

THE LUCY FLYBY OF ASTEROID (52246) DONALDJOHANSON. J. R. Spencer¹, H. F. Levison¹, S. Marchi¹, K. S. Noll², and the Lucy Science Team, ¹ Southwest Research Institute, 1301 Walnut St., Suite 400, Boulder CO 80304 (john.spencer@swri.org), ² NASA Goddard Space Flight Center, and Planetary Science Institute.

Introduction: On April 20th 2025, the NASA Lucy spacecraft encountered its second main-belt asteroid, (52246) Donaldjohanson (“DJ”), on its way to its primary targets, the Trojan asteroids [1]. The flyby successfully accomplished its primary purpose, a dress rehearsal for the Trojan flybys, but also provided valuable science data on this interesting asteroid.

Prior Knowledge of DJ: Prior to the Lucy encounter, DJ was already known from Earth-based data to be an intriguing object. It is a member of the Erigone collisional family, inferred from the orbital distribution of family members to have a relatively young age of ~150 Ma [2]. Lightcurve data indicated that it is an unusually slow rotator, with a primary period of ~250 hours, but the lightcurve was difficult to reconcile with simple rotation. The lightcurve amplitude is large, about a factor of 3 peak-to-peak, showing DJ to be a highly elongated object. Ground-based visible and near-IR spectrum indicated a C-type composition like other members of the Erigone family [3].

Flyby Geometry: Lucy’s close approach to DJ occurred at 17:51:16 UT on April 20th 2025, at a range of 961 km. Lucy approached DJ at a low solar phase angle, ~14°, and passed through zero phase 4.5 minutes before closest approach. 32 seconds before closest approach, at a range of 1050 km and phase angle of 52°, Lucy turned its instrument pointing platform (IPP) away from DJ to avoid pointing the instruments at the sun, terminating science data collection.

Lucy Observations: The encounter observing sequence was based on the planned sequence for the primary Trojan target (15094) Polymele, and was not optimized for DJ. Lucy’s autonomous terminal tracking system kept the IPP pointed at DJ until the turn-away, except for deliberate offsets. Lucy’s high-resolution imager L’LORRI [4] obtained hundreds of images, including a continuous sequence with 1-second cadence starting 1.6 minutes before closest approach. The best L’LORRI image scale was 5.2 m/pixel, with DJ overfilling the field of view. Lucy’s L’Ralph instrument [5] obtained color images with best image scale 85 m/pixel, and 1.0 – 3.8 μm image cubes with up to 70 m/pixel image scale. The L’TES instrument [6] also obtained hundreds of disk-integrated 6 – 100 μm spectra of DJ’s thermal emission.

Science Results: Lucy data provides a detailed shape model for the illuminated hemisphere of DJ, revealing it to be an elongated bi-lobed object 8.8 km

long (Fig. 1), with a heavily cratered surface that also includes boulders and a relatively smooth neck connecting the two lobes (Fig. 2). The encounter also provided improved constraints on DJ’s rotational dynamics, and valuable compositional constraints from its near-infrared spectrum. Evolutionary models provide plausible explanations for many of its features, though mysteries remain. Details will be presented at the conference, and a publication is in preparation.

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References: [1] Levison, H.F. et al. (2021) *Planet. Sci. J.*, 2:171. [2] Marchi, S. et al. (2025) *Planet. Sci. J.*, 6:59. [3] Harvison, B. et al. (2024) *Icarus* 412:115973. [4] Weaver, H.A. et al. (2023) *Space Sci. Rev.* 219:82. [5] Reuter, D.C. et al. (2023) *Space Sci. Rev.* 219:69. [6] Christensen, P.R. et al. (2023) *Space Sci. Rev.* 220:1.

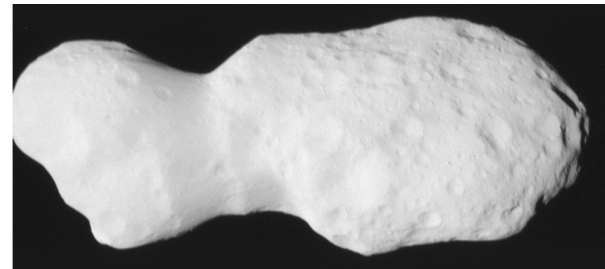


Figure 1. Global L’LORRI view of DJ, obtained 119 seconds before close approach, showing its bi-lobed shape. Phase angle is 16°. DJ is 8.8 km long.

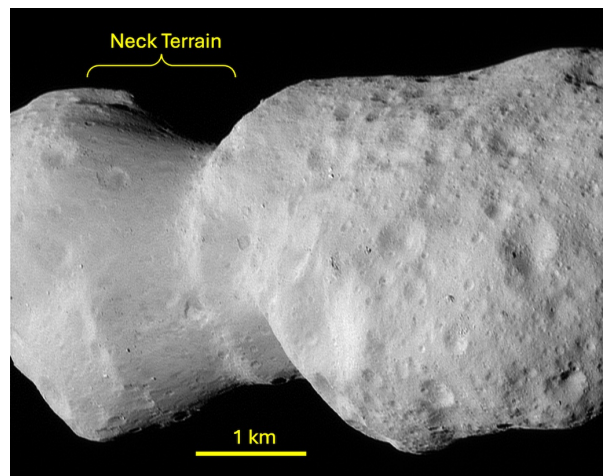


Figure 2. Highest-resolution L’LORRI image of DJ, obtained 33 seconds before close approach, showing the distinctive smoother neck terrain. Phase angle is 51°.