PROPOSAL FOR DEVELOPMENT OF A LARGE ANTENNA

The National Radio Astronomy Observatory requests $250,000 for engineering studies and design of a very large antenna system. We feel that this request is not only justified but is obligatory on our part if we are to fulfill our obligations to American science, as they are envisaged by U. S. scientists.

On October 16, 1957, a meeting was held of the radio astronomy advisory committee to the NRAO, for the purpose of discussing the research programs of the observatory. In addition to the advisory committee, the meeting was attended by astronomers, radio astronomers, and physicists from most of the leading astronomical and radio astronomical institutions in the United States. This group unanimously approved a statement setting forth the general policy of the NRAO, which reads in part;

> "The NRAO must continually anticipate the needs of and future developments in radio astronomy, and act promptly and decisively to provide for these needs.",

and further,

> "Because of the great time lag in the development of major instrumentation, the NRAO should, through its scientific advisors and staff, look now at the general direction of radio astronomy development in coming years, and commence planning for the next stage of development beyond the 140-ft."

The 140-ft. radio telescope is a major step in radio astronomy. It will provide scientists with an instrument unequalled anywhere, for centimeter wave studies, and its productive lifetime will be very long. Thus the 140-ft. telescope should put the United States in the forefront of radio astronomical research. To remain there, we must plan now for future instrumentation. The above mentioned action of our scientific advisors is a clear directive to us to do so.

Radio astronomy is a very young and very rapidly developing science. The 140-ft. telescope will solve many of the current problems of radio astronomy, and will undoubtedly make many new discoveries and open new fields for investigation. But in solving problems and in making discoveries new problems and ideas will inevitably arise, many of which will require still more powerful instruments for their study. This is the way science progresses.

The principle, continuing, need in radio astronomy is for greater antenna gain and resolution. Radio telescopes are still very inferior to optical telescopes in these respects. Antenna gain and resolution are related quantities; both are dependent on the dimensions of the antenna, with gain being proportional to the collecting area of the antenna. We propose to study antenna systems with

about 10^6 square feet of collecting area. This particular size is a scientifically significant increase over existing or currently planned antennas, and appears to be feasible from an engineering point of view. The type of antenna system that would be most advantageous will depend in part on the problems it is to be used for, and in part on economic and time considerations.

We propose to investigate various types of antenna systems from the standpoint of -

(a) scientific capability
(b) engineering feasibility
(c) cost
(d) time required for acquisition.

Out of this study should come recommendations for the next major instrument at NRAO, and a detailed design of the selected system.

The 140-ft. telescope will make possible the determination of the properties of a considerable number of radio sources. A next step after this consists of statistical studies of the properties of a large number of sources. To do this, a very large antenna is required. Thus the 140-ft. will be used to establish and calibrate certain relationships between sources, and the large antenna would be used to extend these relationships to greater distances and a larger number of sources. The properties of a source which are in principal directly obtainable from observations consist, in addition to the optical identification and properties, of the position, intensity, spectrum, polarization, size, and brightness distribution of the source, and any variation with time of these quantities. A very large antenna, of 10^6 square feet collecting area, would allow determination of many of these properties for a very large number of sources. Such studies are essential to the continuing progress of radio astronomy.

An antenna of 10^6 square feet collecting area would have approximately the same gain at 20 cm wavelength that the 140-ft. telescope will have at 3 cm wavelength. Thus the large antenna would have a sensitivity and power in the decimeter range comparable to that of the 140-ft. telescope in the centimeter range, and would make possible extension and expansion to longer wavelengths of the work of the 140-ft.

The usefulness of a very large antenna in 21-cm line studies would be very great. It would make possible the determination of red shifts of a significant number of very distant objects, and would thus contribute materially to cosmological problems. It would enable high resolution studies to be made of regions of special interest in our galaxy-regions, for example, where it is now thought that stars are in the process of formation. It would make feasible the study of magnetic fields in the galaxy. Information about these magnetic fields is now needed for many astronomical problems, including those of the origin of cosmic rays.

This discussion gives only a few of the problems we know of today that require the aid of a very large antenna. The need and desire for very large antenna's is already great, and will undoubtedly increase rapidly in the next few years. It is our conviction that the United States, through the NRAO, should be prepared to meet this need.

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