Ultraviolet Surface Properties of the Icy Galilean Satellites from Phase Curve Analysis. A. R. Hendrix[1] and D. L. Domingue[2], [1]Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Dr., Pasadena CA 91109, amanda.hendrix@jpl.nasa.gov, [2]Johns Hopkins University/Applied Physics Laboratory, Johns Hopkins Rd., Laurel MD 20723, deborah.domingue@jhuapl.edu

Introduction: In this study, we use ultraviolet observations from the International Utlraviolet Explorer (IUE) and the Galileo Ultraviolet Spectrometer (UVS) to compose the ultraviolet solar phase curves of the icy galilean satellites. Broadband rotation phase curves from 0.26 to 0.32 microns are constructed in order to examine the rotational behavior of the icy Galilean satellites in the ultraviolet. After normalizing the rotational variations, modeling of the solar phase variations are compared to comparable studies in the visible.

Background: Studies of the rotational phase curve variations at visible wavelengths for the icy Galilean satellites indicate distinctive albedo changes from leading to trailing hemisphere. Processes such as the preferential bombardment of the leading hemisphere by micrometeorites and/or the preferential bombardment of the trailing hemisphere by co-rotating ions within Jupiter's magnetosphere have been proposed as mechanisms for creating these albedo variations. Ultraviolet observations by IUE [1] and the Hubble Space Telescope (HST) have measured absorption features attributed to surface chemistry resulting from ion interactions with the surface.

Discovery observations with IUE in the late 1970's showed an absorption feature at 0.28 microns on Europa whose strength correlated with the albedo variations observed on this satellite, and whose source was proposed to be the implantation of magnetospheric sulfur ions into the water-ice surface [2]. Later measurements with HST [3] were compared to laboratory spectra of irradiated water-ice and SO_2/H_2O layered frosts [4], to show that the observed spectral feature is better matched by the layered frosts, implying an endogenic origin.

Ganymede's rotational albedo variations are similar to Europa's, with the leading hemisphere being generally brighter than the trailing hemisphere. Ganymede's trailing hemisphere, however, has a different absoption feature than Europa's. Ganymede's absorption feature has been found to be ozone, and is most concentrated in the trailing hemisphere polar regions and at large solar zenith angles., commensurate with production by ion bombardment and destruction by solar photon interactions [5, 6]. HST visible observations of Ganymede have also detected oxygen on the trailing hemisphere at low latitudes, consistent with production via ion bombardment processes [7].

Callisto's rotational albedo varations are opposite to those seen on Europa in the visible, where the leading hemisphere is brighter than the trailing hemisphere. This is also the case in the ultraviolet. IUE and HST observations in the ultraviolet have also detected a 0.28 micron absorption featuer, linked to SO_2 [8, 9]. This absorption feature shows no correlation to the rotational albedo variations, however the IUE observations show some spatial correlation to possible neutral wind interactions suggestive of neutral sulfur implantation into Callisto's water-ice surface. The strongest 0.28 micron absorption seen in the IUE data was in the region containing Valhalla basin. Galileo UVS also detected this absorption feature on the leading hemisphere, but found no definitive correlation with surface feature [10].

Data Set and Analysis: Rotational phase curves were derived for each satellite for each wavelength bin (0.26, 0.27, 0.28, 0.29, 0.30, 0.31 and 0.32 microns), using IUE data in the 10° phase angle range. These rotational phase curves were then used to correct the entire data set (including additional solar phase angles) for each satellite to particular longitudes for photometric analysis. The Europa data set was the most extensive and allowed us to analyze all four longitude regions: the leading and trailing hemispheres, as well as the Jovian and anti-Jovian hemispheres. The Ganymede and Callisto data sets were more limited; for these satellites, we used the rotational phase curves to correct to 90° W longitude, and derived a global set of photometric parameters. This global set of photometric parameters was also derived for Europa, for comparison with Ganymede and Callisto.

Results: In this presentation, we discuss the rotational and solar phase curves we have derived for the three icy galilean satellites. We have fit Hapke photometric models to the solar phase curves for Europa, Ganymede and Callisto, and to four longitude regions on Europa. We intercompare these to look for variations related to differences in exogenic processes as discussed above. Although the data sets are not ideal – the data are sometimes noisy and phase angle coverage tends to be sparse, this work represents the first in-depth ultraviolet analysis of the photometric parameters of the icy galilean satellites, and the results are useful for understanding variations in scattering phenomena with wavelength.

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