result, Edward Purcell and Felix Bloch received the Nobel Prize in Physics in 1952 for the discovery of nuclear magnetic resonance in solids, and Henry Torrey just missed receiving the Nobel Prize.

Torrey was born in 1911 in Yonkers, New York, earned a B.Sc. degree in 1932 from the University of Vermont, and the Ph.D. degree from Columbia in 1937. At Columbia, while working under Isidor Rabi, Torrey made important contributions to the development of the atomic beam technique, which he then used to determine the magnetic moment of the ^{39}K nucleus. This resulted in his first publication, "Sign of the Nuclear

[7]*Rutgers College Catalogues.*

Moment of the K^{39} Nucleus".[8] After a year at Princeton, he joined the faculty at Pennsylvania State College. In 1942 he went to the MIT Radiation Laboratory, where he took over the development of semiconductor crystal rectifiers that were critical to the operation of microwave radar receivers. At the end of World War II he stayed on at MIT to write, along with Charles Whitmer, a book on crystal rectifiers for the Radiation Laboratory Series. It was during that period that he collaborated with Purcell and Pound on the pioneering nuclear magnetic resonance experiment. He came to Rutgers in June 1946 as Associate Professor, and established a theoretical and experimental research program in nuclear magnetic resonance. In the spring of 1946, before he came to Rutgers, Torrey wrote new graduate course descriptions for the Rutgers Physics Department.[9]

Figure 23 Charles Whitmer with Paramagnetic Resonance Equipment

Charles Whitmer also came to Rutgers as Associate Professor. He was born in Flat Rock, Indiana in 1907 and received his Ph.D. degree from Ohio State University in 1936. He served on the faculty of the University of Oklahoma from 1936 to 1942, before going to the Radiation Laboratory at MIT, where he worked during the War on the development of crystal

[8]*Phys. Rev.*, v. 51, p. 501, 1937.

[9]*American Men and Women of Science*, 1989 edition; *Physics Today*, v. 51, p. 100, 1998; Interview with Henry Torrey.

rectifiers. At Rutgers he worked on nuclear magnetic resonance and paramagnetic resonance experiments.[10]

Figure 24 Henry Torrey in Research Laboratory in 1948

Peter Weiss came to Rutgers in 1946 as Assistant Professor. He was born in Portland, Maine in 1915, and received his Ph.D. from Harvard in 1940. He was an instructor at Harvard from 1940 to 1942, before going to the Radiation Laboratory at MIT, where he served as a staff member until 1946. At the Radiation Laboratory, he worked on an instrument to give antiaircraft guns the information needed to hit and bring down airplanes. At Rutgers, Weiss worked on a variety of problems in solid-state theory, and is best known for his contributions to the theory of ferromagnetism. The early work to which he made important contributions became known as the Bethe-Peierls-Weiss theory. In addition to his theoretical work, Weiss helped the research group at Rutgers in the design of laboratory circuits, and in the interpretation of experimental results.[11]

Two other Radiation Laboratory staff members who came to Rutgers in 1946 as Assistant Professors were Joseph Feldmeier and Henry Sommers. Feldmeier was born in Niles, Ohio, in 1916, and received his Ph.D. degree in nuclear physics from Notre Dame in 1942. He was a staff member at the MIT Radiation Laboratory from 1942 to 1946, where he

[10]*American Men and Women of Science*, 1967 edition.

[11]Interview with Peter Weiss; *American Men and Women of Science*, 1989 edition

worked on the design of radar transmitters. At Rutgers he participated in the low-temperature physics research. Sommers was born in St. Paul, Minnesota in 1914. He received his Ph.D. degree from Harvard in 1941, and was an instructor at Harvard for a year (1941-42), before going to the MIT Radiation Laboratory. At Rutgers he worked with Peter Weiss on the design of a current stabilizer, which was designed and built for the 40 kW magnet that was used in the experimental program in magnetic resonance.[12]

Also joining the Physics Department in 1946 as Assistant Professor was James Stewart, whose wife, Ellen Swomley Stewart, became Assistant Professor of Physics at N.J.C. James Stewart was born in Chengtu, China, in 1918, and received his Ph.D. from Johns Hopkins in 1943. He spent two years as Scientific Officer (1943-45) with the Ballistics Laboratory of Canadian Armament Research & Development Establishment, and one year (1945-46) on the faculty of Queens University (Ontario).[13]

