Radio Science Support

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Since 1967, radio scientists have used the Deep Space Network 26- and 64-m antenna stations to investigate pulsars, to study the effect of solar corona on radio signals, and to observe radio emissions from X-ray sources. More recently, very-long-baseline interferometry (VLBI) techniques have been used for high-resolution studies of quasars. During the reporting period, VLBI observations were made of quasars and pulsars. Support was also provided by the 64-m antenna for the measurement of cosmic background noise and weak radio sources to search for interstellar molecules and to observe radiation from Jupiter.

I. Introduction

The 26- and 64-m antenna stations of the DSN have been used for several years to support radio science experiments. NASA, JPL, and university scientists have used key DSN facilities whose particular and unique capabilities were required for the performance of the experiments. In order to formalize the method of selecting experiments and experimenters, a Radio Astronomy Experiment Selection (RAES) Panel was formed in 1969. Notice of availability of these facilities was placed in professional journals to inform the scientific community that they were available for limited use by qualified radio scientists (Ref. 1). No charge is made for use of the standard DSN facilities and equipment; special equipment, however, must be provided by the experimenters. A summary of all experiments conducted through June 1972 is reported in Refs. 2 through 7.

II. Radio Science Operations

In July and August, radio astronomy observations conducted under the auspices of the RAES Panel used approximately 97 hours on the 64-m-diameter antenna at Goldstone (DSS 14). The experiments supported are shown in Table 1. Most of the time was devoted to three 24-h observations of quasars and galaxies, under what is called, for convenience, the "quasar patrol." As described in Ref. 7, the purpose of this activity is to conduct a regularly scheduled set of observations for the purpose of detecting changes in structure and flux output of quasars and galaxies as well as searching for new sources. The proposal was formally approved by the RAES Panel during this reporting period. The various teams of investigators are shown in Table 2. It is the practice to schedule one such 24-h observation each month on a day that does not interfere with critical spacecraft activities and which

is also compatible with the schedule of the MIT Haystack 37-m antenna and/or the 42-m antenna of the National Radio Astronomy Observatory (NRAO). A second day was scheduled in late August in lieu of one in September. Mariner 9, orbiting Mars, will be at opposition in September, and the need is to track the spacecraft in support of a relativity experiment.

The other radio astronomy experiments in Table 1 were supported with several 8-h observations and are now completed.

As shown in Table 1, support was given to Radio Science programs sponsored by the Office of Space Science (OSS) as well as to radio science-related support of flight project requirements. The planetary radio astronomy observations of Jupiter and Uranus made use of the DSN-developed K-band (14 GHz) equipment. This equipment, consisting of antenna feed, microwave components, maser, and receiver, and also the noise-adding radiometer, is also used for searching for interstellar microwave lines.

The program on Earth dynamics sponsored by the Office of Applications (OA) was supported with a short baseline interferometry observation at Goldstone. A baseline between the 64-m antenna at the Mars site and the 26-m antenna at the Echo site was used to check out newly acquired NRAO Mark II very long baseline interferometry (VLBI) digital recording terminals.

Two observations were made that are radio science-related DSN developments. They were undertaken as part of the weak signal detection task. One was the attempt to detect the Jupiter satellite Callisto. The other was the attempt to detect the asteroid Toro. Data from these observations are being processed and analyzed.

III. Radio Astronomy Experiment Selection Panel Activities

The RAES Panel disapproved one proposal in the July–August period and approved the "quasar patrol" (see Table 2).

References

1. *Bulletin of the American Astronomical Society*, Vol. 2, No. 1, p. 177, 1970.
2. Linnes, K. W., Sato, T., and Spitzmesser, D., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. III, pp. 46–51. Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1971.
3. Linnes, K. W., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. V, pp. 42–44. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1971.
4. Linnes, K. W., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VI, pp. 43–45. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1971.
5. Linnes, K. W., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VII, pp. 29–31. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1972.
6. Linnes, K. W., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VIII, pp. 24–28. Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1972.
7. Linnes, K. W., "Radio Science Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. X, pp. 52–58. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1972.

