Part I
The beginning
1 Introduction. US astronomy in the first half of the 20th century.

American observational astronomy was dominated during the first two decades of the 20th century by the Harvard, Lick, Lowell, Yerkes, and Mount Wilson Observatories, all created by private philanthropy. Mount Wilson became the dominant observatory during the next two decades, following the completion of the 100-inch reflector at the end of World War I. Private philanthropy also led to the construction of the McDonald Observatory, which was dedicated only four months before the outbreak of World War II in 1939. Completion of the 200-inch Palomar telescope, also privately funded, was delayed by the war until 1948. Lick and Yerkes were operated by universities, one a state university and the other a private university. Lowell was a private institution supported by a modest endowment. Mount Wilson was part of the Carnegie Institution of Washington, a prestigious research organization that supported work in both the physical and the biological sciences.

The operation of the McDonald Observatory and of the Palomar Observatory was based on a new idea, cooperation in the operation of a major research facility. McDonald was owned by the University of Texas, but it was operated by the University of Chicago’s astronomers, starting in 1932. The director of the Yerkes Observatory was also the director of the McDonald Observatory. The Palomar Observatory was owned by the California Institute of Technology, and it was operated in cooperation with the Mount Wilson Observatory of the Carnegie Institution of Washington, under the name Mount Wilson and Palomar Observatories, from 1948 to 1969. The first director, I.S. Bowen, was from Cal Tech; the second, Horace W. Babcock, was from Mount Wilson. The third director, Maarten Schmidt, was from Cal Tech. This arrangement, called the Hale Observatories during the years 1969-1980, was terminated in 1980. The Chicago–Texas joint operation of the McDonald Observatory ended in 1962, when the contract signed in 1932 by the two universities expired.

Otto Struve, the first director of the Yerkes and McDonald Observatories, had even more ambitious plans for cooperation. In an article “Cooperation in Astronomy”, published in *Scientific Monthly*, February 1940, he described the success of the Chicago–
Texas operation of the McDonald Observatory. Next, he discussed the need for additional large telescopes:

After all, the success of theoretical study depends essentially upon the supply of observational results. These now come almost entirely from a few large American Observatories . . . Is it not also rather disquieting when we contemplate the number of young astronomers who are being trained for future careers at institutions which are unable to carry on modern observational activities?

In the last part of this article he proposed:

In order to enlarge the scope of the work of the McDonald Observatory it would be reasonable to invite the collaboration of other institutions. Let us suppose that a plan of collaboration could be worked out which would be satisfactory to all participating institutions. We should then be able to organize jointly an observing station in the Texas mountains, where the McDonald Observatory is located, which would be much more powerful than the present McDonald Observatory alone . . . It is my strong conviction that astronomers and University administrators should seriously consider such a project.

A letter from Struve to Edmondson, dated March 19, 1940, contains a specific proposal:

Assuming that we can get together five or six collaborating universities, we shall all make a joint application to the Carnegie Foundation or the Rockefeller Foundation for a grant of about a quarter of a million dollars to build a 72-inch Schmidt telescope to be used in addition to the 82-inch reflector. Assuming further that one of the foundations will make the grant, we propose to organize a cooperative observatory in conjunction with the McDonald Observatory. The maintenance of the two large telescopes is to be borne by the collaborating universities. The cost of such maintenance appears to be about $75 per night per telescope. This includes general maintenance, photographic supplies, repairs, small accessory equipment such as spectrographs, photometers, etc., as well as the salaries of six observing assistants who are to secure the plates for the collaborating institutions. The reason for this latter arrangement is that most university departments cannot send astronomers to Texas except during vacation. I am reasonably certain that at least two-thirds of the nights will be useable – and possibly more. Hence, participation in the plan of the extent of 30 nights with one telescope would cost about $2,250.

The management of the new observatory is to be vested in an observatory council, consisting of members of the participating universities, and the council is also to decide on such matters as acceptance of new members, etc. If you are interested, I shall be glad to hear from you so that I can provide you with more detailed information.

