Synthesis of HCN and HNC in Ion-Irradiated N_2-Rich Ices

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Near-IR observations reveal that nitrogen-rich ice containing small amounts of methane, CH_4, and carbon monoxide, CO, is abundant on the surfaces of Triton, a moon of Neptune, and Pluto (Cruikshank *et al.*. 1993; Owen *et al.*, 1993). N_2-rich apolar ices are also possible in some interstellar environments (Ehrenfreund *et al.*, 1998). To investigate the radiation chemical behavior of N_2-dominated ices we performed a systematic IR study of ion-irradiated N_2-rich ices containing CH_4 and CO. Experiments at 18 K, showed that HCN, HNC, and the reactive molecule diazomethane, CH_2N_2, formed along with several radicals. NH_3 was also identified in irradiated $N_2 + CH_4$. Comparing results from similarly photolyzed ices (Bohn *et al.*, 1994) shows that the significant difference between radiolysis and photolysis of these N_2-dominated ices is that photolyzed ices do not form detectable HCN and HNC. Our experiments examined different N_2/CH_4 ratios, the half-life of CH_4, possible HCN and HNC formation routes, and competing pathways in the presence of CO. Intrinsic band strengths (A(HCN) and A(HNC)) were measured and used to calculate nearly equal values of HCN and HNC yields in N_2+CH_4 irradiated ices. Low temperature results apply to interstellar ices.

Reaction products that appear at 30-35 K are also expected to form and survive on the surfaces of Triton and Pluto and interstellar grains. We examined the evolution of ice features as species undergo acid-base (acids such as HCN, HNC, HNCO and a base NH_3) reactions triggered by warming from 18 K to 30-35 K. We identified anions (OCN^-, CN^- and N_3^-) attributed to relatively stable salts in ices where NH_4^+ is the likely cation. These results also have an astrobiology implication since many of these products (HCN, HNC, HNCO, NH_3, NH_4OCN, and NH_4CN) are reactants used in synthesis studies of bio- molecules such as amino acids and peptides.

References:

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