VI. INFRARED INSTRUMENTATION AND ASTRONOMY

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A. INFRARED HETERODYNE DETECTION

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Joint Services Electronics Program (Contract DAAB07-75-C-1346)

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The objective of this program is the development and use in astronomy of a compact continuously tunable infrared heterodyne receiver for the 5-20 μm region. The receiver uses tunable diode lasers as local oscillators and a HgCdTe photodiode for a mixer. These components and their associated optics are assembled in a small liquid helium dewar suitable for bolting as a unit to a telescope. The receiver is matched to the telescope by a transfer optics box which also has an eyepiece for visual guidance.

The transfer optics has been tested in "backyard" observations of the Sun and the Moon by using the HgCdTe mixer in a direct-detection mode. The entire system has also been mounted successfully on the 16" telescope at the M. I. T. Wallace Astrophysical Observatory, Westford, Massachusetts.

Use of the receiver for astronomy has been delayed by rapid deterioration of the diode laser local oscillators. In tests made on several of these lasers (supplied by Laser Analytics, Inc.), we found that the deterioration results primarily from temperature cycling rather than from other factors such as aging. The manufacturer has confirmed this conclusion and expects the problem to be solved soon.

In the meantime, to minimize thermal cycling of the lasers, the dewar apparatus has been altered to allow the dewar to remain cold between experimental runs. The optics can now be focused completely without warming the dewar, which is a major convenience.

We plan to observe Jupiter in the near future. Our original target was to have been the 814 cm^{-1} rotational line of H_2, but in view of the laser difficulties (which appear to be more severe in this region than at higher frequencies) we have made our requirements less stringent. The ν_2 band of ammonia has several strong lines in the 900-930 cm^{-1} frequency range, and we have asked Laser Analytics, Inc. for a laser for this region. The ammonia ν_2 band has been observed on Jupiter before,[1,2] but it is expected that the extremely high spectral resolution of the heterodyne receiver will provide new

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information about ammonia in Jupiter's upper atmosphere.

Unlike ammonia, ethane is expected to have a constant mixing ratio in the Jovian atmosphere, and will therefore be a superior indicator of the temperature-pressure profile. The laser intended for the H_2 observation will also be useful for observations of the $\perp \nu_2$ band of ethane (800-850 cm^{-1}).

References

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2. S. T. Ridgway and R. W. Capps, Rev. Sci. Instrum. 45, 676-679 (1974).