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Shape Reconstruction and Rotation State of Asteroid (52246) Donaldjohanson from *Lucy* Imaging and Ground-Based Photometry

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On April 20, 2025, while crossing the Main Asteroid Belt, the NASA *Lucy* mission—en route to the Jupiter Trojan regions—encountered its second cruise target, the C-type asteroid (52246) Donaldjohanson.

During the fly-by, the L'LORRI instrument [1] acquired a series of images suitable for stereo reconstruction, covering about 40% of the asteroid's surface. The images have a ground sampling distance ranging from 17 to 5 m/pixel and were taken at solar phase angles between 0.9° and 52°. Due to the asteroid's slow rotation (with a spin period exceeding 10 days), no appreciable rotation was observed in the disk-resolved images.

To achieve global shape reconstruction and determine the spin state, we complemented the stereo-photogrammetric data with contour information (limb and terminator features) and lightcurve data. This lightcurve information was drawn from two sources: sequences acquired by L'LORRI during the two months preceding the approach [2]and ground-based lightcurves obtained over the past six apparitions. The ground-based observations had already revealed that Donaldjohanson is currently in a state of complex rotation.

By combining these datasets, we expect to develop a detailed digital shape model of the illuminated portion of the asteroid, along with a low-order model of its non-illuminated hemisphere. Additionally, we plan to derive the asteroid's rotational dynamics and determine its inertia tensor—results that will be presented at the conference.

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References: [1] Weaver, H.A., et al., Space Science Reviews, 219, 82, 2023. [2] Solanki et al., this meeting.