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Comparative Radiation Environments of Europa, Enceladus, and Saturn's Main Rings

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Surface and atmospheric properties of icy moons and rings in the Jupiter and Saturn systems are variously impacted by irradiation from the local magnetospheric environments of these bodies and from the external heliospheric environments of these systems. In this presentation the comparative environments and effects are addressed for Europa in the Jupiter system and for Enceladus and the main rings in the Saturn system. Europa has the most extreme radiation environment of any icy body in the solar system and a surface composition of non-ice materials, mainly hydrated sulfates, that is arguably derived from chemical equilibrium between the intrinsic composition and exogenic inputs from the magnetosphere. The apparent instability of this ocean moon's ice crust may enable conveyance of surface radiation products, e.g. oxidants, of chemical, rheological, and astrobiological importance to the subsurface interior environment. In comparison, Enceladus undergoes much less irradiation but obviously has a more active surface now manifesting cryovolcanism in the south polar cap region. If the current plume activity is near maximum in a high phase after a much longer quiet period, i.e. the Old Faithful model, the cumulative chemical energy in radiolytic oxidant production may be sufficient to power the plumes by gas-driven cryovolcanism. Finally, the surfaces of both of these moons, and of icy bodies in Saturn's main rings, are irradiated to several meters in depth by very high energy cosmic particles originating from galactic sources. Through cosmic ray albedo neutron decay (CRAND) the cosmic ray energy impacting the rings flows into trapped protons of Saturn's inner radiation belts. The in-situ radiation and resultant atmospheric environment may affect surface chemistry of the ring bodies while also offering a potential

measure on ring mass density. In general the surfaces, and potentially the interiors, of all these moon and ring bodies are chemically coupled to the external radiation environments. Accessibility of spacecraft and science instrumentation for close observations at Europa is clearly limited by the radiation environment but may be enhanced by attention to hemispheric and topographic variance of irradiation fluxes at the surface.