COLOR PHOTOMETRY OF MERCURY'S SURFACE BASED ON MESSENGER'S FIRST MERCURY ENCOUNTER. Deborah L. Domingue[1], Brett W. Denevi[2], Gregory M. Holsclaw[3], Noam R. Izenberg[1], Hong Kyu Kang[1], Nori R. Laslo[1], William E. McClintock[3], Scott L. Murchie[1], Louise M. Prockter[1], Mark S. Robinson[2], Robin M. Vaughan[1]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 20723, deborah.domingue@jhuapl.edu; [2]Arizona State University, School of Earth and Space Exploration, Tempe, AZ, 85287; [3]LASP, University of Colorado, Boulder, CO, 80303.

Introduction: During MESSENGER's first flyby of Mercury the Mercury Dual Imaging System (MDIS) Wide-Angle Camera (WAC) [1] will obtain a set of dedicated color photometry images as part of the encounter sequence. Each filter (listed in Table I) will obtain images of the same target area on Mercury's surface over a 66° to 125° range in solar phase angle. Coupled with images taken using the same filters as part of the departure color imaging sequences (at phase angles of 53° to 58°), these observations will provide sufficient photometric coverage of a representative area to characterize many of the photometric properties of Mercury's surface. These data facilitate investigation of spatial variations in surface textural and optical scattering properties. In addition, an accurate photometric model is required for mosaicking map products from both MDIS and the Mercury Atmospheric and Surface Composition Spectrometer (MASCS), because each instrument will acquire global coverage at a range of photometric geometries (MDIS resides on a pivot platform whereas MASCS is mounted within the payload adaptor ring). During the flyby the MASCS observation ground track will cross the same region imaged during the MDIS color photometry sequence, thus allowing for cross-correlation between the two instruments in examining the surface photometric properties. Figure 1 shows the range of incidence and emission angles for the MASCS observations over the MDIS photometric region.

Table I. MDIS WAC Filter Bandpasses [1]

MDIS Filter No.	Central Wavelength (nm)	Filter width (nm)
6	433.2	18.1
3	479.9	10.1
4	558.9	5.8
5	628.8	5.5
1	698.8	5.3
7	748.7	5.1
12	828.4	5.2
10	898.8	5.1
8	947.0	6.2
9	996.2	14.3
11	1012.6	33.3

Current Coverage: Prior to MESSENGER's flyby of Mercury, photometric observations (defined as reflectance measurements over a range of illumination and viewing geometries) have been limited in both spectral and angular coverage. Disk-integrated observations by Danjon [2] and Mallama et al. [3] have provided the broadest phase angle coverage (2°-123° and 2°-170°, respectively) but only at a single wavelength (550 nm). Disk-resolved telescopic observations, such as those by Warell [4], have provided a broader spectral coverage (450 to 940 nm) but over a small range of phase (64° and 84°) and emission (-53° to 65°) angles. Mariner 10 images, while providing high-spatial-resolution, disk-resolved coverage, are also limited in wavelength (clear filter) and phase angle (40° to 118°, but not of a single area) coverage. MESSENGER will provide broad, disk-resolved phase angle coverage (53° to 125°) over a wider wavelength range (430 to 1010 nm) at a single spot on the planet. Examples from the photometry sequences are shown in Figure 2.

Analysis: The Hapke equations [5,6,7] have been applied to photometric observations in attempts to model the photometric reflectance behavior, and to correlate those properties with such regolith characteristics as porosity, roughness, albedo, and particle scattering signatures. From these modeling results, such basic properties as geometric albedo, phase integral, and Bond albedo are derived. Modeling of the disk-integrated observations [8,9,3] has shown that Mercury's regolith is similar to that of the Moon, with some subtle differences in roughness and backscattering behavior. These solutions, however, are non-unique even though they have been partially constrained by Mariner 10 disk-resolved observations. The MESSENGER disk-resolved data set, analyzed with the same set of Hapke equations, will further constrain the modeling solutions and provide regolith characteristics at eleven different wavelengths. These observations will provide estimates of the basic properties of geometric albedo, phase integral, and Bond albedo for a broad range of wavelengths for the first time.

Regolith Properties and Processes: The color photometry image set (centered on 0° latitude and 125° E longitude) taken by MESSENGER will be of the hemisphere not imaged by Mariner 10. This location is at the southern edge of radar feature "C," which is thought to be a bright crater ray system superposed on older, more mature regolith [10]. These data provide the means for modeling the photometric behavior of "generic" or "average" regolith and contrasting it with more freshly exposed ray material. The Hapke equations allow comparative analysis of the regolith properties, such as particle albedos, particle scattering behavior, and surface roughness. Comparisons among geologic units and with other planetary surfaces provide insight into a variety of geologic processes, such as space weathering and comminution. Particle albedos generally trend with spectral properties, but they are also an indicator of particle opacity. Variations in particle scattering behavior are indicative of structural changes, such as those induced by space weathering. Surface roughness properties can be correlated with formation and emplacement mechanisms for distinct geologic units.

