IV. RADIO ASTRONOMY[*]

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A. K-BAND RADIOMETRY AND OBSERVATIONS

Observations at 25.5 kmc were made of Venus, Taurus A, the Sun, and the Moon during the first two weeks of December 1962. These were made with the Lincoln
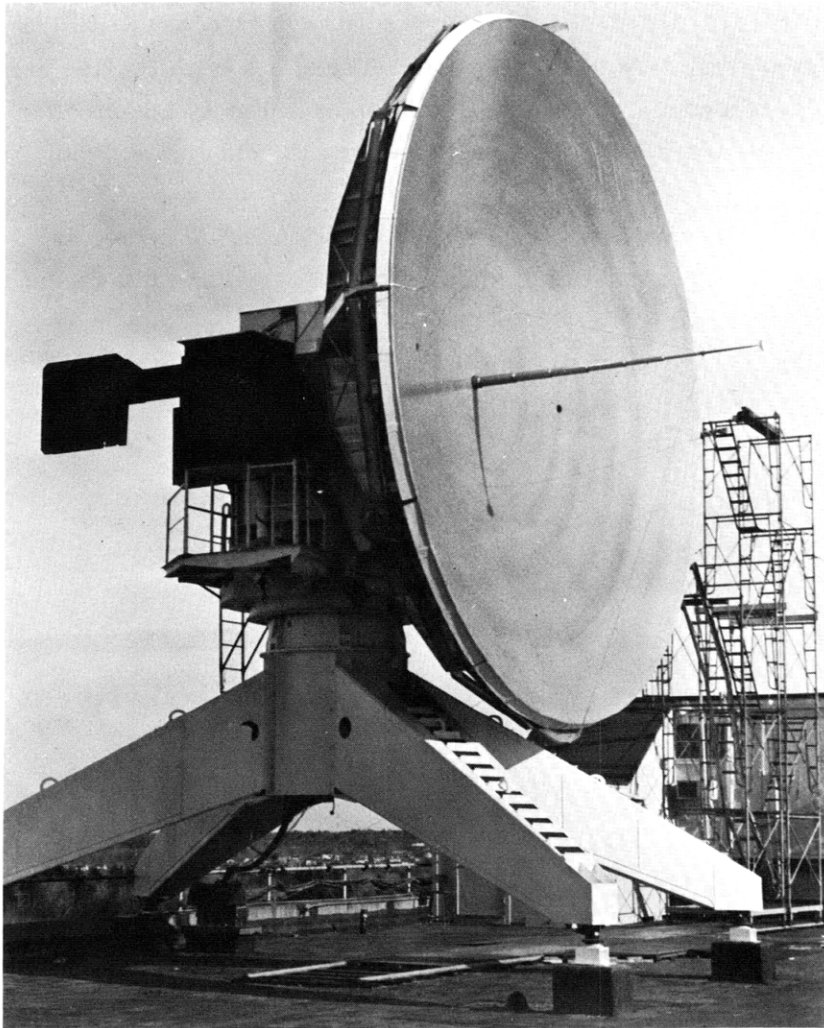

Fig. IV-1.

28-ft diameter parabolic antenna at Lincoln Laboratory, M.I.T.

Laboratory 28-ft antenna shown in Fig. IV-1, and the superheterodyne radiometer described in Quarterly Progress Report No. 68 (pages 35-37). Observations were made simultaneously at 35.2 kmc at Lincoln Laboratory, M.I.T.

The data have not been completely processed, so only preliminary results are available.

The observations of Taurus, the Sun, and the Moon were all drift scans in which the antenna was pointed ahead of the source and held stationary while the source moved past. Venus was observed by using drift scans and on-off measurements. An on-off measurement consisted of tracking with the antenna pointed first at one side of the source, on the source, and then off again. Each of these three steps lasted one or two minutes.

Venus was observed with approximately 130 drift scans, Taurus A with 20, the Sun with 8, and the Moon with 9. Venus was also observed with approximately 60 on-off measurements. Brief attempts were made to observe Cassiopea A and Jupiter, but without success.

