# VUV Photolysis of CO Ices - A Detailed Study Employing Different Light Sources

**Yu-Jung Chen (陳裕榮)[1], Y.-C. Lin (林彥璋)[1], Tai-Sone Yih (易台生)[1], Hong-Kai Chen (陳宏凱)[2], Hsiao-Chi Lu (盧曉琪)[2], Bing-Ming Cheng (鄭炳銘)[2], C.-Y. Robert Wu (吳中榮)[3], and D.-L. Judge[3]**

**[1]Department of Physics, National Central University, Chungli, Taiwan**
**[2]National Synchrotron Radiation Research Center, Hsinchu, Taiwan**
**[3]Space Sciences Center, University of Southern California, Los Angeles, USA**

Experimental results on the VUV photolysis of pure CO ices at 10 K have been obtained by employing a narrow bandwidth synchrotron radiation light source at the National Synchrotron Radiation Research Center, Hsinchu, Taiwan, and a microwave-discharged $H_2$ flow lamp at the National Central University. The latter source provides the H**I** 121.6 nm radiation and $H_2$ molecular emissions in the spectral region between 135 and 145 nm, sharp band in 145-155 nm, and very broad emission bands in 150-300 nm. It is known that the photon flux and the spectral distributions of the microwave-discharge lamp strongly depend on the operating conditions. Different experimental results on photolysis of ice systems at low temperatures have been reported by various research groups [1-7].

In this study we have used pure CO ices as a case study and have measured the production yields of photon-induced chemical products and the destruction yield of the parent CO molecules using Fourier Transform Infrared spectrometry. The features observed in the spectra of the Difference of the FTIR Absorbances are due to absorption features of the photon-induced chemical reaction products in the ices and the depletion features of parent CO ices. The absorption features of the photolyzed products have been identified as the $CO_2$ and isotopic $^{13}CO_2$, $CO_3$, $C_2O$, $C_3O$, and $C_3O_2$.

We have confirmed that the $H_2$ molecular band emissions in the microwave-discharge lamp indeed contribute to the destruction of CO and the formation of $CO_2$ and suboxides [5]. However, our measured production yield for $CO_2$ at 121.6 nm is an order of magnitude smaller than that reported by Gerakines and Moore [5], in which a “broad band” photon source was employed in their measurements. The results reported by Loeffler et al. [1], who used a very low $H_2$ pressure in their discharged lamp, are in reasonable agreements with ours. Ours synchrotron radiation data are determined by utilizing a monochromatic light source, which provides a spectral bandwidth of 1.1 nm at 121.6 nm. Our results obtained by using the microwave-discharged $H_2$ flow lamp show dependence on the various combinations of $H_2$ pressures and the optical windows used. A detailed description of the results will be published shortly.

As demonstrated in this study, the future work on photolysis of cosmic ices in the VUV region should focus on monochromatic measurements [7]. Such data are required for an accurate modeling of cosmic ice photochemistry. Further, the intriguing ice photochemistry deserves further investigations in order to improve our understanding of chemical evolution in cosmic environments. Data obtained by the VUV-UV photolysis are particularly relevant to the icy planets and icy satellites, comets, meteors, Trans-Neptunian objects, and interstellar grains.

**Acknowledgment:** This research is based on work supported by the NSF Planetary Astronomy Program under Grant AST-0604455 and the Astrophysics and Astrochemistry Program of NSRRC, Taiwan.

**References**

[1]. Loeffler, M. J., G. A. Barata, M. E. Palumbo, G. Strazzulla, and R. A. Baragiola, Astron. Astrophys. **435**, 587 (2005).
[2]. Gerakines, P. A., M. H. Moore, and R. L. Hudson, Icarus **170**, 202 (2004).
[3]. Cottin, H., M. H. Moore, and Y. Benilan, Ap. J. **590**, 874 (2003).
[4]. Baratta, G. A., G. Leto, and M. E, Palumbo, A&A **384**, 343 (2002).
[5]. Gerakines, P. A. and M. H. Moore, Icarus **154**, 372 (2001).
[6]. Westley, M. S., R. A. Baragiola,, R. E. Johnson, and G. A. Baratta, Planet. Space Sci. **43,** 1311 (1995).
[7]. Wu, C. Y. R., D. L. Judge, Yu-Jung Chen, and T. S. Yih, AAS Bull. **38**, No. 3, 606 (2006).