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Irradiation Effects on Amorphous and Crystalline Water Ices

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The presence of water ice extends from the polar caps of Earth and Mars of the inner solar system, to the icy satellites of Jupiter and Saturn, to the outer limits of the heliosphere where comets and the Kuiper Belt Objects exist. Intense radiation fields in the form of the solar wind, magnetospheric particles, and cosmic rays alter the ice both chemically and physically. Several other research groups have experimentally investigated the irradiation effects on water ice and have identified H_2, O_2, and H_2O_2 as stable products in the solid state. However, the relevant mechanisms of this processing are still not clear owing in part to possible contamination from residual gases inside the vacuum systems. Therefore, we will present a systematic study investigating the irradiation effects on water ice carried out at a low backing pressure (1.0×10^{-10} torr) and at a variety of temperatures (10-100 K) to reproduce the conditions of the many environments where solid water exists. Irradiation effects on amorphous and crystalline ices were investigated to understand the radiation induced physical changes that occur in water ice. The samples were analyzed using a FTIR spectrometer and a quadrupole mass spectrometer to identify molecular species released into the gas phase during warmup. In our experiment, H_2, O_2, and H_2O_2were observed and quantified during irradiation and until they sublimed into the gas phase. The production rates of these species are compared for the different temperatures and phases of water ice to help us better understand the chemistry and mechanisms that occur on the icy bodies of the solar system.