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Atmospheres of Europa and Ganymede

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Abstract

Europa and Ganymede are imbedded in the Jovian magnetospheric plasma. The incident plasma alters the surface and produces tenuous atmospheres (Johnson et al. 2009) often called surface boundary-layer atmospheres (Johnson, 2002). That is, the interaction of the atmospheric neutrals with the regolith that ultimately determines the composition and morphology of these atmospheres (Cassidy et al. 2009; Cipriani et al. 2009). Those neutrals that escape the satellite's gravity remain gravitationally bound to Jupiter in a toroidal-shaped cloud until they are ionized and contribute to the ambient plasma (Smyth and Marconi 2006). Since gas-phase species whether produced by the plasma, thermal desorption or outgassing are readily identified in situ, these atmospheres are of interest as an extension of the satellite's surface. If the atmospheres were only populated by thermal desorption, they would have a small subsolar component (Shematovich et al. 2005) but the trace volatiles would be rapidly depleted. However, they orbit in a region of the Jovian magnetosphere in which the trapped plasma density and temperature are relatively high and their surfaces are exposed to the solar EUV flux. Since H_2 is produced and escapes more readily than the heavier species, hydrogen is a principal component of the neutral torus and the surface and atmosphere are rich in oxidized species (Johnson et al. 2009). Atmospheric simulations using models for the surface composition, the radiation flux to the surface, and laboratory data have been used to interpret the available observations and to suggest which trace species might be detectable by an orbiting spacecraft. In a nearly collisionless, surface-boundary-layer atmosphere, redistribution and loss to the surface compete with other loss processes such as pick-up, direct escape, and escape of hot dissociation products. Models for the atmospheres of Europa and Ganymede and the possible effect of venting will be described. The principal interest is the relationship of the morphology and composition of the atmosphere and to its surface properties and the possibility of detection of atmospheric species.