The President of Indiana University, Herman B. Wells, wrote to Struve on July 17,
1 INTRODUCTION

1940, expressing the interest of Indiana University in this proposal. Struve acknowledged the letter on July 24. The plan had been presented to the University of Chicago President, Robert M. Hutchins, on March 16, 1940, in a memorandum: “Plan for Astronomical Collaboration in Connection with the McDonald Observatory.” Hutchins forwarded it to Homer P. Rainey, President of the University of Texas. Hutchins and Rainey were not opposed to the idea, but the time was not ripe for executing it. World War II was in progress, and it was clear that the United States would have to become involved before long. Struve wrote again to Wells, on December 27, 1940:

Because of the heavy rearmament program, it now seems out of the question that a new large telescope could be built until normal conditions have been reestablished. Hence, even if it should be possible to obtain a grant from one of the foundations for the construction of such an instrument, it would, I believe, be unwise to make any definite plans and after discussing the matter with President Hutchins and Dean Compton, it seems best to postpone this phase of the project.

Struve was far ahead of his time when he made this proposal. His idea was the spiritual ancestor of AURA and the Kitt Peak National Observatory, but with some differences of detail. Private funding was replaced by federal funding through an agency, the National Science Foundation, which was created ten years after Struve’s paper was published in *Scientific Monthly*. A small group of universities cooperating in a joint enterprise for their mutual benefit was replaced by a consortium of universities, AURA, Inc., organized to provide management for a national observatory that would be available to the entire astronomical community, not just the members of the consortium.
Planning for the growing needs of US astronomy in the post-war period. The important role of the National Science Foundation.

The bill that created the National Science Foundation was passed by the House of Representatives on April 27, 1950, and by the Senate the next day. President Truman signed it into law on May 10. This was the successful conclusion of a vigorous debate that started in 1945. The interesting and complicated story has been told in J. Merton England’s book, *A Patron for Pure Science*, covering the period 1945–1957; an earlier informal history covering the first 25 years of the National Science Foundation, *A Minor Miracle*, was written by Milton Lomask. These books are the source for some of the following discussion. The National Science Foundation’s first formal activity was on December 12, 1950 when the National Science Board (NSB), having been chosen by the President and confirmed by the Senate, held its first meeting. The bill that created NSF required the President to consider the National Science Board’s suggestions for a director when he filled that post. A special committee initially prepared a list of 40 names, and cut it down to 11 to be discussed by the Board at its second meeting on January 3, 1951. The name of Alan T. Waterman, Deputy Director and Chief Scientist of the Office of Naval Research (ONR), was on the final list of three, and he received the first formal offer of the NSF directorship. He accepted, and the appointment was made by President Truman on March 9, 1951. Dr. Waterman was reappointed by President Eisenhower in 1957, and President Kennedy allowed him to finish his second term by waiving the compulsory retirement rule when he turned 70 in 1962.

Waterman’s first task was to assemble a staff, including a deputy director, and several assistant directors who would be in charge of the operating divisions of the Foundation. Program directors, advisory panels, and consultants also had to be appointed. His second task was to persuade Congress to appropriate funds sufficient to allow the Foundation to initiate programs to support research and education in the sciences. The start-up budget for FY1951 was $225,000, and the NSF Law had set a ceiling of $15 million on later NSF appropriations.

The Bureau of the Budget approved a $14 million budget request for FY1952, the fiscal year starting July 1, 1951, and this was in the budget sent to Congress. On August
2 PLANNING FOR THE POST-WAR PERIOD: THE NSF

17 the House Appropriations Committee recommended $300,000, a 98 percent cut, and that is what the House voted to include in the FY1952 budget. Waterman immediately appealed to the Senate Appropriations Committee to restore most of the cut, and asked for a hearing. In September the Senate voted approval of $6.3 million, and the compromise finally approved on October 20 was $3.5 million. The late date, one-third of the way through FY1952, and the small size of the appropriation served to delay the start of the grants and the fellowship programs. Twenty-eight research grants in biological and medical sciences finally received Board approval on February 1, 1952. There was one grant in astronomy, $8,000 for two years to Willem J. Luyten of the University of Minnesota to support “Astronomical Research: Motions of the Stars.” The first awards in a scaled-down fellowship program were announced in April 1952.