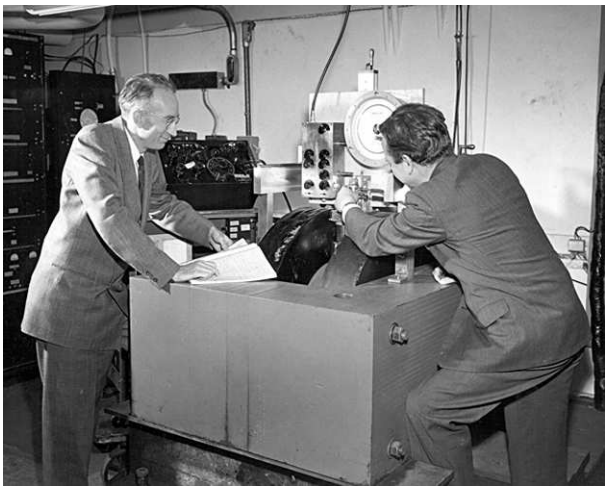

Figure 25 Dunnington and Torrey with GE Electromagnetic

When Torrey arrived at Rutgers he set out to continue his investigations of Nuclear Magnetic Resonance, begun at Harvard with Purcell and Pound. He was the first worker in the field of nuclear magnetic resonance to develop pulse techniques in order to study nutational

[12]*American Men and Women of Science*, 1989 edition.
[13]Ibid.; *Rutgers College Catalogues*.

resonance, and he exploited this technique as a new tool in the study of nuclear relaxation in bulk matter. The research group at Rutgers designed the first electromagnet purposely developed for NMR research. The large-gap magnet, requiring unusually high homogeneity at large fields, was constructed to their design by the General Electric Corporation in 1947, and provided service for over 35 years. The group also pursued research interests in paramagnetic resonance. For the resonance experiments, low temperatures were desired.

Figure 26 Physics Department Party in 1947

Bottom Row: Eleanor Greenlees, Lloyd Greenlees, Nancy Sommers, ?, Franklin Miller, Joe Feldmeier, Mrs. Jackson, Henry Torrey, Janet Feldmeier.
Second Row: Mae Freeman, ?, ?, Mrs. Garfunkel, Libuse Miller, Mrs. Obencrantz, ?, Helen Torrey, ?, ?, Ellen Stewart.
Third Row: ?, ?, ?, Nell Porter, ?, ?, Jeannette Whitmer, Fran Dunnington, Frank Dunnington, Betty Weiss, Peter Weiss, Paul Greebler, Mrs. Blosser, Jean Weidner, Dick Weidner, ?, ?, ?, ?, Bunny Serin.
Back Row: Ira Freeman, Doug Porter, ?, Wilfred Jackson, Charlie Whitmer, ?, Myron Garfunkel, ?, Hank Sommers, Dave Blosser, Rich Odencrantz, Jim Stewart, Irwin Binsburg, Bernie Serin, ?.

Frank Dunnington (1946-1952)

During the spring of 1946, Feldmeier spent four months in Collins' laboratory at MIT, assisting with the development of a new helium refrigerator, with the intention of duplicating the equipment at Rutgers. In the summer of 1946 A.D. Little, Inc., decided to build a limited number of refrigerators following the Collins design. In the summer of 1947 one of the of these commercial refrigerators was installed in the physics laboratory at Rutgers, one of six of its kind in the U.S. The Collins helium cryostat produced temperatures of two degrees Kelvin, and was an important step in establishing a low temperature laboratory at Rutgers. The U.S. Navy, the Research Corporation, and the Rutgers Research Council supported the cryostat, costing about $20,000.[14]

While the Physics Department in the College of Arts and Sciences was being transformed in 1946 into a major research department, there were less dramatic changes in the Physics Department at N.J.C. Frank Pratt retired after 39 years on the faculty at Rutgers, and 23 years as Chairman of the Physics Department at N.J.C. Wilfred Jackson became the new Physics Department Chairman at N.J.C., having joined the N.J.C. Physics Department in 1928. Jackson had been interested in teaching physics, not only for the specialists, but also for those who wanted physics as a part of a liberal education. Also leaving the Physics Department at N.J.C. in 1946 was Katherine Van Horn, who had served as Instructor and Assistant Professor for five years. Ellen Swomley Stewart, who had received her Ph.D. at Johns Hopkins in 1946, replaced her. She came to N.J.C. as Assistant Professor of Physics, when her husband, James Stewart, joined the Physics Department in the College of Arts and Sciences. A list of all the physics and astronomy faculty members at N.J.C. and Douglass College is given in Appendix 2.[15]

In addition to Stewart, Jackson was assisted in teaching physics at N.J.C. for several years by a small number of faculty members who served for short periods of time. Gladys Francis, M.Sc. Rutgers, was Instructor for two years (1947-49); Emma Townsend, Ph.D. Columbia, was Lecturer and Associate Professor for nine years (1949-1959); Lai-wing Fung, Ph.D.

