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Production of complex molecules in astrophysical ices

Marla H. Moore[1] **and Reggie L. Hudson**[1,2]

[1]Astrochemistry Branch, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA
email: Marla.H.Moore@nasa.gov

[2]Department of Chemistry, Eckerd College, St. Petersburg, FL 33711, USA
email: hudsonrl@eckerd.edu

Abstract. The inventory of interstellar and solar system molecules now numbers well over 100 species, including ions and molecules both charged and neutral. Gas-phase formation pathways for many of the observed organics are still uncertain, so that solid-phase syntheses are of interest. Low-temperature reactions are thought to occur within interstellar ices, on ice and grain surfaces in the interstellar medium, and on icy surfaces of solar system objects (e.g. Europa, Pluto). Ionizing radiation, such as cosmic rays, and far-UV photons are two possible initiators of such chemistry.

In the Cosmic Ice Lab at NASA's Goddard Space Flight Center, we can study both the photo- and radiation chemistries of ices at 8 - 300 K. Our most-recent work has been motivated by the detections of ethylene glycol, $C_2H_4(OH)_2$, in an interstellar source (Hollis, Lovas, Jewell, *et al.* 2002) and in comet Hale-Bopp (Crovisier, Bockelée-Morvan, Biver, *et al.* 2002). Ethylene glycol is currently the largest firmly-identified cometary molecule as well as one of the larger interstellar organics. This molecule's formation and accompanying chemistry provide challenges and tests for current astrochemical thought.

Here we discuss laboratory experiments on ethylene glycol's solid-phase formation and destruction. Using infrared spectroscopy, we have identified low-temperature radiation-chemical pathways that lead from known interstellar ices, such as either CH_3OH or H_2O and CO, to ethylene glycol. We also have identified a role for ethylene glycol in the formation of glycolaldehyde, $HC(O)CH_2OH$, a simple sugar (Hollis, Lovas & Jewell 2000). Related to these results are the 6- and 7-atom molecules formed by oxidation and reduction processes in irradiated H_2O + C_2H_2 ices. Analogous experiments have been conducted on two other triply-bonded molecules in H_2O-rich ice, HCN and N_2. An important focus of our work is the development of reaction schemes for the formation of complex molecules within astrochemically-relevant ices, and the use of such schemes to predict new molecules awaiting detection.

Keywords. astrobiology - astrochemistry - ISM: abundances - ISM: molecules - molecular processes - methods: laboratory

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References

Crovisier, J., Bockele-Morvan, D., Biver, N., Colom, P., Despois, D., Lis, D. C. 2004, *AA* 418, L35

Hollis, J. M., Lovas, F.J., Jewell, P. R. 2000, *ApJ* (Letters) 540, L107

Hollis, J. M., Lovas, F.J., Jewell, P. R., Coudert, L. H. 2002, *ApJ* (Letters) 571, L59