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Title: Energetic Ion and Electron Irradiation of the Icy Galilean Satellites

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Measurements of energetic particles in Jupiter's magnetosphere from the Energetic Particle Detector on the Galileo Orbiter, and the trapped radiation model of Divine and Garrett, are used to compute irradiation effects on the optical surface (depth ~ 1 mm) layers of Europa, Ganymede, and Callisto. Incident flux modeling for Ganymede includes Stoermer deflection by a dipole magnetic field imbedded in the jovian magnetospheric field. Incident energy flux ≤ 10^{11} keV/cm^2-s at Europa from 0.02-100 MeV ions (H, O, S), and 0.02-40 MeV electrons (model spectra ≤1 MeV), is comparable to internal heat flux from tidal and radiogenic sources, while also exceeding that for solar UV photons at energies (> 6 eV) relevant to ice chemistry. Particle energy fluxes to Ganymede's equator and to Callisto are similar at ~ 10^8 keV/cm^2-s with ~ 10^9 keV/cm^2-s at Ganymede's polar cap. Electrons and protons deliver large fractions of the globally averaged energy fluxes to the trailing hemispheres of Europa and Callisto, while energetic heavy ions with low charge states (e.g., O^{2+}, S^{3+}) have preferential access to the Ganymede equatorial region. Rates of change in optical reflectance and molecular composition on Europa, and on Ganymede's polar cap, must be strongly driven by energy from irradiation, even in relatively young regions. Compositional changes are also driven everywhere over times << 10^9 years for irradiation of enhanced concentrations of non-ice materials from sputtering and sublimation. Irradiation is a likely energy source for production of detected H_2O_2 on Europa, O_2 and O_3 on Ganymede, and CO_2 on Callisto. Iogenic neutral atoms and micrometeoroids deliver relatively negligible energy ~ 10^{4-5} keV/cm^2-sec. However, ejecta from micrometeoroid impacts are critical for burial and accumulation of irradiation products below the sensed optical layer. Downward transport of these products, driven by tidal stresses and thermal instabilities on 10^7 to 10^9 year time scales, could deliver significant chemical energy and other astrobiological resources to sub-

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