# UV Lamp Flux Calculations and Photolysis of Planetary Ice Analogs Containing $H_2O$+CO (1:1)

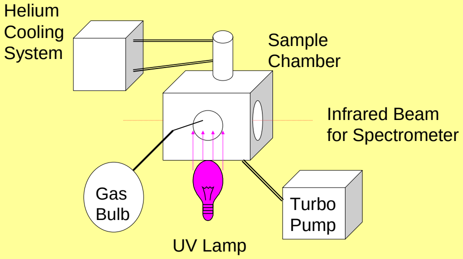

P. J. Mares, P. A. Gerakines, C. R. Richey

Astro- and Solar-System Physics Program, Dept. of Physics, University of Alabama at Birmingham, Birmingham, AL 35294-1170


## INTRODUCTION

Ultraviolet photolysis can cause major changes in the compositions of ices in the interstellar medium and on icy planetary surfaces. Our study focused on two goals: (i) the determination of the flux of the UV-emitting microwave discharge $H_2$ flow lamp in the UAB astrophysics lab, and (ii) the production of near-IR spectra of products formed in the photolysis of $H_2O$+CO (1:1) mixture at 10 K. Near-IR spectra of the photolyzed ices may be compared to observational data from ground- and space-based telescopes. We focused on near-IR spectra due to their wide use by planetary astronomers.

## METHODS




While UV radiation can only penetrate the top 0.1-1 μm of an ice, the very low strengths of near-IR absorption features require 10-100 μm of ice in order to detect them. Thus, ices had to be built up in stages (Richey 2006). We did this in the following manners:

- Simultaneous Method: A series of 30-minute deposits simultaneously exposed to the UV radiation from the lamp.

- Combination Method: 10-minute deposits with simultaneous photolysis followed by an additional 20 minutes of photolysis.

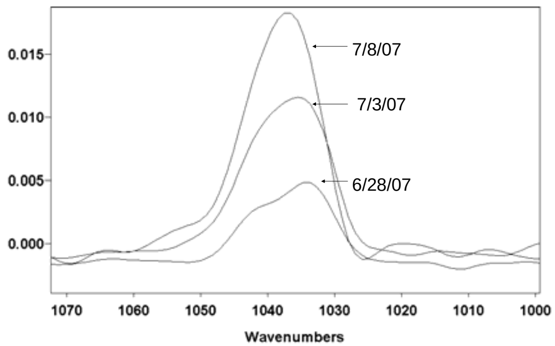
The flux of the lamp was calculated by making an ~1 μm deposit of $O_2$ and photolyzing the ice for a total time of 1920 seconds. The flux of the UV lamp ($\phi$) is then determined from the growth of the 1040 $cm^{-1}$ $O_3$ absorption feature using the equation:

$$\phi = \frac{\Delta t \cdot \ln(10) \int \alpha d\nu}{2 \cdot B(O_3)}$$

where $\Delta t$ is the photolysis time, $\alpha(\nu)$ is integrated over the $O_3$ absorption feature at 1040 $cm^{-1}$, and $B(O_3)$ is the band strength of the 1040 $cm^{-1}$ feature (equal to $1.3 \times 10^{-17}$ cm/molecule).

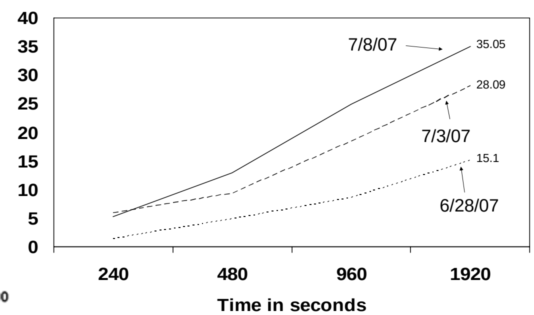
## RESULTS

Increase of flux of UV Lamp over 3 experiments




The flux at the beginning of our experiment (6/28/07), after the first cut-back of the deposition tube blocking the UV-Lamp (7/3/07), and after the final cut-back of the deposition tube (7/8/07).

