Radiolysis of Surface Components

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Pluto, Charon, and many other solar system objects are known to have icy surfaces. Because these ices are exposed to keV and MeV ions and far-UV photons, their chemical and physical properties evolve over time. For some years, our research group and others have employed a laboratory approach to investigate these radiolytic and photolytic changes. Ices, either one-component or mixtures, are subjected to ionizing radiation and UV photons and then probed by IR spectroscopy and other techniques. It has been found that radiolysis and photolysis destroy reactant molecules, synthesize new molecules, cause changes of phase in pure materials, and eject molecules from ices. Although our laboratory approach initially focused on product identification, it has become increasingly necessary to work toward a comprehensive understanding of ice chemistry for applications to many solar system environments. To this end, this presentation will describe some of our experiments, and those of others, on some of the more-important outer solar system molecules, such as N_2, CH_4, CO, H_2O, and NH_3. Some background information also will be given so as to compare and contrast radiolytic and photolytic effects. Predictions of molecular evolution in complex ices, both H_2O- and N_2-dominated, will be made. - Our work has been funded in recent years through NASA's Outer Planets Research, Planetary Geology and Geophysics, Cassini Data Analysis, and Exobiology programs, as well as the NASA Astrobiology Institute's Goddard Center for Astrobiology.