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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND TECHNOLOGY RESUME

TITLE

Advanced Infrared Astronomy

PERFORMING ORGANIZATION

Planetary Systems Branch
Laboratory for Extraterrestrial Physics
Goddard Space Flight Center
Greenbelt MD 20771

INVESTIGATOR'S NAME

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DESCRIPTION (a. Brief statement on strategy of investigation; b. Progress and accomplishments of prior year; c. What will be accomplished this year, as well as how and why; and d. Summary bibliography)

a. Strategy: This task supports the application of infrared heterodyne and Fourier transform spectroscopy to ultra-high resolution studies of molecular constituents of planetary astomspheres and cometary comae. High spectral and spatial resolutions are especially useful for detection and study of localized, non-thermal phenomena in low temperature and low density regions, for detection of trace constituents and for measurement of winds and dynamical phenomena such as thermal tides. Measurement and analysis of individual spectial lines permits retrieval of atmospheric molecular abundances and temperatures and thus, information on local photochemical processes. Determination of absolute line positions to better than 10^{-8} permits direct measurement of gas velocity to a few meters/sec. Observations are made from ground based heterodyne spectrometers at the Kitt Peak McMath solar telescope and from the NASA Infrared Telescope Facility on Mauna-Kea, Hawaii. FTS observations are conducted from ground base facilities and the Kuiper Airborne Observatory.

b. Accomplishments: Wind velocities at 110km altitude on Venus were extracted to ~1 m/sec from measurements of non-thermal emission cores of 10.3 μm CO_2 lines. Results indicate a subsolar to antisolar circulation with a small zonal retrograde component. Results are now being compared to existing 2-D dynamical models. Measurements of ozone distribution on Mars were made in June, 1988 at the IRTF. The study of hydrocarbon abundances and variability on Jupiter is proceeding. Increased temperature, photochemistry and abundances in the polar regions was investigated. The first measurement of ethylene (10.5 μm) on Jupiter was made, retrieving mole fraction ~4×10^{-10}. Continuing analysis of FTS spectra of comets Halley an Wilson produced new information on the temperature of the nucleus and excitation conditions in the inner coma. A model for the detection of formaldehyde in comets was developed and initial observations were made on Comet Bradfield from the Kitt Peak 4 m FTS.

c. Anticipated accomplishments: Analysis of Venus wind data will be completed, dynamical models tested and modified accordingly. Wind velocities near 70 km on Mars will be measured and the study of mesospheric dynamics will continue. Confirming measurements of ethylene on Jupiter will be made and its spatial distribution studied. Behavior of hydrocarbons in the Jovian auroral region will be further investigated and appropriate theoretical models developed. Attempts to observe H_2CO (3.7 μm) on bright comets "of opportunity" and the development of the detailed model of cometary comae (radiative transfer and asymmetric outflow) will continue.

d. Publications:

1987 "Infrared Investigation of Water in Halley's Comet", H. A. Weaver, M. J. Mumma, and H. P. Larson, Astronomy and Astrophysics, 187, 411-418.

1987 "The Ortho-Para Ratio of Water Vapor in Comet Halley", M. J. Mumma, H. A. Weaver, and H. P. Larson, Astronomy and Astrophysics 187, 419-424.

1987 "Kinematic Properties of the Neutral Gas Outflow from Comet Halley", H. P. Larson, M. J. Mumma, and H. A. Weaver, Astronomy and Astrophysics 187, 391-397.

1987 "Variability of Ethane on Jupiter", T. Kostiuk, F. Espenak, M. J. Mumma, D. Deming, and D. Zipoy, Icarus 72, 394-410.

1988 "Airborne Infrared Spectroscopy of Comet Wilson 1986 and Comparisons with Comet Halley", H. P. Larson, H. A. Weaver, M. J. Mumma, and S. Drapatz, Ap. J. (submitted).

1988 "Possible Identification of the 3.4 μm Emission Feature in Comets", A. C. Danks, D. L. Lambert, and M. J. Mumma, Proc. Cornell Cometary Grain Workshop (in press).

1988 "Is Ethane Varying in the Jovian North Polar "Hot Spot"?, T. Kostiuk, F. Espenak, and M. J. Mumma, Proc. Intl. Conf. Time-Variable Phenomena in the Jovian System, (in press).