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Lucy - First to the Trojan Asteroids

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Mission Overview

The Lucy mission is the first reconnaissance of the Jupiter Trojan asteroids that hold vital clues to deciphering the history of the Solar System. Due to an unusual and fortuitous orbital configuration, Lucy, which is part of NASA's Discovery Program, will perform an exhaustive landmark investigation that visits six of these primitive asteroids, covering both the L_4 and L_5 swarms, all the known taxonomic types, the largest remnant of a catastrophic collision, and a nearly equal mass binary. It will use a suite of remote sensing instruments to map the geology, surface color and composition, thermal and other physical properties of its targets at close range. Thus, Lucy, like the human fossil for which it is named, will revolutionize the understanding of our origins.

Lucy's Comprehensive Tour

Lucy will perform flybys of six Trojans that span the diversity of the Trojan population: Eurybates (L_4, C-type), Polymele (L_4, P-type), Leucus (L_4, D-type), Orus (L_4, D-type), and the Patroclus-Menoetius binary (L_5, P-types). Lucy will also flyby the main belt asteroid DonaldJohanson. It will launch in 2021 and will have encounters from 2025–2033 (Fig. 1). Eurybates and the binary are of particular interest. Eurybates is the largest member of the only major collisional family in the Trojan swarms. The Patroclus-Menoetius binary, which consists of two roughly equal mass objects in circular orbits, is likely a leftover from the first macroscopic objects in the Solar System.

Payload

Lucy's instrument platform will carry the major instruments for remote-sensing science:

• L'Ralph is Lucy's color visible imager (the Multispectral Visible Imaging Camera, MVIC, 0.4–0.85 μm) and infrared imaging spectrometer (Linear Etalon Imaging Spectral Array, LEISA, 1–3.6 μm). LEISA will look for the absorption lines that serve as the fingerprints for different silicates, ices and organics that likely exist on the surface of the Trojan asteroids. MVIC will take 5 band color images of the Trojan asteroid targets to correlate geology and composition.

• L'LORRI, the LOng Range Reconnaissance Imager is the high spatial resolution visible imager. It is panchromatic, covering the wavelengths 0.35–0.85 μm. This camera will provide the most detailed images of the surface of the Trojans.

