

NATIONAL SCIENCE FOUNDATION
Washington 25, D.C.

Dedication of the
George R. Agassiz Radio Telescope
Harvard College Observatory
Harvard, Mass., April 28, 1956, 11:00 a.m.

Remarks by Dr. Alan T. Waterman
Director, National Science Foundation

WINDOWS ON THE FUTURE

President Pusey, Dr. Menzel, friends of the Harvard Observatory: I can think of no more felicitous occasion than one which brings us together for the dedication of new facilities for research and learning. The occasion that we observe with appropriate ceremonies today is especially fraught with expectation and promise. Radio astronomy is still so new, and the possibilities so vast, that we may be pardoned if, a little like children in happy anticipation of a new toy, we can scarcely wait to find out what each new instrument will do for us.

Considering the time that is usually required for the planning and construction of important new research tools, Drs. Bok and Ewen, the D. S. Kennedy Company, and the Ewen Knight Corporation have surely established something of a record in having completed, in little more than a year, the 60-foot radio telescope which we dedicate today. I bring you the greetings and congratulations of the National Science Foundation, which is happy to have had a part in making this occasion possible.

This is a week in which the spotlight has been focussed on radio astronomy. On Monday night last, the National Academy of Sciences awarded the Henry Draper Medal to Professor H. C. van de Hulst, professor of theoretical astronomy at the University of Leiden. Today, only 12 years after van de Hulst predicted that radiation of 21cm wave length should be emitted by neutral hydrogen in interstellar space, and a mere five years after the triumphant observation of this line by Ewen and Purcell here at this University, we dedicate a fine new instrument especially

constructed to give better resolution at this wave length. Rarely do events conjoin so happily.

I am sure we are conscious, this morning, of being among pioneers in a pioneering field. In such distinguished company I shall not attempt to retrace familiar ground. Rather, I shall ask what significance this occasion has for the future of radio astronomy and, more broadly, for the future of research generally. I have noted that radio astronomy is frequently described as a new window on the universe. I think we may extend this figure of speech and look upon it as a window on the future of research. For who can tell to what far limits our present knowledge and understanding may be extended by the tools that we are creating today?

I always enjoy recalling the incident that is reported to have occurred in the French Academy of Sciences, before the advent of spectroscopy, when a member disposed of a radical thesis by saying "That is as impossible as ever to discover the constitution of the stars."

Today's event is notable for a number of reasons, not the least of which is the fact that it represents a cooperative effort. Research tools of today, requiring, as they do, costly materials and the highest skills in planning and engineering, are necessarily expensive. The instrument that we dedicate today was made possible by funds provided by Harvard itself, by generous benefactors who prefer to remain anonymous, by the Research Corporation, and by the Federal Government through the National Science Foundation. All but the last represent traditional means by which research facilities are provided.

The interesting and promising note in the present situation is the fact that the Federal Government sees a responsibility for the provision of the tools of basic research where these cannot be provided, or can be provided only with difficulty, by the usual methods of support. There would be less novelty in the situation if the instrument in question were expected to provide results of immediate and practical application from which the Government could expect to benefit. The fact is, however, that radio astronomy at the present time is fundamentally basic research in one of its purest forms. One can see on the horizon, even now, certain applications which must inevitably result. But our real purpose in creating these facilities is to further our knowledge of the universe of which we are so infinitesimal a part, or, as one writer has so beautifully put it, to construct a mirror in which we may view our own galaxy.

As we all know, government support of basic research developed during the postwar period, when our colleges and universities began to accept grants and contracts in order to make

up for the time lost from research during the war. They did so, not without initial misgivings, but I believe it is the common feeling that this was not only a necessary development, but that it has, on the whole, been a very healthy development. Certainly it has seemed to be the only way by which the increasing costs of many types of research equipment could be met and the shrinkage of nongovernmental funds compensated for. Such things as supersonic wind tunnels, nuclear accelerators, and electronic digital computers, which have proven to be such essential research tools, could not have been financed in any other way. Now funds for the developments of which I speak were provided initially because of their importance and significance to industry and to Government, notably defense. In other words, there were practical reasons, as well as scientific reasons, for embarking upon these costly programs. It is also true that the staffs of government research agencies, notably the Office of Naval Research, have reflected in their policies full awareness of the importance of such facilities to the progress of science. In many cases, however, these machines are used wholly or to a considerable extent for military or commercial purposes. The National Science Foundation has therefore undertaken to see what may be done about the development and construction of similar facilities for the primary purpose of basic research. In fact, this question was raised directly as a matter of Government policy, and I am pleased to state that the Federal Government does indeed stand ready to support facilities for pure research when such support is necessary in the interest of science.

