IMPLICATIONS OF LABORATORY INFRARED REFLECTANCE SPECTRA FOR FINDING H_2S ON IO; B. H. Betts and D. B. Nash, San Juan Capistrano Research Institute, 31872 Camino Capistrano, San Juan Capistrano, CA 92675, Email: betts@sji.org.

Does H_2S exist on Io's surface? We believe this is an open question with significant implications for Io's volcanic and surface processes. Current evidence for its presence depends most upon infrared bands detected from Earth that overlap not only with H_2S fundamentals [1,2], but also with bands seen in SO_2 ice [3,4,5]. Thus, to better prepare for Galileo observations of Io, and as part of a broader look at H_2S infrared spectra and Io [6], we present H_2S spectra in the range 2.3-5.2 μm and compare them with the known Io surface constituent, SO_2. In particular, we combined our lab H_2S spectra [1,6] and SO_2 spectra [4] with the approximate Galileo-NIMS spectral bandpasses and channel separations [6] to create simulated NIMS spectra of H_2S and SO_2 frost surfaces. The 2.7 μm H_2S band ($\nu_1 + \nu_2$ and/or $\nu_3 + \nu_2$) is the most significant and unique band for distinguishing H_2S from SO_2 in this spectral range, but the shape and size of the extremely strong 3.9 μm band (ν_1 and ν_3 stretching fundamentals) will be useful in determining the thickness of H_2S deposits. Thin (0.1 to 1 mm) H_2S frosts create deep bands relative to much thicker SO_2, so on Io, NIMS should be able to distinguish very thin deposits of H_2S from thicker or intermingled SO_2 deposits.

Background. Temporally varying spectral bands near 3.9 μm observed on Io by groundbased telescopes [1] are near the locations of the ν_1 and ν_3 fundamentals of solid H_2S, which occur at approximately 3.957 and 3.931 μm, respectively [8]. So, H_2S may be at least occasionally present on Io's surface [1,2]; however, the recent identification of bands at similar wavelengths in SO_2 ices and thick frosts makes identification of H_2S on Io tentative [3,4,5]. As we show here, the Galileo near infrared mapping spectrometer (NIMS) should be able to provide an answer as to the presence of solid H_2S for areas of Io that will be observed.

Experimental Method. Biconical diffuse reflectance spectra were measured in our laboratory in near vacuum using an FTIR spectrometer covering 2.2-25 μm with a cooled HgCdTe detector. Sample reflectances were ratioed to the reflectances of a reference standard, gold-coated sandpaper [1,5].

Results. Spectra of H_2S frosts including thin H_2S over thick SO_2 are shown in Figure 1. Thin (0.1 to 1 mm) H_2S frosts create very deep bands, and in fact the 1 mm thick sample has caused not only very deep bands but also a very broad and flat 3.9 μm band. Even a very thin layer of H_2S (0.1 mm) creates bands nearly as strong as bands created by thick (> 2 mm) SO_2 frost in this spectral region.

In Figure 2, we show the results of combining the spectra of Figure 1 with the approximate Galileo-NIMS spectral bandpasses and channel separations [7] to create simulated NIMS spectra of H_2S and SO_2 frost surfaces for NIMS' maximum sampling mode of 408 channels. The 2.7 and 3.9 micron H_2S bands are still clearly distinct. In fact, simulations with far fewer channels still distinguish the bands, as long as the starting grating position is carefully chosen. So, on a planetary body like Io, NIMS should be able to distinguish even very thin deposits of H_2S from SO_2 due to the strength of the H_2S bands. The 2.7 μm band, difficult to observe from Earth, is the most significant for distinguishing the two because of the lack of overlap of H_2S and SO_2 bands in this region. The extremely strong 3.9 μm band can also be distinguished from SO_2 bands by its depth and its broad shape if there is sufficient (~1 mm) H_2S frost. Then, the 3.9 μm band can actually be used as a simple indicator of the thickness or quantity of H_2S frost.