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[14]Physics Department Reports; Interview with Henry Torrey; *Rutgers Alumni Monthly*, October, 1947.

[15]Schmidt, *Douglass College*, 230; *N.J.C. Catalogues.*

Michigan, was Lecturer for three years (1950-53); and Katherine Van Horn Peret, A.M. Wellesley, was Lecturer for five years (1950-55).[16]

In the College of Arts and Science Physics Department, there was further expansion of the faculty in 1947. Elmer Eisner left the Department after three years to go to Argonne National Laboratory, and Ira Freeman, Bernard Serin, and Richard Weidner joined the Department.[17]

A native of New York City, Serin had received his Ph.D. with L. I. Schiff at the University of Pennsylvania. He then served at New York University for a year as a postdoctoral fellow before coming to Rutgers in 1947. At Rutgers, Serin developed a program in low-temperature physics that was to bring him and the Department international renown. Richard Weidner received his Ph.D. degree from Yale in 1948, after coming to Rutgers. At Rutgers he carried out research in electronic paramagnetism, initially with Whitmer, and then on his own.[18]

Ira Freeman had received his Ph.D. in theoretical physics from the University of Chicago in 1928. After receiving his Ph.D., he held a fellowship for two years at Goethe University in Frankfurt, Germany. He then served for two years as Associate Physicist for the U. S. National Advisory Committee for Aeronautics in Washington, D.C. Following that appointment, he became Associate Professor of Physics at Central College in Chicago, from 1932 to 1943. He then went to Purdue for a year as Visiting Professor, to Princeton as Research Associate, where he was engaged in research for the National Defense Research Center, and to Swarthmore, where he was Associate Professor for two years. In the summer of 1945 he was a member of the Princeton Solar Eclipse Expedition that observed and photographed the eclipse in Montana. He was the editor and translator of Joos' *Theoretical Physics*. He was also noted for his efforts to present physics to the public and to children. Before coming to Rutgers in 1947, he and his wife, Mae Blacker Freeman, had published four books on a new way to learn about science through personal experience. His first book, *Invitation to Experiment*, published in 1940, was featured in *Life* magazine, which described it as one of the most interesting and absorbing works of its kind. This book was followed by

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[16]*N.J.C. Catalogues.*

[17]*American Men and Women of Science*, 1955 edition; *Rutgers College Catalogues*.

[18]*American Men and Women of Science*, 1967 edition.

Fun with Science, *Fun with Chemistry*, and *Fun with Figures*. He was recruited in 1947 by Harry Owen, Dean of the Faculty of Arts and Sciences, to bolster the instructional program of the Physics Department. Some members of the Physics Faculty resented this appointment because it had been made without consultation with the Department. In the Department, Freeman set about organizing a physics course for non-science students, and wrote a textbook for such a course. In 1950-51 he took a leave of absence to go to Paris, where he was appointed Special Consultant to the United Nations Educational, Scientific and Cultural Organization to study science education in U. N. member countries.[19]

Figure 27 Instructional Physics Laboratory in Van Dyck Hall in 1947

In 1948 Joseph Feldmeier, Franklin Miller, and Ellis Williams left the Department, and Nelson Alpert joined the Department. Feldmeier left the Department after two years of service to become Chairman of the Physics Department at the College of St. Thomas in Canada, followed by appointments at Westinghouse Electric Corp., Philco Corp., Franklin Institute, STV Engrs., and as Dean of Montgomery County Community College.

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[19]*Rutgers Alumni Monthly*, 1948; *American Men and Women of Science*, 1979 edition; *New York Times*, May 7, 1950; Interview with Henry Torrey.

Frank Dunnington (1946-1952)

Franklin Miller left the Department in 1948, after eleven years of service, going to Kenyon College, where he was Chairman of the Physics Department for a number of years. He published an introductory textbook in 1959, which went through five editions, and retired in 1981, a year before the last edition of the book was published. Williams left the Department after two years of service.