Table 1. Radio science experiments involving 64- and 26-m-diameter antenna facilities

Experiment	Purpose	Experimenter	DSN facility	Date
		RAES Panel experiments		
Small-scale variations in cosmic background radiation	To search for small-scale spatial variations in the 2.7 K cosmic background radiation of 3.5 cm	R. Carpenter (Calif. State College of Los Angeles) S. Gulkis (JPL) T. Sato (JPL)	DSS 14	Jan. 10, 11, 1972 Feb. 11, 12, 22, 1972 Mar. 14, 25, 1972 May 8, 28, 1972 July 14, 1972
Weak radio source observations	To measure the "confusion distribution" of weak radio sources at 2.3 GHz	D. L. Jauncey (Cornell University) M. J. Yerbury (Cornell University) J. J. Condon (Cornell University) D. J. Spitzmesser (JPL)	DSS 14	June 5, 12, 1972 July 5, 13, 1972
Quasar structure by X-band VLBI "quasar patrol"	To monitor time variations and fine structure and apparent position of quasars	T. Clark (GSFC) R. Goldstein (JPL) H. Hinteregger (MIT) C. Knight (MIT) G. Marandino (University of Maryland) A. Rogers (MIT Haystack Observatory) I. Shapiro (MIT) D. J. Spitzmesser (JPL) A. Whitney (MIT)	DSS 14 (and MIT Haystack antenna)	June 9, 19, 1971 Sept. 19, 1971 Oct. 2–4, 10, 17, 1971 Jan. 4, 1972 Feb. 18, 1972 Mar. 10, 1972 May 9, 1972 July 3, 1972 Aug. 29, 1972
X-band VLBI "quasar patrol"	To study the structure of extra galactic sources with improved resolution	J. Broderick (NRAO) B. Clark (NRAO) K. Kellermann (NRAO) D. Jauncey (Cornell University) M. Cohen (Caltech) D. Shaffer (Caltech)	DSS 14 (64-m antenna at Goldstone) (and MIT Haystack antenna)	Feb. 1971 Nov. 2, 1971 Feb. 5, 1972 Mar. 4, 1972 Apr. 24, 1972 May 20, 1972 June 6, 1972 Aug. 8, 1972
		OSS Experiments		
Interstellar microwave low-noise spectroscopy	To search for interstellar molecules at 14 GHz	S. Gulkis (JPL) T. Sato (JPL) B. Zuckerman (Univ. of Maryland) D. Cesarsky (Caltech) J. Greenstein (Caltech)	DSS 14	Apr. 2, 10, 18, 1972 May 2, 6, 14, 17, 1972 June 4, 19, 1972 Aug. 5, 1972
Planetary radio astronomy	To study radio emissions of Uranus and Jupiter at 14 GHz	S. Gulkis (JPL) B. Gary (JPL) M. Klein (JPL) M. Jansen (JPL Resident Research Associate) E. Olsen (JPL Resident Research Associate) P. Rosenkranz (JPL Resident Research Associate)	DSS 14	Apr. 29, 30, 1972 July 14, 1972 Aug. 3, 1972

Table 1 (contd)

Experiment	Purpose	Experimenter	DSN facility	Date
		OA Experiment		
Earth dynamics VLBI	To demonstrate the NRAO Mark II digital recording terminal by measuring the baseline between DSS 14 and 12 at Goldstone	P. MacDoran (JPL) J. Fanselow (JPL) J. Thomas (JPL) J. Williams (JPL)	DSS 14 DSS 12	Aug. 15, 1972

Table 2. Recently approved radio astronomy experiments

Title	Purpose	Experimenters	Facilities required
"Quasar patrol"	To make detailed measurements on radio galaxies and quasars at 2.3, 7.8, and 15.6 GHz; to search for weak compact sources in the nuclei of extended radio galaxies and quasars; to monitor time variations in fine structure and apparent positions of quasars	Group A D. S. Robertson, WRE A. J. Legg, WRE J. Gubbay, WRE A. T. Moffet, Caltech G. Nicholson, CSIR Group B J. J. Broderick, NAIC B. G. Clark, NRAO M. H. Cohen, Caltech D. L. Jauncey, Cornell K. I. Kellermann, NRAO G. H. Purcell, Caltech D. B. Shaffer, Caltech Group C T. A. Clark, GSFC R. M. Goldstein, JPL H. F. Hinteregger, MIT C. A. Knight, MIT G. E. Marandino, Univ. of Maryland G. Resch, Univ. of Maryland A. E. Rogers, Haystack Observatory I. I. Shapiro, MIT A. R. Whitney, MIT	64-m antenna at Goldstone (working with the MIT Haystack antenna and/or the NRAO 42-m antenna) 26-m antenna in Australia