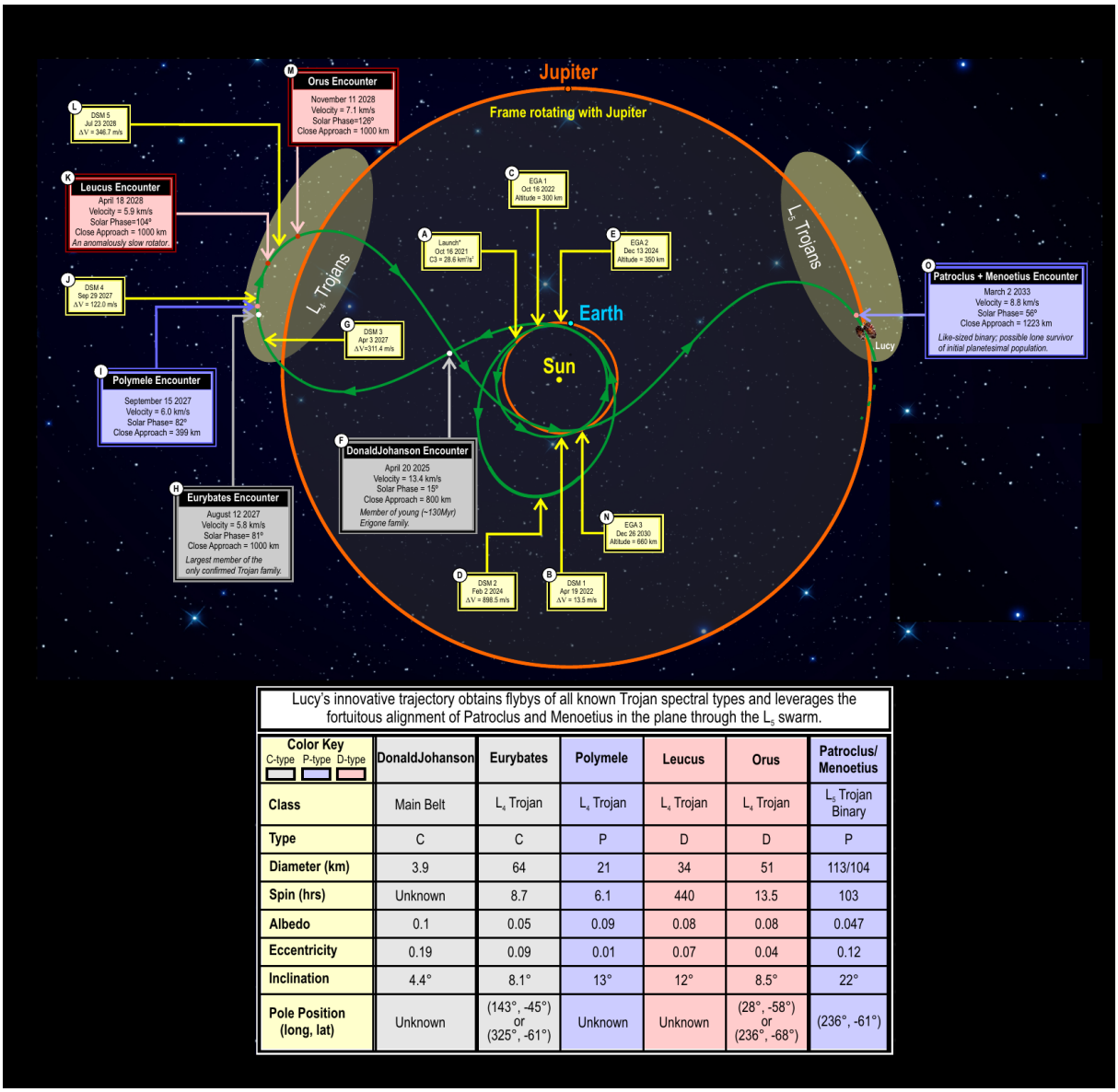
• L'TES is the Thermal Emission Spectrometer. It is similar to instruments flying on OSIRIS-REx and Mars Global Surveyor. This infrared spectrometer (6–75 μm) will allow the Lucy team to learn much more about the properties of the Trojans such as their thermal inertia, how well the bodies retain heat, which teaches us about the composition and structure of material on the surface of the asteroids.

Additionally, Lucy will be able to use its High Gain Antenna to determine the masses of the targets using the Doppler shift of the radio signal.

Science Objectives

1) Surface composition. Lucy will map the color, composition and regolith properties of the surface and determine the distribution of minerals, ices and organics species; 2) Surface geology. Lucy will map albedo, shape, crater spatial and size distributions, determine the nature of crustal structure and layering, as well as determine the relative ages of surface units; 3) Interior and bulk properties. Lucy will determine the masses and densities, and study subsurface composition via crater windows, fractures, ejecta blankets, and exposed bedding; 4) Satellite and ring search. Lucy will determine the number, size-frequency distribution and location of km-scale satellites and dense rings.

1. Figures



Lucy's innovative trajectory obtains flybys of all known Trojan spectral types and leverages the fortuitous alignment of Patroclus and Menoetius in the plane through the L_5 swarm.

Color Key (C-type P-type D-type)	DonaldJohanson	Eurybates	Polymele	Leucus	Orus	Patroclus/ Menoetius
Class	Main Belt	L_4 Trojan	L_4 Trojan	L_4 Trojan	L_4 Trojan	L_4 Trojan Binary
Type	C	C	P	D	D	P
Diameter (km)	3.9	64	21	34	51	113/104
Spin (hrs)	Unknown	8.7	6.1	440	13.5	103
Albedo	0.1	0.05	0.09	0.08	0.08	0.047
Eccentricity	0.19	0.09	0.01	0.07	0.04	0.12
Inclination	4.4°	8.1°	13°	12°	8.5°	22°
Pole Position (long, lat)	Unknown	(143°, -45°) or (325°, -61°)	Unknown	Unknown	(28°, -58°) or (236°, -68°)	(236°, -61°)

Figure 1: The Lucy trajectory.