The President's budget for the National Science Foundation in the coming fiscal year contained a request to the Congress for the support of several such facilities including, in addition to radio astronomy facilities, an astronomical observatory equipped with modern electronic devices, nuclear reactors for research purposes at universities, modern digital computers for university use, and biological field stations. The Government's position in this matter is that it should help to advance science by providing facilities for research when these are beyond the means of our educational institutions and are urgently needed for the advancement of research. At the same time, it is our feeling that it is to the best interest of our universities to make every effort to provide funds for continued maintenance of these facilities in order that permanent subsidy by the Government may be avoided. If such efforts fail, the Federal Government should be prepared to stand behind the continuation of the facilities for research.

It is encouraging that the people of the United States, through their elected representatives, should be willing to commit substantial funds for the enrichment of learning. In this, of course, our Government is not unique. Dr. A. C. B. Lovell, the distinguished British radio astronomer, in commenting on the construction of the new instrument at Jodrell Banks, observed:

* When a country that is struggling with a financial crisis and shortages of raw materials decides to spend a million dollars and 2,000 tons of steel on a single instrument for fundamental research, important results must be expected. Great Britain is now making such an investment in a new kind of gigantic telescope. It will be concerned with what may seem a visionary enterprise--the exploration of the universe--but Britain anticipates a rich harvest of discovery from the investment.

It has been a source of embarrassment here that radio astronomy should have been permitted to lag in the United States, where it was initially discovered by Karl Jansky some 25 years ago and where the field was so effectively pioneered by Grote Reber. Until recently there was no prospect of radio astronomy facilities in the United States that could compare with those under construction or already in operation in England, Australia, and Holland. Fortunately, the picture now looks very much brighter, with Harvard taking the lead in research on interstellar hydrogen, and other significant projects also under way. The Naval Research Laboratory continues to pioneer in the field. John D. Kraus, of Ohio State University, is making splendid progress on the construction of his new radio telescope of novel design. The Carnegie Institution of Washington's Department of Terrestrial Magnetism is planning a new installation, and the California Institute of Technology has recently announced plans for the construction of a radio telescope, with the assistance of Navy funds.

The National Science Foundation has for some time been financing site studies and the preparation of plans for a radio telescope with a 140-foot dish to be operated ultimately by a group of universities. Substantial funds for this purpose have been included in our 1957 budget, and our program in this field will be determined by the final action of Congress. Senate Appropriation Committee hearings on our budget were held yesterday, and it should not be very long before we know the results.

Regardless of the outcome, however, the significant thing for the future of research in radio astronomy, as well as other fields, is that the Government is firmly committed to the encouragement and support of basic research and education in the sciences, and that such support is now to include major facilities for basic research.

* The New Astronomy, Simon and Schuster, 1955, p. 229.

In the past 300 years, the history of scientific research has been marked by the efforts of scientists to obtain the funds needed for their work and their indispensable instruments. When the instruments were small and simple, the problems were not so great. As science has progressed and its tools have become larger and more complex, and hence more expensive, scientists have had to dissipate a good deal of their energy in looking for the wherewithal to provide their tools.

Especially is this true in the field of astronomy, where the instruments have been large and costly almost from the beginning. All of the large telescopes, for example, have required cooperative financing or some form of subsidy. Such absolute monarchs as King Frederick II of Denmark and Emperor Rudolph II were early patrons of astronomical research; so Government aid is not wholly without precedent. To such enlightened and benevolent monarchs all credit is due. But there is a special thrill about the process by which people in a democracy undertake to provide for the needs of research and the education of the oncoming generation. Traditionally, we have done this, to the extent possible, through private resources and by local effort. But when the need has been sufficiently great, it is significant that the Government has responded.

The process has not always been swift nor necessarily without difficulty. Many of you will recall that the Congress debated the establishment of the National Science Foundation some five years before passing the bill which brought it into being. Having finally come into being, the infant agency at first appeared to be in some danger of dying from lack of nourishment. The Foundation's first appropriation for Fiscal Year 1952 was only $\$3\frac{1}{2}$ million, an amount far below the statutory limitation of \$15 million, which has since been removed. As public awareness of the importance of basic research and education in the sciences has grown, however, our appropriations for these purposes have increased commensurately. This year we are greatly pleased that the House voted a budget of \$36 million for the Foundation, which is about ten times as large as our first appropriation and more than double that for the current year.

