NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND TECHNOLOGY RESUME

TITLE

Infrared Spectroscopy of Jupiter and Saturn

PERFORMING ORGANIZATION

Astronomy Program
State University of New York at Stony Brook

INVESTIGATOR'S NAME

Roger Knacke, Principal Investigator

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: High resolution infrared spectroscopy provides unique insights into the chemistry and dynamics of the atmospheres of Jupiter and Saturn. The 5 μm spectral region, which is transparent to deep levels, is particularly useful for the identification of molecules that are present at very low (parts per billion) concentrations. These are tracers of convective and strongly non-equilibrium processes in the atmospheres. High resolution ground-based spectroscopy complements Voyager and Galileo measurements. Spectroscopy is sensitive to lower mixing levels for selected molecules, while the on-board mass spectrometers probe molecules that are spectroscopically inaccessible.

b. Accomplishments: We completed analysis and modeling of the 4.7 μm carbon monoxide band in Jupiter. CO is present at a mole fraction of $1.6\pm0.3\times10^{-9}$ and concentrated in the troposphere. At this abundance, it must be convected upward from much deeper levels in Jupiter where the temperature is near 1100K. Thus CO is a tracer of the deep atmosphere which is otherwise unobservable. The oxygen abundance in Jupiter (as measured by the CO abundance) is near solar. Chemical or physical process must deplete the major oxygen carrier, H_2O. Germane, GeH_4, was discovered on Saturn at a mole fraction of $4\pm2\times10^{-10}$. The spectra show evidence for a strong reflecting layer. The data also contain an absorption band near 2115 cm^{-1}, which we propose is of arsine, AsH_3.

c. Anticipated Accomplishments: The results show that molecules at extremely low abundances are observable with high resolution spectroscopy in the 5 μm band. A significant new development is the completion (by French laboratories) of high resolution spectroscopy and molecular data of phosphine, PH_3, which has hundreds of lines in the Jovian spectrum. With the new laboratory data we can distinguish weak lines from the phosphine forest for the first time. We plan to observe both Jupiter and Saturn in the AsH_3 region. Confirmation of this gas would corroborate the strongly convective properties of the deep atmosphere. Several other unidentified features in the spectra will be analyzed in the light of the new phosphine data. These may be features of species whose identification would provide new information about giant planet composition and chemistry.

d. Publications

Noll, K. S., Knacke, R. F., Geballe, T. R., and Tokunaga, A. T. 1988, The Origin and Vertical Distribution of Carbon Monoxide in Jupiter, Ap. J., 324, 1210-1218.

Noll, K. S., Knacke, R. F., Geballe, T. R., Tokunaga, A. T. 1988, Evidence for Germane in Saturn, Icarus, in press.