SULFUR-OXYGEN PROCESSES ON IO

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After many years of research efforts dedicated to interpreting the spectral geometric albedo of Jupiter's satellite Io, the only chemical specie which is generally agreed to exist on Io's surface is, condensed sulfur dioxide (Smythe et al., 1979). Although the evidence for the presence of elemental sulfur is strong, there are several important astronomical observations and laboratory studies which constrain or question the presence of elemental sulfur in widespread areal abundance on the surface. In addition, the presence of sulfur dioxide on Io's surface raises questions regarding the presence of environmentally produced daughter products (if any) which also might be expected on the surface. This laboratory work is directed to understanding sulfur/oxygen processes in the Io environment.

Laboratory studies of irradiated sulfur dioxide frost have found that sulfur trioxide should be formed as a consequence of the irradiation process. We have measured the spectral reflectance of solid sulfur trioxide in the laboratory and we find that it has strong absorption features at 3.37 and 3.70 μm. These features are not present in the spectral geometric albedo of Io. We interpret this as an indication that sulfur trioxide may exist in such limited abundance that it is undetectable in disk averaged spectrophotometry. We suggest that the Near-Infrared Mapping Spectrometer on the Galileo spacecraft should be able to identify condensed sulfur trioxide on Io particularly in regions bordering the sulfur dioxide deposits (Nelson and Smythe, 1986).

The presence of elemental sulfur on Io's surface has been questioned on several grounds most notably the suggested production process (quenched molten sulfur extrusions) and the effect of radiation (most notably x-rays) on some of the allotropes. We have produced mixtures of sulfur allotropes in the laboratory by quenching molten sulfur and we find that the spectra indicate the presence of certain red-colored allotropes which are preserved upon quenching. We find that the color of the sulfur glass produced is redder when the temperature of the original melt is higher (Nelson and Smythe, 1985). This is consistent with the suggestion that Io's spectral geometric albedo can be partly explained by the presence of quenched sulfur glasses.

Preliminary investigations of the effect of x radiation on elemental sulfur indicates that at low temperatures (~100 deg K.), a red-colored allotropes. This would be consistent with the presence of elemental sulfur on Io. Further work in this area remains for a follow-on investigation.

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