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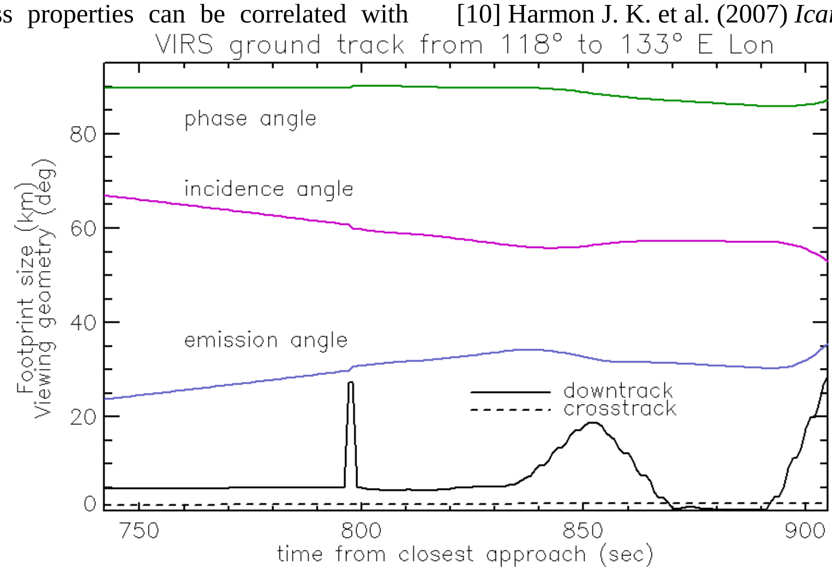

Figure 1. This plot is a description of the MASCS observations over the region to be imaged by MDIS during the color photometry sequence. The Visible and InfraRed Spectrograph (VIRS) component of MASCS, which covers the spectral range 320-1450 nm at 5-nm spectral resolution, will observe this region over a phase angle range of 85° to 90°, with the incidence and emission angle values ranging as shown. This data set overlaps the MDIS observations in both spectral and phase angle regimes.

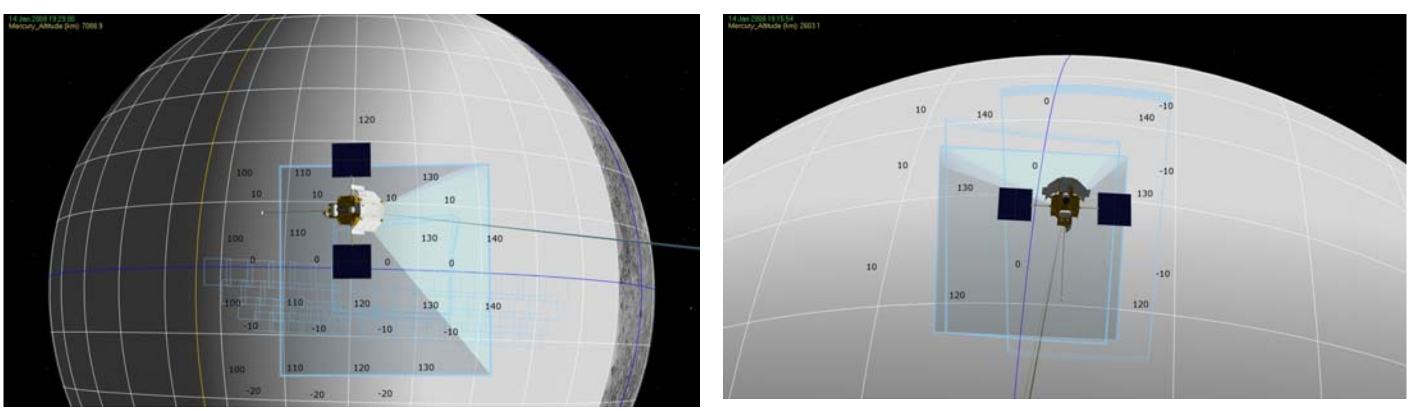

Figure 2. Two snapshots taken from encounter planning software of the color photometry sequence at low (left) and high (right) phase angles. Spacecraft orientation, positions of the image frames (blue squares on the surface), and latitude and longitude are shown.