The potential of the National Science Foundation as a source of funds to support astronomical research, including facilities, was quickly recognized by American astronomers. The American Astronomical Society (AAS) appointed a special committee in 1950, chaired by C.D. Shane, to study relations between astronomers and NSF. A draft report, written by Jesse Greenstein, was circulated to the Committee on July 6, and Shane sent a revised version to R.C. Gibbs at the National Research Council on July 20. After further revisions the report of the committee was published in late 1951. It proposed a National Science Foundation budget for astronomy of $380,000 in four main categories for the fiscal year ending June 30, 1952: A. Fellowships, $35,000; B. Publications, $35,000; C. Short-term Research Projects, $160,000; D. Capital Equipment Grants, $130,000. The report did not include funds for large new facilities in the first year, but said these would be needed later. The committee’s estimate of the “requirements in longer-term grants for urgently needed expansion of capital equipment” was a modest additional $200,000 per year.

The report also contained some administrative suggestions that NSF quite properly chose to ignore. The Office of Naval Research had started a program of small grants in astronomy in 1948 to provide interim support until the political problems of creating the National Science Foundation could be resolved. The AAS report proposed that NSF should use the ONR Committee on Astronomy in an advisory capacity to evaluate the scientific merit of research proposals, and to give advice on other astronomical matters. An upper limit of $10,000 per project was recommended, twice the size of the largest ONR grants. The members of the ONR Committee had been named by the Council of the American Astronomical Society, and NSF preferred to choose its own advisors. Dr. Paul Kloepsteg, the NSF Assistant Director for Mathematical, Physical, and Engineering Sciences (MPE), attended the meeting of the ONR Committee on January 19, 1952 to observe its mode of operation. In private conversation he rejected the AAS proposal in strong terms: “Who the hell do they think is running the NSF?”

The first “Ad Hoc Meeting of Astronomical Consultants” took place on August 1, 1952, the name was changed to “Advisory Panel for Astronomy” at the second meeting on February 5 and 6, 1953. The members were: Lawrence H. Aller, Dirk Brouwer, Jesse L. Greenstein, Gerald E. Kron, Gerard P. Kuiper, Martin Schwarzschild, and Fred L. Whipple. Joel Stebbins was an invited guest and Leo Goldberg represented the MPE Divisional Committee. The NSF staff members in attendance were: Alan T. Waterman (Director), Paul E. Kloepsteg (Assistant Director for MPE), Harry C. Kelly
THE BEGINNING

(Assistant Director for Scientific Personnel and Education – SPE), Ralph A. Morgen (Program Director for Engineering and Metallurgy – MPE), Raymond J. Seeger (Program Director for Physics and Astronomy – MPE), and Robert R. Stoll (MPE).

The meeting began with a general statement by Dr. Waterman about the purpose of the Foundation. In response to a question about NSF’s possible action in relation to ONR's termination of its support of astronomy, he said that NSF would try to avoid having the support of any worthwhile project abruptly terminated. Dr. Kelly described the various fellowship programs, and Dr. Klopsteg summarized the grants program for fiscal year 1952. He also said the $4.75 million appropriation for fiscal year 1953 would permit research expenditures in MPE of $800,000. Allocation to the different disciplines would depend on the spread and pattern of the proposals that were received.

Dr. Seeger reviewed his activities as Program Director for Physics and Astronomy. The nine astronomy proposals that had been received were reviewed by 22 reviewers. These proposals were 2.4 percent of the 369 received by MPE, and the two astronomy grants were the same percentage of the 85 grants that had been made. The morning session ended with a report by Dr. Goldberg on the recent meeting of the MPE Divisional Committee.