Figure IV-2 shows a typical drift scan of the sun. The variation in the center is believed to be due to small gain fluctuations, and the wings of the curve are due to the
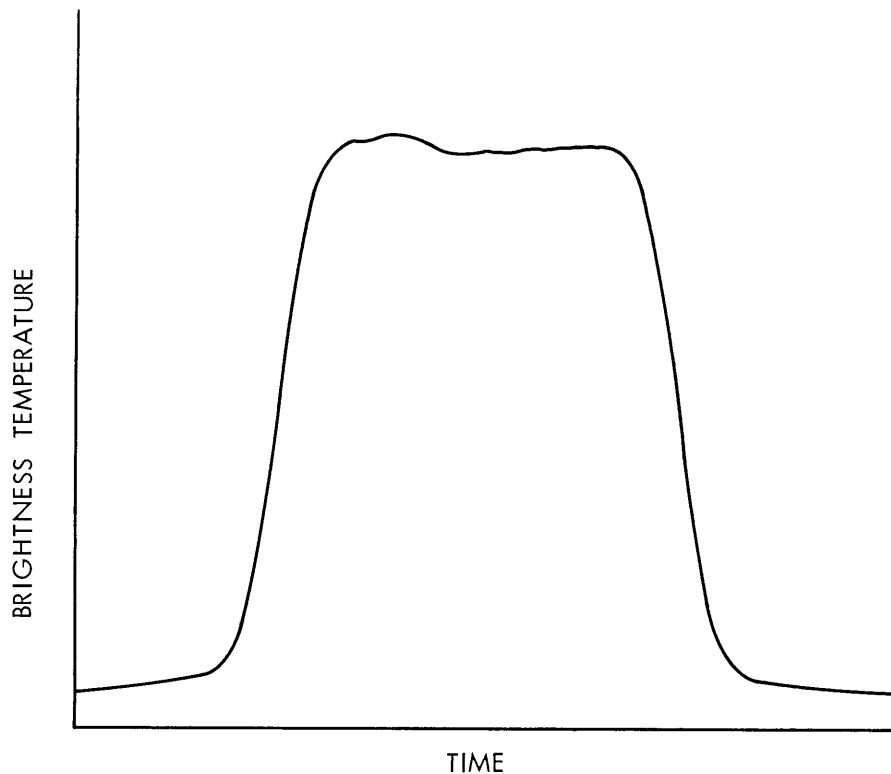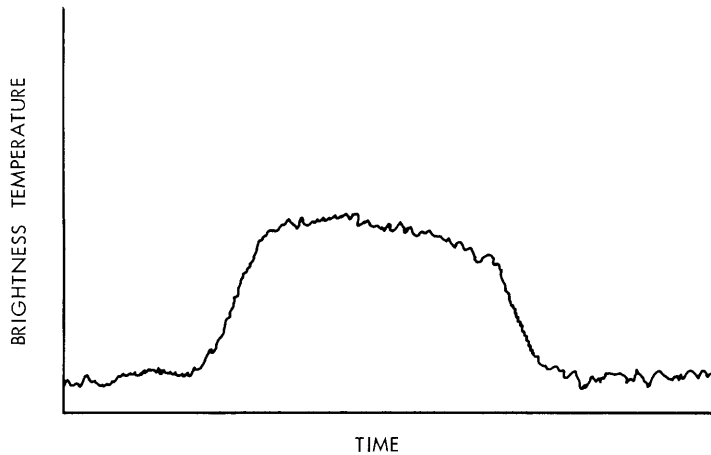

Fig. IV-2. Solar drift curve.

Fig. IV-3. Lunar drift curve.

antenna side lobes. Figure IV-3 shows a typical drift scan of the Moon. The asymmetry in the curve is due to the nonuniform temperature of the Moon's surface which exists 3.5 days before full Moon.

The preliminary results are:

1. Venus (on-off data), $\overline{T}_B = 400 \pm 100°K$

2. Taurus A (assuming disk of 3.6' diameter of uniform intensity),
$$S_\nu = 230(\pm 100) \times 10^{-26} \text{ w/m}^2\text{cps}$$

3. Sun (center), $T_B = 8900 \pm 980°K$

4. Moon (center)

   3.5 days before full Moon, $T_B = 240 \pm 40°K$

   0.3 day before full Moon, $T_B = 254 \pm 30°K$

   1.8 days after full Moon, $T_B = 254 \pm 30°K$

In this list the error brackets are estimates.

These preliminary results are close to the expected values. The final results will be presented after the rest of the data are analyzed and final corrections for antenna gain and atmospheric attenuation are completed.

D. H. Staelin

B. RADIOMETER AT FOUR MILLIMETER WAVELENGTH

In Quarterly Progress Report No. 66 (page 49) a Millimeter Radio Telescope was described. This report will discuss the development of a radiometer for use with this antenna.