Column Densities of 1040 $cm^{-1}$ $O_3$ Features ($10^{15}$ molecules/$cm^2$) vs. time



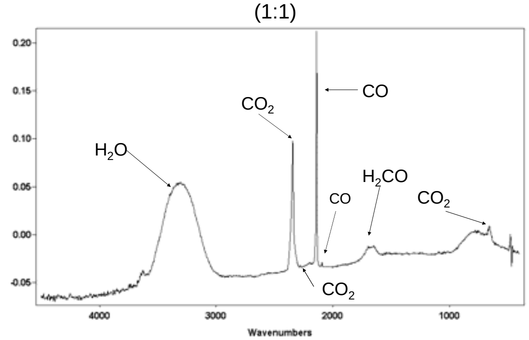

Using the column density to determine $\phi$:

$\phi_{6/28/07}=4.83\times10^{12}$ photons $cm^{-2}$ $s^{-1}$

$\phi_{7/03/07}=9.43\times10^{12}$ photons $cm^{-2}$ $s^{-1}$

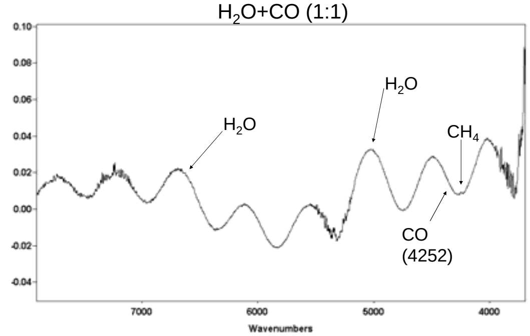
$\phi_{7/08/07}=9.43\times10^{12}$ photons $cm^{-2}$ $s^{-1}$

Features in the Mid IR After Photolysis of $H_2O$+CO (1:1)

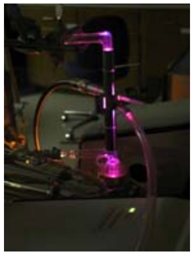



10K mid-IR absorption spectrum of ice mixture $H_2O$+CO (1:1) after 62 minutes of deposition while being photolyzed, and 140 minutes of only UV-photolysis (combination method).

Features in the Near IR After Photolysis of $H_2O$+CO (1:1)




10K near-IR absorption spectrum of ice mixture $H_2O$+CO (1:1) after 1210 minutes of deposition while being photolyzed, and 460 minutes of only photolysis (simultaneous and combination methods). Also a possible leak in the system added to the amount of $H_2O$+ $CO_2$ in the system overnight.

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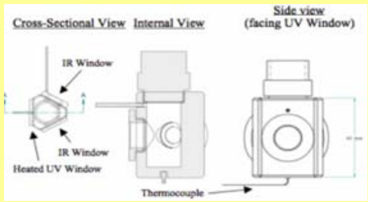
## CONCLUSIONS

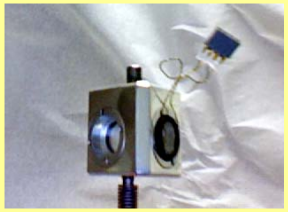
In our mid-IR spectra of the photolyzed $H_2O$+CO ice mixture, we found features of $CO_2$ (at 2345 $cm^{-1}$) and $H_2CO$ (1700 $cm^{-1}$). We can see faint features of $H_2O$, CO, and possibly CH4 in the near-IR. Insufficient amounts of $CO_2$ and $H_2CO$ were created in order to detect them in the near-IR.

By increasing the flux of the lamp, we may yield greater amounts of ice that have strong features in the near-IR, which is the overall goal of the project. While we were able to increase the flux by a factor of 10, we are still well below the flux of 2003 ($1.1\times10^{14}$ photons $cm^{-2}$ $s^{-1}$).

## FUTURE GOALS

Our future work involves the use of a new closed gas cell system to make the ice deposits. The cell is a three-sided capsule with a window on each side. Two of the windows are made of KBr and will allow the transfer of the spectrometer's IR beam, while the third window is made of $MgF_2$ in order to allow the input of UV radiation for photolysis. The UV window will be heated in order to prevent ice from forming there and blocking the UV photons.



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