It is only now that we are in a position to offer support to the large instruments and facilities that are so indispensable a part of much modern research. In the past we have divided our efforts approximately between the support of worthwhile projects by investigators of proven ability or potential promise and the furtherance of education through the award of fellowships and experimental programs in research education. Funds in minor amounts went for support of scientific conferences, the furtherance of acquisition of data, exchange of scientific information, and studies in support of national science policy.

Now, however, we shall be able to do these things on a more satisfactory scale, and in addition, we shall be able to give support, at least in a limited way, to certain much needed facilities.

Astronomy has come in for a relatively large share of facilities support by the Foundation, above and beyond the support which we are giving to radio astronomy. Plans are going forward for the construction of a new National Astronomical Observatory. If present plans mature, the addition of new instruments, both optical and electronic, should give great impetus to astronomical research in the years just ahead.

Probably more than any other field, astronomy can be classed as pure research. Inasmuch as the Foundation is dedicated to the furtherance of basic research and education in the sciences, it is especially important for us to see that the interests of astronomy are supported.

Here I should like to emphasize the important implications which these new instruments have for education. For it is certainly clearer than ever before that research and teaching go hand in hand, and that no great research effort can go forward unless there are gifted young investigators coming along to carry it forward. In radio astronomy, Harvard again takes the lead, as it has so often done in years past. I understand that the small 24-foot radio telescope has already produced more radio astronomers than any other radio telescope in the country, and that Drs. Heeschen and Lilley were the first to receive Ph.D.'s in radio astronomy. With such a record of achievement, stemming from so modest a beginning, who knows how many more youthful geniuses may come along as the new instrument is brought into operation?

Radio astronomy, like several other modern fields in the physical sciences, is notable for the youth of its pioneers. We are impressed by the accomplishments of such young men as Drs. Ewen, Lilley, and Heeschen, and Mr. T. K. Menon, to say nothing of the fact that Professor van de Hulst made his notable hypothesis at the age of twenty-four. As we look into the future, we are deeply aware of the special thrill of being in on the beginning of a new art. Undoubtedly Karl Jansky and Grote Reber, when they first consciously tuned their receivers to signals from outer space, felt something the way Galileo must have felt when he first trained his telescope on the heavens. The older generation cannot but envy our young colleagues who can look forward to uncovering new secrets of the universe far beyond those that we can anticipate or imagine.

These are the special rewards of basic research that the investigator enjoys, but they are also values that cannot be so easily explained to society. For society tends to confuse

science with its end-products. Despite the growing appreciation of the importance of science and technology for our defense, for our health and economic strength, the fact remains that the basic research on which these things depend is still not so well understood, nor so well supported as it should be. This is a view which the Foundation has expounded regularly and with some emphasis. It goes back to the pithy statement of Vannevar Bush that "Applied research drives out basic." Funds will always be available for research programs that are of obvious and practical value to society. Basic research, on the other hand, is sometimes cynically defined as the kind of research for which one cannot secure financial support.

The emphasis that I place upon basic research is in no way intended to detract from the importance of applied research and technology. These are probably manifestations of an irresistible force characteristic of our stage of civilization. Nevertheless, it must be remembered that we can continue to enjoy the fruits of research only if basic progress in science is encouraged, both for the sake of the ideas and information it produces and because scientists and engineers are trained fundamentally via basic research.

But the most important point of all is the intimate relationship that exists among scholars in our colleges and universities. If we are to combat materialism and develop a proper sense of proportion in our values, it is essential that basic research in science continue in a strong and healthy state in the academic environment. For it is primarily in such an environment that science maintains its needed contacts with the liberal arts and the best thinking of all our scholars. As a matter of fact, there is no good reason to regard the sciences as essentially different from other scholarly pursuits. They require the same qualities of deliberation, concentration, and imagination that all research demands. In the years to come, the universities and colleges should continue as the strongholds of fundamental research and education, not only in the interest of each discipline but more especially because of their common interests and the importance of those interests to coming generations.

I congratulate Harvard University and the Harvard Observatory on this magnificent new addition to its facilities. I note with pleasure that you have chosen to name the new instrument the George R. Agassiz Radio Telescope, in honor of a man who was one of the great benefactors of Harvard, whose interests and friendships were closely identified with the Harvard College Observatory, and whose name is one of the ancient and splendid ones in science. I am told that Mrs. Agassiz and other members of his family continue to follow the affairs of the Observatory

with warm and friendly interest. The National Science Foundation joins them and other friends and benefactors of Harvard University in wishing the new station well on the threshold of new achievements in research.

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