The afternoon session was devoted to a discussion of the first four of the five questions listed on the agenda. It was agreed that the consultants should meet twice a year, and that they should evaluate all proposals. Other reviewers should be used only in exceptional cases. The third question was: “In what way can NSF support the building of observatories? Their overall programs?” Following some general discussion the group voted in favor of a grant of $10,000 – $12,500 to Vanderbilt University, half of the requested $25,000. A proposal from the University of Arizona, Ohio State University, and Indiana University was discussed in detail. The vote “favored rejection of this specific proposal, although most were favorable to the idea of a photometric observatory and to cooperation of several institutions for major installations.” (This proposal, its background, and subsequent actions by NSF will be taken up in Chapter 4.) A radio astronomy proposal from Bok for $32,000 was discussed, and culminated in a tie vote (with Whipple absent); however, it had already been recommended favorably to the National Science Board by the Director. An Advisory Panel for Radio Astronomy was established in early 1954, and it reviewed later proposals in radio astronomy until the two panels were merged in 1957.
Radio astronomy was already two decades old by the time the first NSF research grants were made. However, the 21-centimeter line from neutral hydrogen in interstellar space was detected on March 25, 1951, only 16 days after the appointment of Alan T. Waterman as the first Director of the National Science Foundation. Thus, the Foundation and 21-centimeter radio astronomy, an exciting new development in a relatively new branch of astronomy, began life together. The first proposal to NSF for a radio astronomy project was submitted by Bart J. Bok in June, 1951 and a revised version was received on July 3rd in which $32,000 was requested to cover part of the cost of constructing a 24-foot equatorially mounted radio telescope designed for 21-centimeter observations; some private funding had already been obtained. Upon receipt of the revised proposal, the Director recommended favorable action to the National Science Board. Nevertheless, support for this proposal received only a tie vote after discussion by the astronomical consultants on August 1, 1951. Raymond J. Seeger, at that time Program Director for Physics and Astronomy, recalls that later “the Panel jumped on me” about making this grant, the beginning of support for radio astronomy by NSF.

Approval by the National Science Board came in September at its 16th meeting, and the grant was made in October. A later and larger grant, in March 1955, provided funds for a 60-foot equatorially mounted radio telescope at Harvard's Agassiz Station.

The concept of a National Radio Astronomy Observatory grew out of two conferences. The first of these was held in Washington, DC on January 4–7, 1954. It was an interdisciplinary conference on radio astronomy, sponsored by NSF, the Carnegie Institution of Washington and Cal Tech, that included discussion of the need for large radio telescopes in the United States. Further discussion took place in a small meeting that was requested by NSF after the conference. One immediate result from this meeting was the appointment by the NSF Director on May 3, 1954 of an Advisory Panel for Radio Astronomy, consisting of Merle A. Tuve (chairman), Bart J. Bok, Jesse L. Greenstein, John P. Hagen, John D. Kraus, Rudolph L.B. Minkowski, and E.M. Purcell. Tuve was a major figure in the reemergence of radio astronomy in the United States. Bok had started the radio astronomy program at Harvard, and Greenstein was
one of the first to appreciate the astronomical importance of Grote Reber’s pioneer observations. Hagen was deeply involved in radio astronomy at the Naval Research Laboratory (NRL), Kraus had designed and was building a large antenna at Ohio State, and Purcell was co-discoverer of the 21-centimeter line of neutral hydrogen. Minkowski was playing a major role in the optical identification of radio sources, using the Palomar 200-inch telescope.

In the meantime, Donald H. Menzel and several other scientists from the Massachusetts Institute of Technology (MIT), Harvard, and NRL, following a suggestion by Julius Stratton, requested Associated Universities, Inc. (AUI) to explore with NSF the feasibility of a national radio astronomy facility. AUI called a conference of 37 scientists with an interest in radio astronomy to discuss this proposal on May 20, 1954 in New York. NSF personnel in attendance were Paul Klopsteg, Associate Director; Raymond J. Seeger, Acting Assistant Director for MPE; and Peter van de Kamp, recently appointed as the first Program Director for Astronomy. The President of AUI, Lloyd V. Berkner, was chairman of the conference. A recommendation was approved that AUI should request funds from NSF to support “basic preliminary planning and preliminary feasibility studies – looking toward the creation of a large facility.” A 12-member ad hoc committee was appointed by AUI to guide the project, and it met on July 26, 1954 in New York. A draft proposal for $105,000 to be submitted to NSF by AUI was approved.

The AUI proposal was discussed by the Radio Astronomy Panel at its first meeting on November 18–19, 1954. Those in attendance were Tuve (chairman), Bok, Hagen, Kraus, Minkowski, and van de Kamp. The Panel reviewed the AUI proposal and recommended a grant of $85,000, which was made in January 1955. The Panel also stipulated that the site should be within 300 miles of Washington, in order to provide an eastern astronomical facility to complement the western optical observatories.

