A FINAL REPORT

HIGH-RESOLUTION TEMPERATURE-DEPENDENT PHOTOABSORPTION CROSS SECTION MEASUREMENTS OF S_2, WITH APPLICATION TO HST UV SPECTRA OF SL9/JUPITER

(NASA Contract # NAGW-4800)

Period of Performance: December 1, 1995 - November 30, 1997

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The Hubble Space Telescope (HST) UV spectra of Jupiter after the collision of Comet SL9 show predominantly molecular features of S_2, CS_2, NH_3, and H_2S in the 1800-3200 Å region. The HST observations were made under various phases of impact conditions which gave temperatures higher than 1000 K. It is thus clear that temperature-dependent laboratory cross section data are required in order to determine the molecular abundances in Jupiter's atmosphere after the impact of Comet Shoemaker-Levy 9. The required high-resolution temperature-dependent S_2 absorption cross sections have not been directly measured in the laboratory.

To provide the required data for modelers our objective is to accurately measure the high-resolution (FWHM=0.003 Å) and medium resolution (FWHM=0.08 Å) temperature-dependent (800-1300 K) photoabsorption cross sections of S_2 in the 2450-3200 Å region. We have constructed a hybrid heat-pipe double-oven absorption cell to prepare pure S_2 gaseous molecules. A schematic diagram of the hybrid heat-pipe double-oven cell (20 cm long and 3 cm inside diameter), made of stainless steel with a wall thickness of 0.3 cm, is shown in Fig. 1a. The wick, indicated as dashed line inside the heat-pipe, was made of four layers of stainless steel mesh extending out to the water cooling section. The characterization of its operation and the determination of S_2 column density have been successfully completed. A typical data is shown in Fig. 1b and the detailed results have been presented in the 8th International Conference on Laboratory Research for Planetary Atmospheres which was held at Tucson, Arizona, October 22-25, 1996, by C. Y. Robert Wu, F. Z. Chen, and D. L. Judge. The title of the presentation was "The Preliminary Experimental Setup for S_2 Photoabsorption Cross Section Measurements."

The construction of a hybrid heat-pipe double-oven absorption cell is necessary because gaseous S_2 molecules only exist at high temperature. The elemental Sulfur has very interesting thermodynamic characteristics. In a *single-oven* condition and at about 600 K the saturated sulfur vapor is in equilibrium with liquid and solid sulfur. The saturated sulfur vapor mainly consists of S_8, S_7, and S_6 while smaller species like S_5, S_4, S_3, and S_2 begin to play a significant role only at high temperature. The mole fractions of the various sulfur species at given equilibrium temperatures from 400 to 1300 K have been reported by Rau et al. [1973, *J. Chem. Thermodynamics, 5*, 833] and Meyer [1976, *Chem. Rev., 76*, 367]. In contrast with the *single-oven* setup the mole fractions of the smaller S_n (n=2-4) species can be significantly enhanced by employing a *double-oven* technique [e.g., Chen et al., 1993, *Appl. Phys. B, 56*, 113; Wu et

al., 1978, *Rev. Sci. Instrum., 49*, 380]. In such a device the conditions of low saturated sulfur vapor and high cell temperature can be readily achieved. That is, the lower oven is operated at low temperature which provides the desired low saturated pressure of sulfur vapor in thermal equilibrium with the solid and liquid sulfur and gas phase S_n species. The upper oven is operated at high temperature (e.g., 800 K or higher) and provides thermal equilibrium only among the gas phase species. As a result, the mole fraction of S_2 in the upper oven is significantly higher than that in the *single-oven* operated at the same temperature. The characterization, see Fig. 1b, of the column density of S_n species in a double-oven set-up has been vigorously and systematically investigated in the present project. Using the experimental setup we have obtained absorption spectra of S_2 under various temperature conditions. The temperature-dependent cross section measurements of S_2 are in progress and the results will be published in the future.

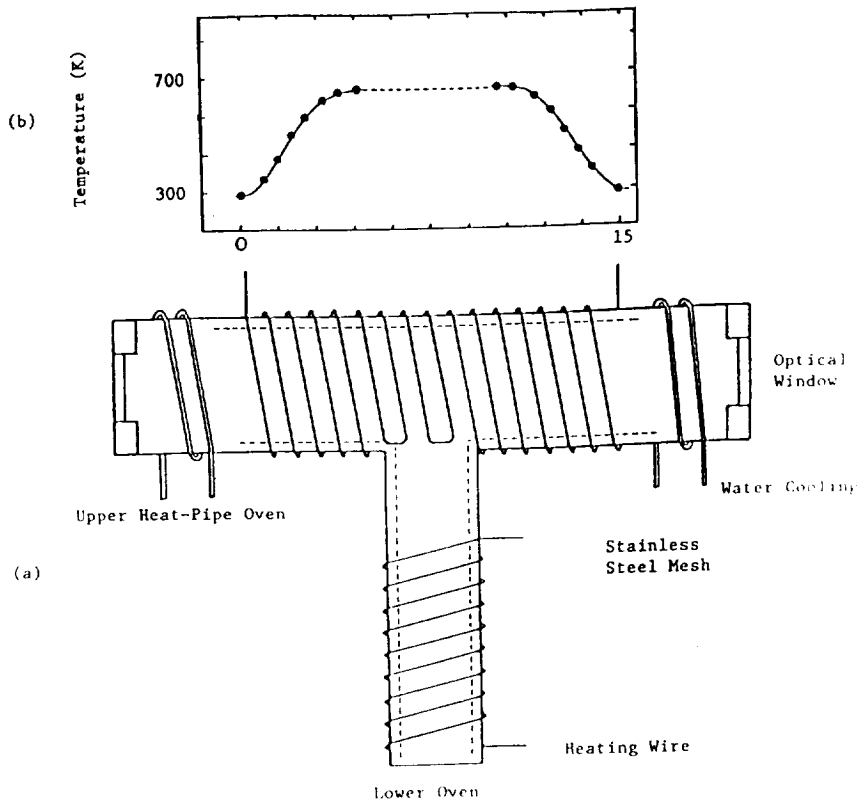

Fig. 1. (a) A schematic diagram of the hybrid heat-pipe double-oven cell.
(b) The characterized isothermal zone (column density) of S_2 vapor.