The block diagram of the radiometer is shown in Fig. IV-4. It is a Dicke type of radiometer utilizing a ferrite switch to compare the input signal with a known signal, a single-ended mixer, and two traveling-wave tubes for if amplifiers. The input is

centered at 72 Gc (4.16 mm), the local oscillator at 69.0 Gc, and the if strip has a measured bandpass of approximately 1200 mc. The receiver noise figure was measured to be 31 db, 10 db greater than the design objective. The source
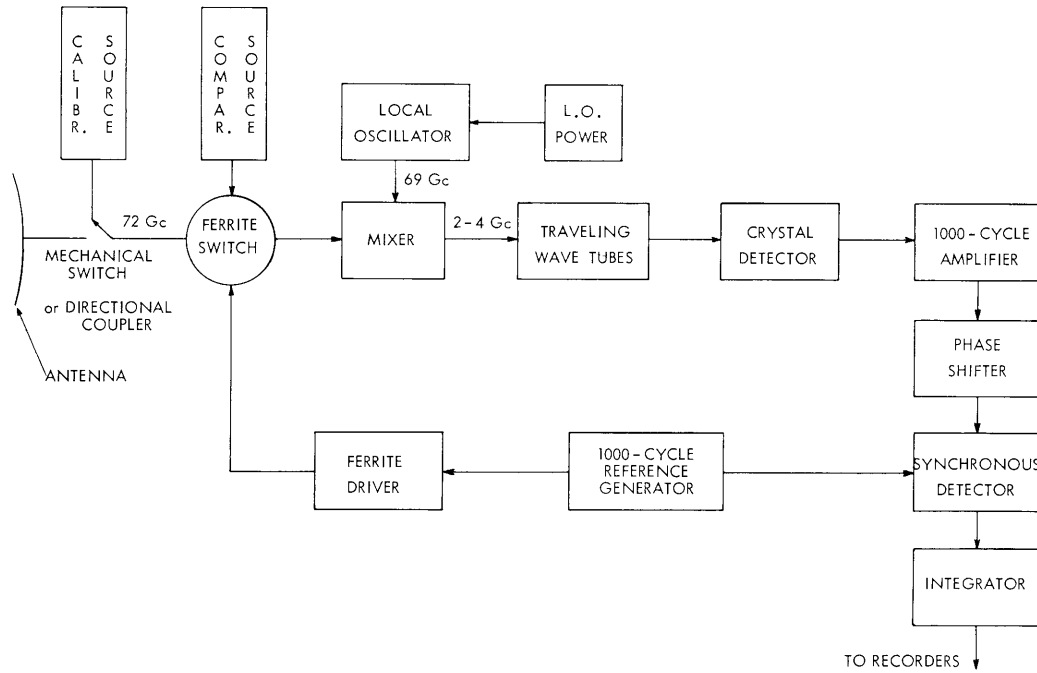

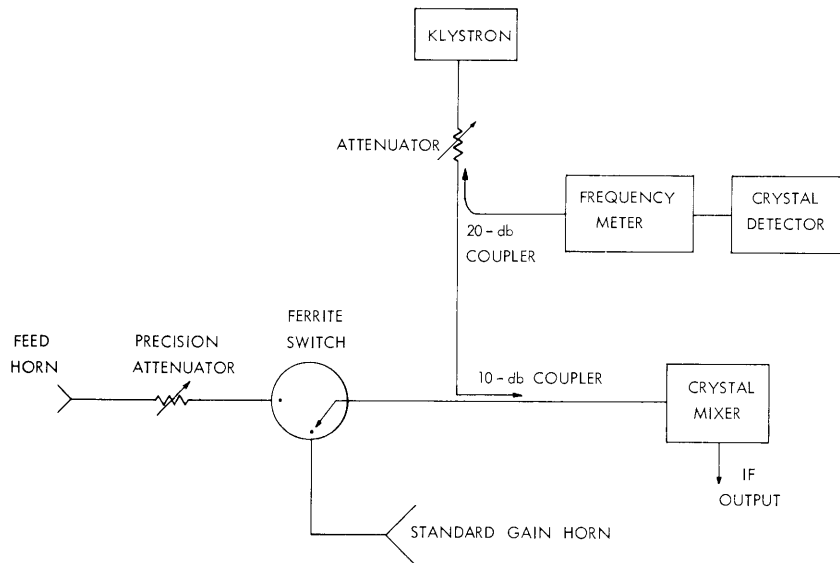Fig. IV-4. Four millimeter wavelength radiometer.