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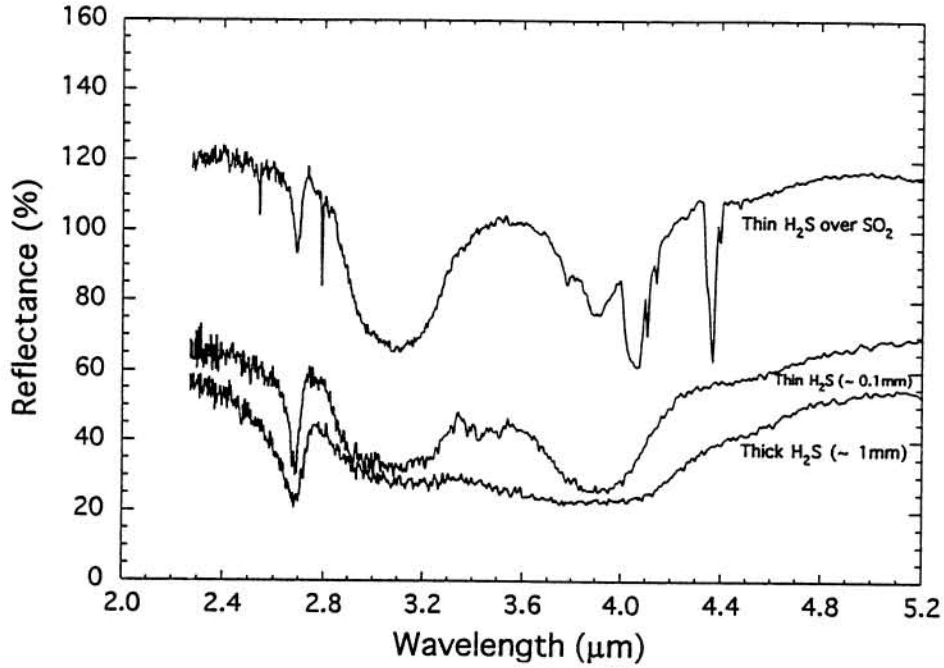

Figure 1: The lower two spectra are of thin and thick H_2S frosts grown directly on a stainless steel platen. The upper spectrum sampled a thin layer of H_2S frost over SO_2 frost. Spectral resolution is approximately 4 cm^{-1}.

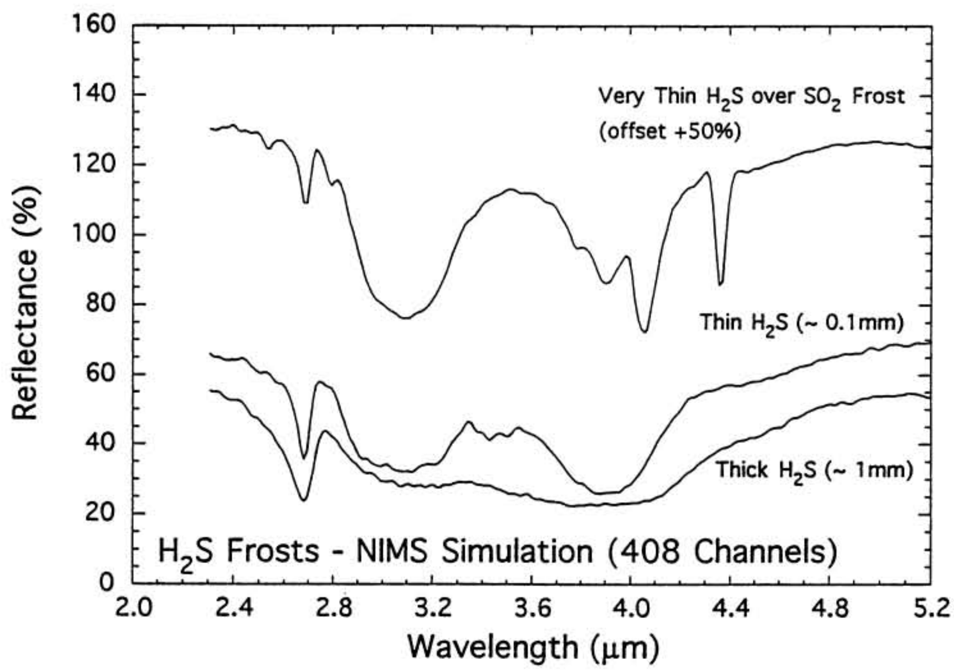

Figure 2: NIMS simulations of the same spectra shown in Figure 1 for NIMS 408 channel mode. Notice that the 2.7 µm H_2S band is clearly distinguishable from the surrounding 2.5 and 2.8 µm SO_2 bands, and in fact dominates them even for a very thin (<0.1 mm) layer of H_2S frost. One can also distinguish the H_2S 3.9 µm band, but thick SO_2 ices and frosts have bands at very similar wavelengths that complicate interpretation.

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