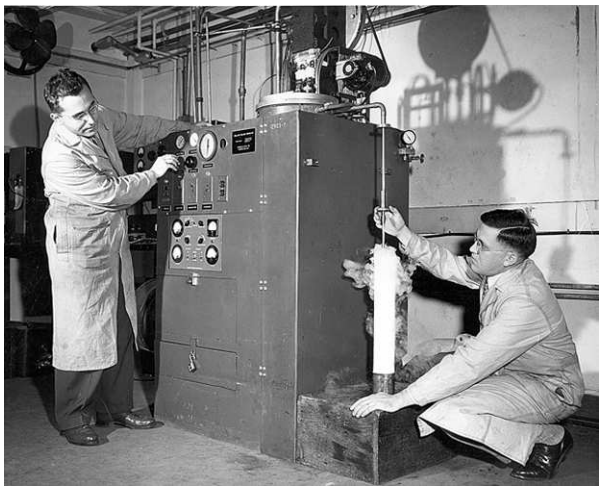

Figure 28 Bernard Serin and Charles Reynolds with Helium Cryostat

Nelson Alpert was born in New Haven, Conn., in 1925, and received his Ph.D. from Yale in 1948, when he came to Rutgers. At Rutgers he worked with Torrey on the nuclear magnetic resonance experiments.

Instruction in astronomy, which had been a part of the Rutgers scene for 177 years, was interrupted with the departure of Franklin Miller in 1948. For two years no course in astronomy was offered, and then the Mathematics Department at N.J.C. stepped in to fill the void. The course in descriptive astronomy was offered there, alternately, by Cyril Nelson and Robert Walter in the Mathematics Department. Nelson earned his Ph.D. at Chicago in 1921 and began teaching at Rutgers in 1927. Nelson succeeded Richard Morris as Chairman of the N.J.C. Mathematics Department when Morris retired in 1944. Walter, in turn, succeeded Nelson as Department Chairman when Nelson retired in 1959. Walter

continued to teach this descriptive course in astronomy at Douglass College until 1967.[20]

Members of the College of Arts and Science Physics Department continued to recognize the importance of astronomy, but it would be many years before that interest could be transformed into an active program in astronomy.

In 1949 Henry Sommers left the Department after three years, and Charles Reynolds joined the Department. Sommers went to the Los Alamos Scientific Laboratory, and then to the RCA Laboratories. Reynolds received his Ph.D. in low temperature physics from Yale in 1949, the year he came to Rutgers. At Rutgers he worked with Serin on the low-temperature physics experiments.[21]

The physics graduate program, which had been suspended during World War II, was expanded in 1946, along with the physics research program. In 1949 Jen-Sen Hsiang received the first post-war Ph.D. degree. Hsiang's thesis was on theoretical studies of ferromagnetism with Peter Weiss.

The half-time teaching appointments in the Department that were created in 1946 resulted in two groups of faculty within the Department, which was somewhat analogous to an issue that was to surface again fifty years later with the creation of the string theory group. In 1949-50 the research staff of the Physics Department, with a reduced teaching load, consisted of Chairman Dunnington, Associate Professors Torrey, Weiss, and Whitmer, and Assistant Professors Alpert, Reynolds, Serin, and Weidner. The instructional staff of the Department included Associate Professors Freeman and Greenlees, and Assistant Professors Porter and Stewart. There was also a technical support staff, including one assistant research specialist (Codrington), two secretaries, a stockroom person, an electronic technician, and four mechanics.[22]

While Atkinson's work on stellar evolution was the first great research accomplishment in the history of the Physics Department, there was another great research accomplishment of equal or greater importance, which would significantly enhance the reputation of the Department. In

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[20]*Rutgers College Catalogues*.

[21]*American Men and Women of Science*, 1989 edition.

[22]Physics Department Archives.

1950 Serin and Reynolds published the results of their low-temperature experiments, showing that the transition temperature for superconductivity in mercury isotopes decreased with increasing isotopic mass. In particular, they found that the product of the square root of the average atomic mass and the transition temperature is a constant for various isotopes. Emanuel Maxwell reached this result independently the same year, and John Bardeen provided the theoretical interpretation in 1950, providing the critical basis for what became known as the BCS theory of superconductivity. The series of papers in the *Physical Review* on "The Isotope Effect in Superconductivity", by Serin, Reynolds, and their students Nesbitt, Lohman and Wright, attracted international attention and was enormously important because of the fundamental bearing the isotope effect had on the theory of superconductivity.[23]

