FINAL REPORT

National Aeronautics and Space Administration

Grant NsG-250-62

Covering the Period

June 1, 1964 - December 31, 1964

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January 4, 1964

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The National Aeronautics and Space Administration awarded Grant NsG-250-62 to Massachusetts Institute of Technology in April, 1962, for a term of one year. The grant was subsequently extended several times, without any increase in funds, until the final expiration date of December 31, 1964. This report is intended to review the work supported under this grant during the period June 1, 1964, to December 31, 1964, and to serve as the final report. During the period covered by this report, theoretical work has been carried out in support of two phases of the M.I.T. experimental program carried out under NASA grant NsG-419. These programs are (1) ground-based observations of Venus in the wavelength range from 0.90 to 1.40 cm, and (2) balloon-borne measurements of microwave emission from molecular oxygen in the terrestrial atmosphere. A summary of this work follows.

INTERPRETATION OF VENUS OBSERVATION

During the interval from December, 1963, to February, 1964, while a multi-channel radiometer was being readied for observations of Venus during the inferior conjunction of June, 1964, an extensive program of computations of Venus radio spectra was undertaken. The computations were performed for several different physical models of the Venusian environment and the results were published in Space Science Reviews, vol. 3, pp. 109-135, July, 1964. Following an extended series of observations at six wavelengths near 1 cm during the interval from June to August, 1964, the computations were modified and extended in an attempt to produce agreement between the observations and the spectra

predicted on the basis of various models. The results of the observations, as yet unpublished, are contained in a doctoral thesis submitted to the Electrical Engineering Department by David H. Staelin in partial fulfillment of the requirements for the Doctor of Science degree. The results are:

Wavelength	Brightness Temperature
0.93 cm	$430 \pm 24^{\circ}K$
1.02	463 ± 32
1.18	428 ± 20
1.28	450 ± 23
1.37	404 ± 28
1.43	502 ± 82

These results are inconsistent with previously considered non-resonant emission mechanisms involving CO_2 and N_2, but can be approximately matched by including H_2O in the atmospheric model because H_2O has a resonant line at 1.35 cm. It is also possible that the observatinns can be fitted with a model which includes microwave scattering with either resonant or non-resonant absorption. Investigation of this effect is being conducted at the present time and will continue after the expiration of this grant. A complete paper reporting the observations and the interpretations is in the process of preparation and will be submitted for publication.

MICROWAVE EMISSION FROM ATMOSPHERIC MOLECULAR OXYGEN

During the time interval covered by this report, two series of balloon flights, each consisting of two flights, were carried out from the National Center for Atmospheric Research Balloon Flight Base at

Palestine, Texas. The flights were conducted on the dates of July 23, July 28, October 28 and November 8. In each case the flight profile was a 1 1/2 hour ascent to approximately 30 km (100,000 feet), 5 hours at the "float" altitude, and 1 1/2 hour "valved" descent to about 15,000 feet at which point the payload was separated from the balloon and parachuted to earth. For the flights of October 28 and November 8 data was both recorded on board, as on all previous flights, and also telemetered to a ground-based receiving station. Equipment malfunctions limited successful data-taking on all but the flight of November 8. On this flight a full 8 hours of data were acquired and are currently being compared with theoretical predictions.

The experiment consisted of measuring the $N = 9^+$ line of molecular oxygen at 61, 150.6 Mc/s during ascent, at "float," and during descent. The emission was measured at three frequencies, centered on the line, and at two elevation angles, 60° and 75°. The data is currently being interpreted in terms of previously computed line profiles and in terms of establishing the proper line width as a function of height in the atmosphere. The experiments, and theoretical interpretation, are continuing under NsG-419.

Alan H. Barrett

Principal Investigator

PUBLICATIONS RESULTING FROM GRANT NsG-250-62

"A Method for the Determination of High-Altitude Water-Vapor Abundance from Ground-Based Microwave Observations," A. H. Barrett and V. K. Chung, Journal of Geophysical Research, vol. 67, pp. 4359-4266, October, 1962.

"Microwave Spectral Lines as Probes of Planetary Atmospheres," A. H. Barrett, Mémoires de la Société Royale des Sciences de Liège, vol. 7, pp. 197-219, 1962.

"Mariner 2 Microwave Radiometer Experiments and Results," F. T. Barath, A. H. Barrett, J. Copeland, D. E. Jones, and A. E. Lilley, Astronomical Journal, vol. 69, pp. 49-58, February, 1964.

"Radio Observations of Venus and the Interpretations," A. H. Barrett and D. H. Staelin, Space Science Reviews, vol. 3, pp. 109-135, July, 1964.