**DETAILED ANALYSIS OF THE TVASHTAR PLUME SPECTRAL BEHAVIOR.** K.L. Jessup[1] and J R. Spencer[2], Southwest Research Institute, 1050 Walnut Suite 300, Boulder CO 80302, [2] Southwest Research Institute, 1050 Walnut Suite 300, Boulder CO 80302.

In February and March 2007 in route to the edge of the solar system the New Horizons (NH) spacecraft passed through the Jovian system obtaining imaging and spectroscopic observations of Jupiter, and the Galilean satellites.

The eruption of Io's Tvashtar plume was one of the most spectacular phenomena observed by NH during the Jupiter-fly. Previous evidence of the eruption of the Tvashtar plume included Cassini observations of the plume itself [1] and Galileo observations of red surface deposits centered around the vent of the Tvashtar volcano [2]. New Horizons observed the Tvashtar plume in scattered light on 39 occasions for ~ 8 days starting from February 28, 2007. These observations provided surpassing detail regarding the dynamics of the plume eruption [3]. For each of these observations the plume was observed to extend to an altitude of ~ 320 to 360 km and a width of ~ 1100 km, consistent with the diameter of the pyroclastic deposits centered around the vent of the Tvashtar volcano.

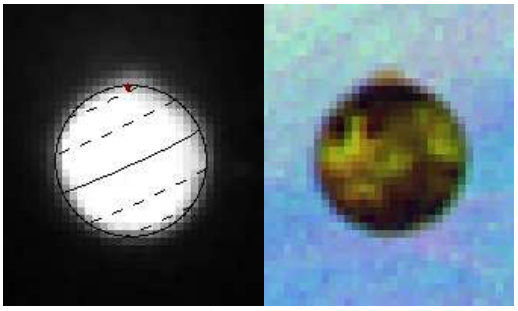

**Figure 1**: HST image of the Tvashtar plume taken against dark sky (left) on February 14, 2007 at a CML of 234 W in the F255W filter, and a false color image of the plume derived from a composite of the images obtained on February 21, 2007 during Jupiter transit in the F255 W, F336W and F410M filters (right). The Tvashtar volcano vent location is indicated with a diamond. The resolution in the images is ~ 180 km/pix [3]

However, detailed observation of the spectral properties of the plume between 2000 and 3200 Å, the wavelengths where Io's volcanic plumes are most conspicuous could not be obtained with the NH instrumentation. To cover this spectral gap, observations of Io were made with the Hubble Space Telescope Wide Field and Planetary Camera 2 (HST/WFPC2) over the week-long period extending from February 14 to 22, 2007. During this time the Tvashtar plume was observed in both scattered light and in absorption (Fig 1.). Observations of Io were made against dark sky in the ultraviolet using the F255W filter, and at visible wavelengths using the F336W, F569W and F791W filters. Images of Io taken during Jupiter transit were obtained in the ultraviolet and visible using the F255W, F336W, F410M filters (see Table I for bandpass details).

**TABLE I**

| Filter | Mean wavelength (Å) | Effective width (Å) |
|---|---|---|
| F255W | 2577 | 395 |
| F336W | 3329 | 374 |
| F410M | 4086 | 147 |
| F569W | 5582 | 966 |
| F791W | 7811 | 1231 |

The HST observations indicate that the Tvashtar plume is most conspicuous in the F255W filter, i.e., the plume scatters and absorbs strongly near 2600 Å. This behavior is consistent with all previous ultraviolet observations of the Pele plume [4,5]. It is known that the Pele plume is rich in $S_2$ gas [6,7], and it is likely that short chain sulfur products produced by the quenching of sulfur gas are the source Pele's red surface deposits (Fig. 2). $S_2$ gas absorbs strongly between 2400 and 2900 Å, thus corresponding to the wavelengths covered by the F255W filter (see Table 1). By comparison to Pele it is likely that the efficient absorption of light in the F255W filter by the Tvashtar plume is due to the fresh eruption of diatomic sulfur within the plume. Additionally, all available measurements of the size of the Tvashtar plume and the nature of its surface deposits suggest that the Tvashtar plume is in the class of the Pele plume.

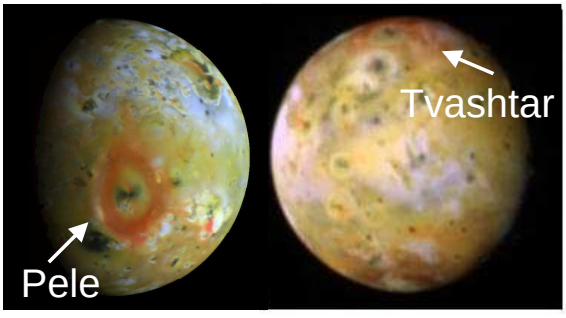


**Figure 2**: Images of the Pele (left) and Tvashtar (right) plume deposit regions as observed by Galileo [2].

Nevertheless, one to one correspondences between the two plumes cannot be assumed. For example,

the optical depth of the absorbing plume in the F255W filter for Tvashtar is a factor of 2 higher than the ~0.18 ± 0.016 value derived from 1996 HST observations of Pele plume obtained using the same filter [8].

In this presentation variation in the optical depth of absorption of the Tvashtar plume as a function of wavelength between 2600 and 4100 Å will be reported. We will also discuss constraints on the density of $SO_2$ and $S_2$ gas within the Tvashtar plume based on the optical depth observed in the F255W filter. It is necessary to discuss both gases because the F255W filter covers a wavelength region where both $SO_2$ and $S_2$ gas absorption can occur; additionally, analysis of spectra of the Pele plume indicates the $S_2/SO_2$ ratio in Pele can vary from 0.01 to 0.30 indicating that $SO_2$ gas is the dominant gas species in that plume [7]. In spite of this the $S_2$ gas absorption cross-section near 2600 Å is 50x higher than that of $SO_2$. Thus, even if $S_2$ gas is not the dominant species in the plume, $S_2$ gas will be the dominant absorber contributing to the optical depth of any plume detected in the F255W filter unless the $S_2/SO_2$ gas density ratio is 0.02 or less. Using Pele as an analog we will report the range of $SO_2$ and $S_2$ gas densities possible in the Tvashtar plume.

In order to further investigate the similarities and differences between the Pele and Tvashtar plumes the optical depth of each plume as a function of the wavelengths observed by HST in transit and scattered light will be provided. Additionally, updates on the plausible range of $SO_2$ and $S_2$ gas densities likely to have been detected in previous HST F255W images of the Pele plume obtained during Jupiter transit will be provided for comparison to the Tvashtar results.

**References:** [1] Geissler et al. 2004, *Icarus, 172*, 127-140.
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