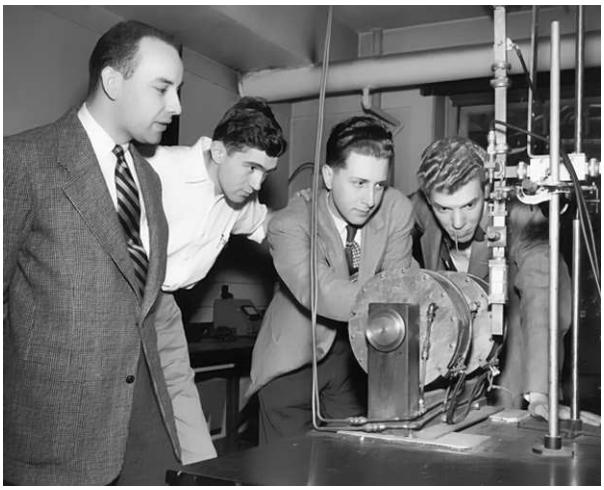

Figure 29 Richard Weidner with Students in Microwave Laboratory

By 1950 the balance of the physics research program was also well advanced. Torrey and Alpert carried out Nuclear Magnetic Resonance studies, in which they measured relaxation constants in proton containing solids and liquids as a function of temperature. Whitmer and Weidner carried out electronic paramagnetic experiments with various iron alum

[23]*Physical Review*, v. 78, p. 487 and p. 813, 1950, and v. 80, p. 761, 1950.

compounds, and Weiss undertook theoretical calculations of the influence of nuclear quadrupole moments on microwave spectra.

In addition to the research by the new members of the Department, Dunnington continued his work on atomic constants, carrying out a precision measurement of the value of *h/e*. The preliminary results of this work were published in 1950, the final results in 1954.[24] In this experiment, the excitation potential of helium from the ground state to the $2p^1P_1^0$ state was measured as the energy lost by electrons in causing this excitation. The excitation of the helium was produced by electrons traveling in a circular path in a uniform magnetic field, and having the energy lost by the electrons restored when the electrons traversed a gap with a known accelerating potential. The value of *h/e* was obtained from the value of that accelerating voltage and the known value of the wave number for the radiation from that state in helium. The apparatus used in this experiment was somewhat similar to the apparatus used by Dunnington in his earlier *e/m* experiment. Dunnington was assisted in the *h/e* experiment by graduate students Curtis Hemenway and James Rough. Hemenway received his Ph.D. for this work in 1950, and went on to the faculty at Union College in New York, where he was Director of the Dudley Observatory, and then to a position as Professor of Astronomy & Space Science at SUNY, Albany.[25]

In 1951 James and Ellen Stewart left the College of Arts and Sciences and Douglass Physics Departments after five years to go to the U.S. Navy Electronics Laboratory in San Diego, California, where they worked on underwater acoustic problems for the Navy. While there was a new focus on research in the Physics Department, there was also an expansion of the undergraduate physics major program. In 1951 ten physics majors received their undergraduate degrees, and four of them received appointments for graduate study in physics. Two of these graduates were Peter Bender, who earned his Ph.D. at Princeton and went on to a career at the National Bureau of Standards, and Aaron Temkin, who earned his Ph.D. at MIT and went on to a career at the Goddard Space Flight Center. In addition to the graduating physics majors, three graduate students received the Ph.D. degree (Myron Garfunkel, Irwin Ginsburg, and Sidney

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[24] *Physical Review*, v. 79, p. 887, 1950, and v. 94, p. 592, 1954.

[25] *American Men and Women of Science*, 1972 edition.

Gray), and two received the M.S. degree. All of the graduate degree recipients obtained attractive positions, three in teaching, and two in industrial research. At that time, the demand for physicists with the Ph.D. degree far exceeded the supply, and beginning salaries for fresh Ph.D.'s in industry were in the range of $6,000 to $7,000. These salaries were substantially higher than the faculty salaries at Rutgers, which created some difficulty in maintaining the physics faculty.[26]

By 1951-52, there were 468 students enrolled in the three elementary physics courses, 30 undergraduate physics majors, and 22 graduate students. The 22 graduate students included 8 teaching assistants, 3 research assistants, 5 research fellows, and 5 students holding no appointments. Of these 22 graduate students, 7 were candidates for the M.S. degree and 15 were working for the Ph.D.

