PHOTOMETRIC PROPERTIES OF (152830) DINKINESH FROM DISK-RESOLVED IMAGING.
S. Mottola[1], F. Preusker[1], H. A. Weaver[2], J. M. Sunshine[3], S. J. Robbins[4], S. Marchi[4], K. S. Noll[5], J. R. Spencer[4], H. F. Levison[4], E. Bierhaus[6] and the Lucy Science Team. [1]DLR, Berlin, [2]APL, Laurel, [3]UoM, College Park, [4]SwRI, Boulder, [5]NASA/Goddard, Greenbelt, [6]Lockheed Martin.

Introduction: On Nov. 1, 2023, the NASA Lucy mission [1] performed a targeted fly-by with Main-Belt asteroid (152830) Dinkinesh – its first visit to a small body *en route* to the Jupiter Trojans. Although the primary goal of the encounter was to rehearse the functionality of the autonomous navigation system, the onboard instruments returned a rich data set that enables the characterization of the body in terms of its surface photometric properties.

Observation geometry: The spacecraft encounter started from an asymptotic solar phase angle of 118°, which progressively decreased to reach zero-phase and increased again to 60° during the outbound leg. The minimum fly-by distance to the ~720 m-sized target was about 430 km, which resulted in best-resolved imagery with a scale as good as 2.2 m/pixel on the Lucy LOng Range Reconnaissance Imager (L'LORRI) instrument [2] – the highest-resolution camera aboard Lucy. This encounter geometry was particularly favorable for the study of the photometric properties of the surface of Dinkinesh.

Data set: During the encounter, more than 60% of the surface of the object was imaged, and about 45% is useful for photometric inversion. For the purpose of the photometric analysis, a total of 48 L'LORRI images were used, with a scale ranging from 2.2 to 10 m/pix and a phase angle ranging from 2.0° to 104.4°. The range of the illumination geometry is shown in Fig. 1.

Methods: We perform disk-resolved photometric analysis of Dinkinesh by applying the Hapke photometric model [3] with assumed constant model parameters across the body's surface. The photometric angles for each suitable pixel in the images are computed via the digital shape model described in [4]. Retrieval of the best-fit parameter set is achieved via Levenberg-Marquardt non-linear optimization [5]. Instead of applying explicit constraints for the model parameters, we enforce the parameter validity range by using variable substitution. This approach is shown to achieve better convergence than constrained inversion. Robust outlier detection is implemented, in order to exclude from the fit data points affected by artifacts due, e.g., to mis-registration or local shape model defects. The stability of the solution is investigated per sensitivity analysis, which also provides estimates for the formal parameter errors.

Results: The derived global photometric model is used to generate photometrically-corrected maps and mosaics by computing the surface reflectance for a reference illumination and viewing geometry. These maps allow disentangling the intrinsic brightness variations on the surface from those due to variations in illumination and/or viewing geometry. They constitute a proxy for normal albedo maps, and can be used for assessing the degree of heterogeneity of the surface. Furthermore, they facilitate the reduction and interpretation of imaging data from other Lucy instruments. In addition, the derived model parameters are used to determine geometric albedo, phase integral and bond albedo, which, together with the radiometric data acquired by L'TES [6], will enable the development of a radiometric model for Dinkinesh.

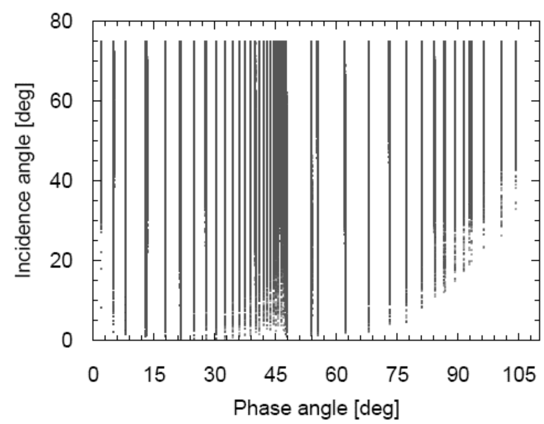

Figure 1 Range of useful illumination geometries available on the surface of Dinkinesh for the determination of its photometric properties from L'LORRI imaging data.

The derived photometric properties will be discussed in the context of the local topography and will be compared with those of other small Main-Belt and Near-Earth asteroids.

Acknowledgments: The Lucy mission is funded through the NASA Discovery program on contract No. NNM16AA08C.

References: [1] Levison H. F. et al. (2021) *The Planetary Science Journal, 2:171 (13pp).* [2] Weaver H. A. et al. (2023) *SSRv, 219, 82.* [3] Hapke B. (1984) *Icarus,* 59, 41–59. [4] Preusker F. et al. (2024) this conference, [5] Press W. H. et al. (1992) *Numerical recipes in C,* Cambridge Press. [6] Christensen P, R. et al. (2023) *SSRv, 220, 1.*