The first AUI report, including recommendation of a 140-foot dish as the principal instrument for the observatory, was submitted to NSF in early May 1955, to be available for the NSF meeting on May 19–20, its 34th meeting. An important and far-reaching recommendation from the MPE Committee of the Board was adopted by the NSF at this meeting:

1. The NSF should recommend as a national policy the desirability of government support of large-scale basic scientific facilities when the need is clear and it is in the national interest, when the merit is endorsed by panels of experts, and when funds are not readily available from other sources.
2. A national astronomical observatory, a major radio astronomy facility, and university research installations of computers, accelerators and reactors are examples of such desirable activities for NSF.
3. Funds for such large-scale projects should be handled under special budgets.

The “special budgets” provision was meant to prevent any encroachment “upon the regular established programs of the Foundation.”

AUI next submitted a request for $234,000, in July 1955, to support continuation of the studies for establishment of the radio astronomy facility. In September the Radio Astronomy Panel cut this to $140,500, and a grant of this amount was made on October
11, 1955. Two months later Green Bank, West Virginia was designated by the AUI Steering Committee as the best site, and this was approved by the Radio Astronomy Panel in mid-January 1956.

Tuve's personal hostility to Berkner, and to AUI as manager of the radio astronomy facility, began to surface at the first meeting of the Radio Astronomy Panel. The full story has been told by Allan A. Needell. The National Science Board’s MPE Committee decided that a conference should be called to discuss the AUI feasibility study “and this whole question of a pattern for a truly national organization to further radio astronomy research.”

The “Conference on Radio Astronomy Facility” was held in Washington on July 11, 1956, and it was a baptism of fire for the new Program Director for Astronomy, the author of this book, who was responsible for arranging the logistics of the meeting. The morning session was quiet and straightforward, with no warning of what would take place in the afternoon session. It began with an official welcome by Detlev W. Bronk, Chairman of the National Science Board. Waterman discussed the “Purpose of the Conference,” and described the present state of the radio astronomy facility in the Foundation. A separate item for facilities had been included in the NSF budget request for fiscal year 1957, and this facility would be the first major effort to be supported by NSF. Tuve discussed “U.S. Needs in Radio Astronomy,” and Bok surveyed “Radio Astronomy Research in the United States.” Berkner made some introductory remarks about the “NSF Feasibility Study by AUI,” and Richard M. Emberger, Berkner's assistant, gave a detailed account of the site survey and design studies for the 140-foot radio telescope. Minkowski spoke on the “Liaison of the Radio Astronomy Facility with Astronomers,” and Goldberg discussed the “Liaison of the Radio Astronomy Facility with Universities.” The final topic, discussed by Hagen, was “Expediting the U.S. Program.”

The afternoon session was concerned with the “Possible Organization and Management to Insure National Character of the Radio Astronomy Facility.” Two proposals were presented. AUI, which had been encouraged by NSF grants to carry on the site survey and radio telescope design studies, proposed that it would construct the facility for NSF and operate it for NSF under a management contract. A plan proposed by William G. Pollard, Executive Director of the Oak Ridge Institute of Nuclear Studies (ORINS) proposed that universities with an interest in radio astronomy should form a new group and incorporate under the title “Association of Universities for Radio Astronomy.” AURA would construct the facility under a management contract with NSF, and then operate the facility under conditional title, with NSF support through grants. The official minutes and a 70-page transcript give a sanitized version of the points made by speakers favoring the AUI plan and by speakers favoring the ORINS plan. The discussion was personal and bitter. For example, Tuve faced the AUI representatives and called them “self approved and self approving people.” Finally, Edward Reynolds, Harvard’s Vice-President for Administration and an AUI trustee, could stand it no longer and asked for the floor. A handsome man, he resembled Michelangelo's bust of Jove, and when he stood up, extended his arm at full length, and pointed at Tuve, he was for the moment Jove hurling thunderbolts from Olympus. At the start he said: “The atmosphere here has disturbed me very, very much indeed.” He concluded by saying: “We don’t want this contract under this atmosphere. You