Two of the three seniors graduating in 1952 received graduate appointments, Allen Robbins, author of this *History*, and O. Wallace Greenberg. Robbins went on to graduate study at Yale, and then to the faculty at Rutgers, and Greenberg went on to graduate study at Princeton, and then to the faculty at Maryland. Greenberg is credited, along with Yoichiro Nambu, with the proposal in 1964-65 that quarks come in different varieties called colors. The significance of this work was recognized in a 1998 article in the *New York Times*, describing the seminal steps towards the development of a unified theory of the universe. It is noteworthy that Greenberg is featured in that article with the likes of Newton, Einstein, Oersted, Faraday, Maxwell, Dirac, Feynman, Fermi, and Weinberg.[27] In addition to the graduating physics majors, three graduate students received the Ph.D. degree (Eschenfelder, Gittleman, and Wright). A full list of the Ph.D. recipients is given in Appendix 3.

In 1951-52 the research program continued to flourish, with the work in nuclear magnetic resonance, paramagnetic absorption, low temperature, and theoretical studies, receiving external research support in the amount of $51,396, in addition to the university support of $23,440 for half of the salaries of eight faculty members engaged in research.

In addition to its programs in instruction and basic research, the Physics Department was active in a number of other areas. The Physics

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[26]Physics Department Archives; *American Men and Women of Science*, 1989 edition.
[27]*New York Times*; *American Men and Women of Science*.

Department carried out, with the Department of Chemistry, an applied research program, an unclassified program of research with military applications that were developed away from the Rutgers campus.

Other acitivities in the Department included the undergraduate physics club, which affiliated with the American Institute of Physics. There was also an active physics colloquium series, and a journal club, with weekly reports on current research by graduate students. The Physics Department cooperated with other science departments in a State Science Day, which was well received by high school science teachers, and Charles Reynolds took groups from various organizations to the University Observatory. Dunnington, Weidner, and Whitmer presented a background of basic physics for the Atomic Energy Seminar for Working News People, sponsored by the University. Ira Freeman was appointed Associate Editor of the *American Journal of Physics*.[28]

By 1952 Frank Dunnington had assembled an outstanding group of physicists, who successfully built a first-class physics research program and established a growing graduate program in physics. While Dunnington collaborated to some extent with some of the early research projects, his direct involvement in postwar research was in his *h/e* experiment. Dunnington deserves substantial credit for organizing this program at the end of World War II, and starting the Department on the way to becoming a world-class physics department. However, in the course of building and managing that program, Dunnington evoked strong feelings of resentment from his colleagues about the heavy-handed way that he ran the Department. Although he had been appointed Department Chairman, he managed the Department more like the old-style department head, who ran the Department autonomously, without consulting his colleagues. Incidents of this high-handed treatment accumulated over a few years. There was especially intense feeling about Dunnington's decision not to recommend Franklin Miller's promotion to associate professor with tenure. Miller was a strong teacher, although he did not have a very active research program. It has been suggested that Dunnington's views were colored by a clash between Dunnington's stern

[28]Physics Department Archives.

conservatism and Miller's more liberal tendencies, including his pacifism during World War II.[29]

In 1951 Dunnington completed five years as Chairman of the Department. As was customary, the Department held an election to nominate the Chairman for the next five years. The vote was five votes for Frank Dunnington and six votes for Charles Whitmer. President Clothier announced that, after reviewing the recommendations of the Department, Dean Harry Owen, Dean Albert Meder, and Provost Mason Gross, he had decided to reappoint Frank Dunnington as Chairman of the Physics Department.

In a letter to the Physics Faculty, President Clothier outlined the reasons for his decision to continue Dunnington's Chairmanship. He pointed out that when George Winchester announced his retirement in 1945 the University had made a fundamental decision to transform a small teaching physics department, with a moderately good undergraduate curriculum, an inadequate graduate curriculum, and no research to speak of, into a university department, with an excellent undergraduate and graduate curricula and a strong research program. He concluded that this had been accomplished, and that Frank Dunnington was instrumental in that transformation. Clothier pointed out that a quarter of a million dollars had already been raised for the program, and that another quarter million dollars had been raised for the future program. In the light of those accomplishments, Clothier saw his reappointment of Dunnington as support for the further development of the program and urged the support of the members of the Department.[30]

This decision by the President was not well received by members of the Department, who called upon the President and indicated the strength of their feelings. Henry Torrey, who had initially voted for Dunnington in the election, joined with other members of the Department in strongly demanding that Dunnington be replaced. The President eventually acceded to these demands and Charles Whitmer was named Department Chairman in 1952.

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[29]Physics Department Archives; Interviews with former faculty members.

[30]Physics Department Archives.