Fig. IV-5. Schematic diagram of millimeter wave section of the radiometer.
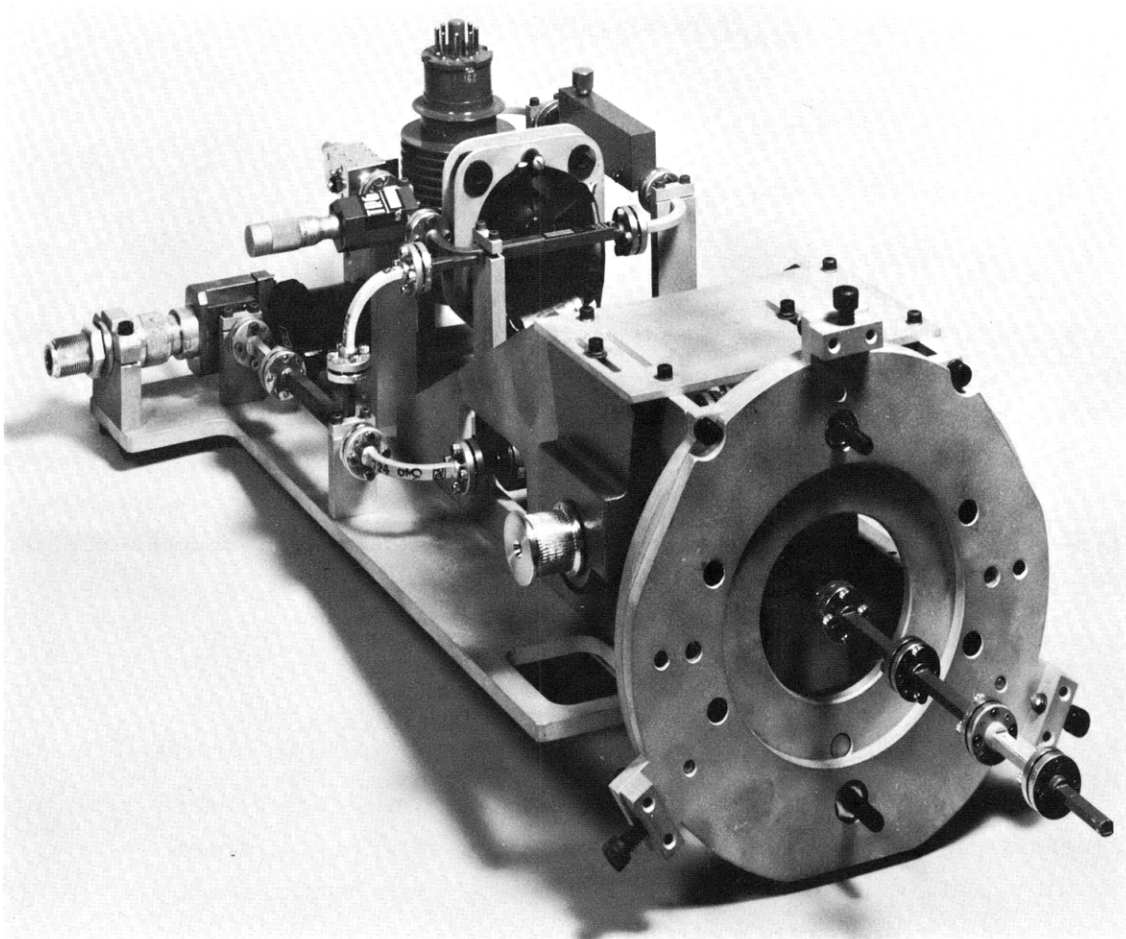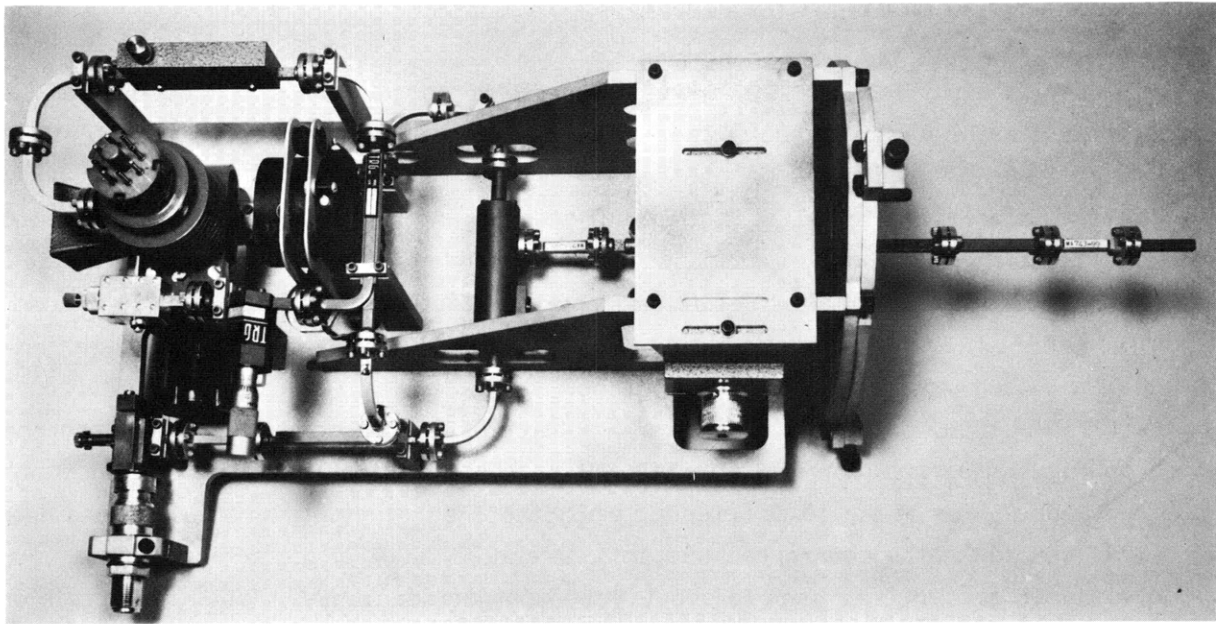
Fig. IV-6. Millimeter wave section of the radiometer.
Upper: top view. Lower: front view.

