AOGS 2005

Reaction Pathways of Radiation Induced CarbonMonoxide Chemistry in Comets

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While the study of radiation induced chemistry of carbon monoxide ices is not relevant to the inner solar system, its importance increases in the outer fringes of the solar system. Beginning at the icy bodies of Triton, Neptune's largest moon, and Pluto with a distance of at least 30 AU for the orbit of Neptune, carbon monoxide has been observed in the solid state at non-negligible quantities. On comets, carbon monoxide becomes a major component sometimes reaching abundances of 20% relative to water ice. Radiation induced effects from cosmic rays or solar outflows can chemically process these carbon monoxide ices yielding new molecules. This has been experimentally investigated by irradiating a carbon monoxide ice layer held at 10K with 5 keV electrons. This electron radiation simulates the interaction between a bombarding ion and the molecules in the ice surface, since a typical cosmic ray ion (10 MeV energy) loses 99.95% of its energy to the electronic interaction and holds a similar Linear Energy Transfer (LET) value to the electrons. A variety of C_nO and C_nO_2 molecular species were observed. Reaction pathways along with their kinetics and mechanisms are presented and understood. In anticipation of data from the Deep Impact mission, this work could prove useful for identification of minor species present within comet 9P/Tempel 1. Although the surface of the comet should be devoid of any solid carbon monoxide, its presence can not be discounted underneath a hardened water ice surface cap. High-energy cosmic rays that penetrate ice surfaces to meters deep could still initiate chemical alterations in subsurface carbon monoxide ice.