

various sulphur and other compounds and the physical and optical effects of adsorbed gases such as H₂S and SO₂ thereon need to be studied as possible strong contributors to Io's spectral reflectance and other surface properties.

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Spectral evidence for SO₂ frost or adsorbate on Io's surface

William D. Smythe*†, Robert M. Nelson*, & Douglas B. Nash*

*Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91103

†Institute of Geophysics and Planetary Physics, University of California at Los Angeles, Los Angeles, California 90024

The infrared reflection spectrum of Io matches that from an SO₂ frost grown in the laboratory.

It has been recently suggested that adsorbed SO₂ and/or H₂S on the surface of a spectroscopically benign substrate can explain the IR spectrum of Jupiter's satellite, Io¹. SO₂ gas has been identified as a major constituent of the volcanic gas plumes recently discovered by the Voyager 1 spacecraft². We have measured the reflection spectrum of SO₂ frost grown under low pressure at 140 K in the laboratory and find that it provides an excellent match to Io's spectrum in the 1.0-4.5 μm range.

The apparatus used and experimental methods have been described by Kieffer³ and Smythe⁴ respectively. Figure 1 compares the spectral geometric albedo of Io^{5,6} and our laboratory spectrum. Clearly SO₂ frost can explain the Io absorption bands at 1.35, 2.55, 2.80, 3.80, 3.90, 3.95, and 4.08 μm. Other candidate materials such as sulphates, nitrates and carbonates⁵ do not provide such a unique match to these bands.

Although SO₂ frost may be unstable on Io, except at the poles or nightside (see ref. 7), adsorbed SO₂ should be present on the surface particulates due to the extensive volcanic outgassing. The absorption bands of adsorbed and condensed species are known to be similar in wavelength⁸. Slight shifts in band positions and depths may reflect areal or temporal variation in frost/adsorbate or condensate/substrate contribution ratios to a multicomponent spectrum. Mixtures of alkali sulphides, free sulphur and adsorbates of SO₂ or H₂S have been suggested to explain Io's overall UV-VIS-IR reflectance¹. We conclude here that SO₂ as a frost or an adsorbate is the primary contributor to Io's IR spectral reflectance.

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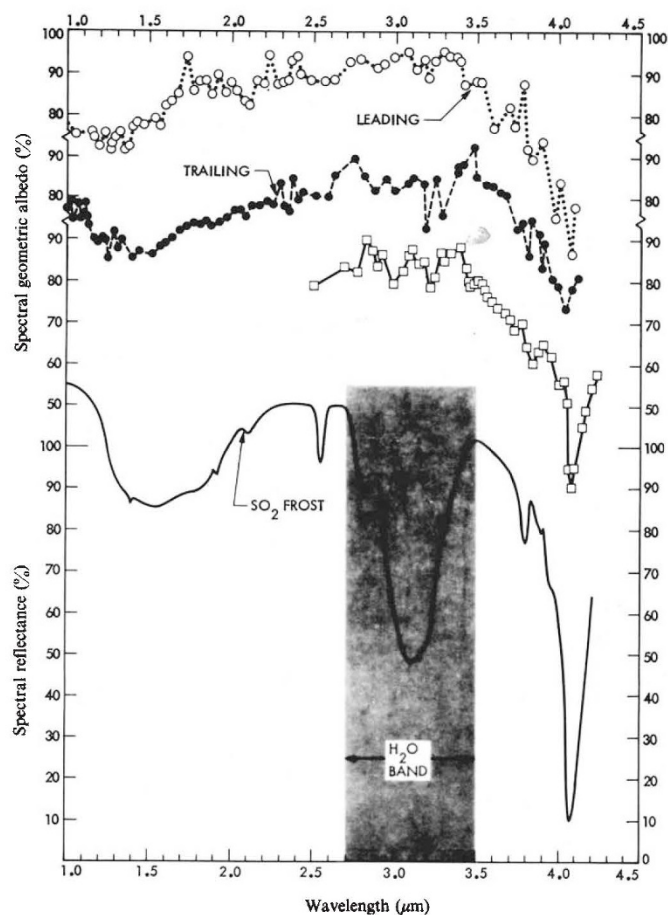


Fig. 1 *a*, Spectral geometric albedo of Jupiter's satellite Io, 1.0-4.5 μm based on previous studies^{5,6}, normalised as in ref. 1. O, ●, Data from ref. 5; □, data from ref. 6. *b*, Spectral reflectance of SO₂ frost grown in the laboratory. The 3.1 μm H₂O band (stippled area) is due to contaminant water.