of difficulty lies in the crystal mixer. An effort is now being made in the laboratory to obtain an improved mixer for use in millimeter-wave radiometers with microwave if strips.

The radiometer was installed in the 10-ft antenna, and an on-axis gain measurement made. The remote transmitter used in testing the 10-ft parabolic antenna was located at Quigley Memorial Hospital at Soldier's Home in Chelsea, a distance of 4.25 miles from the Compton Laboratories Building in Cambridge. The transmitter package consisted of a 6-inch parabolic antenna, klystron, and microwave equipment mounted on an optical telescope. The millimeter-wave section of the radiometer is shown schematically in Fig. IV-5, and pictorially in Fig. IV-6. This section of the radiometer was mounted at the focus of the 10-ft antenna, while the TWT if amplifiers and second detector were mounted in the counterbalance structure at the rear of the antenna.

A standard gain horn is used to provide the comparison signal. When the precision attenuator is tuned to balance, the antenna gain is given by

$$G(db) = G_{cal}(db) + L_{attn}(db) + L_{path}(db)$$

where

G_{cal} = gain of standard gain horn

L_{attn} = calibrated attenuation

L_{path} = difference in path loss.

A comparison technique such as this reduces the effects of variations in transmitter power and atmospheric attenuation.

Weather conditions have not permitted a careful optimization of the feed-horn position. Consequently, the following data indicate only a lower bound on the performance of the antenna. Rough measurements show that the antenna has an on-axis gain of at least 62 ± 2 db, an efficiency of 31 per cent, H-plane (azimuth) side lobes of 12 db and 15 db, and E-plane (elevation) side lobes of 20 db.

J. C. Blinn III

C. OPTICAL RADAR TO STUDY THE EARTH'S ATMOSPHERE

The use of an optical radar to study the Earth's atmosphere by back-scattering has been considered and the construction of an instrument is well advanced.

In particular, we plan to study the dust layers[1] up to heights of 100 km. At first our main object will be some systematic observations of the noctilucent clouds (~80 km); these clouds are more easily distinguishable from molecular Rayleigh scattering, which is predominant at lower heights. The mechanism of Raman scattering will also be

utilized to infer density profiles for the various atmospheric molecular species because the value of the wavelength shift is a characterictic of each species.

The optical radar consists of a short-pulse ruby laser capable of the following performance:

energy in one pulse,	0. 5-1. 0 joule
length of pulse,	1 μsec
pulse repetition frequency,	1 cps.

The laser beam is collimated by means of a refractor of 2. 019-m focal length, and 0. 075-m diameter. The receiver utilizes a Newtonian reflecting telescope of 2. 70-m focal length and 0. 30-m diameter, and a photoelectric photometer.

G. Fiocco

References

1. Following are a few of the numerous references on the subject of cosmic dust and noctilucent clouds: E. J. Öpik, Irish Astron. J. 4, 84 (1956); E. H. Ludlam, Tellus 9, 341 (1957); C. E. Junge and J. E. Manson, J. Geophys. Research 66, 2163 (1961); F. L. Whipple, Nature 189, 127 (1961); G. Witt, Tellus 14, 1 (1962).