

LUCY: SURVEYING THE DIVERSITY OF THE TROJAN ASTEROIDS: THE FOSSILS OF PLANET FORMATION. H. F. Levison¹, C. Olkin¹, K. S. Noll², S. Marchi¹, and the Lucy Team. ¹SwRI, Boulder, CO, USA; ²NASA-GSFC.

Mission Overview: The Lucy mission is the first reconnaissance of the Jupiter Trojan asteroids - objects that hold vital clues to deciphering the history of the Solar System (Fig. 1). Due to an unusual and fortuitous orbital configuration, Lucy, which has been selected as part of NASA's Discovery Program, will perform an exhaustive landmark investigation that visits six of these primitive asteroids, covering both the L4 and L5 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 high-heritage 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, and a main belt asteroid: Eurybates (L4, C-type), Polymele (L4, P-type), Leucus (L4, D-type), Orus (L4, D-type) and the Patroclus-Menoetius binary (L5, P-types). It will launch in 2021 and will have encounters from 2025-2033 (Fig. 2). Lucy leverages multiple successful missions: 1. Payload: New Horizons, OSIRIS-Rex, and MGS/MER; 2. Spacecraft: High heritage; 3. Operations: Experienced spacecraft (LM), mission (GSFC), and science (SwRI) Ops Teams.

High Impact Science: Through its unique tour, Lucy will provide crucial input to four of the ten Priority Questions for Planetary Science as expressed by the Decadal Survey in 2013 (DS13):

- What were the initial stages, conditions and processes of Solar System formation ...?
- How did the giant planets ... accrete, and is there evidence that they migrated to new orbital positions?
- What governed the accretion ..., and what roles did bombardment by large projectiles play?
- What were the sources of primordial organic matter?

The Trojan swarms contain a wide variety of small bodies, C-, D-, and P-type spectral types. Some argue they formed throughout the outer Solar System and were captured in the aftermath of giant planets migration. Therefore, it is only by sampling their diversity, as Lucy does, that their true scientific potential can be realized.

Measurements: Lucy's primary 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, and 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.

Conclusions: Owing to their unique location near Jupiter and the critical role they play in revealing and constraining models of the formation and evolution of the Solar System, Trojans have been a high priority for space missions for over a decade. This is evidenced by calls for their reconnaissance by spacecraft in DS13 and the 2014 NASA Science Plan. Both documents identify a survey of the diversity of Trojan asteroids among the two highest priority missions to small bodies. Lucy will accomplish the related goals of DS13 and the NASA Science Plan with a high-heritage, low-risk spacecraft and science payload.

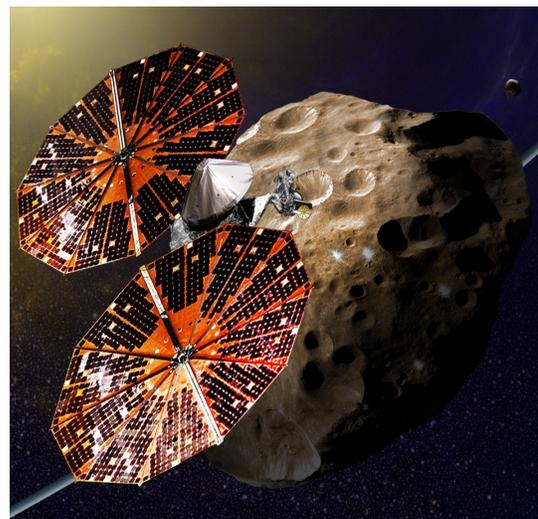


Fig. 1. Artistic rendering of the Lucy spacecraft.

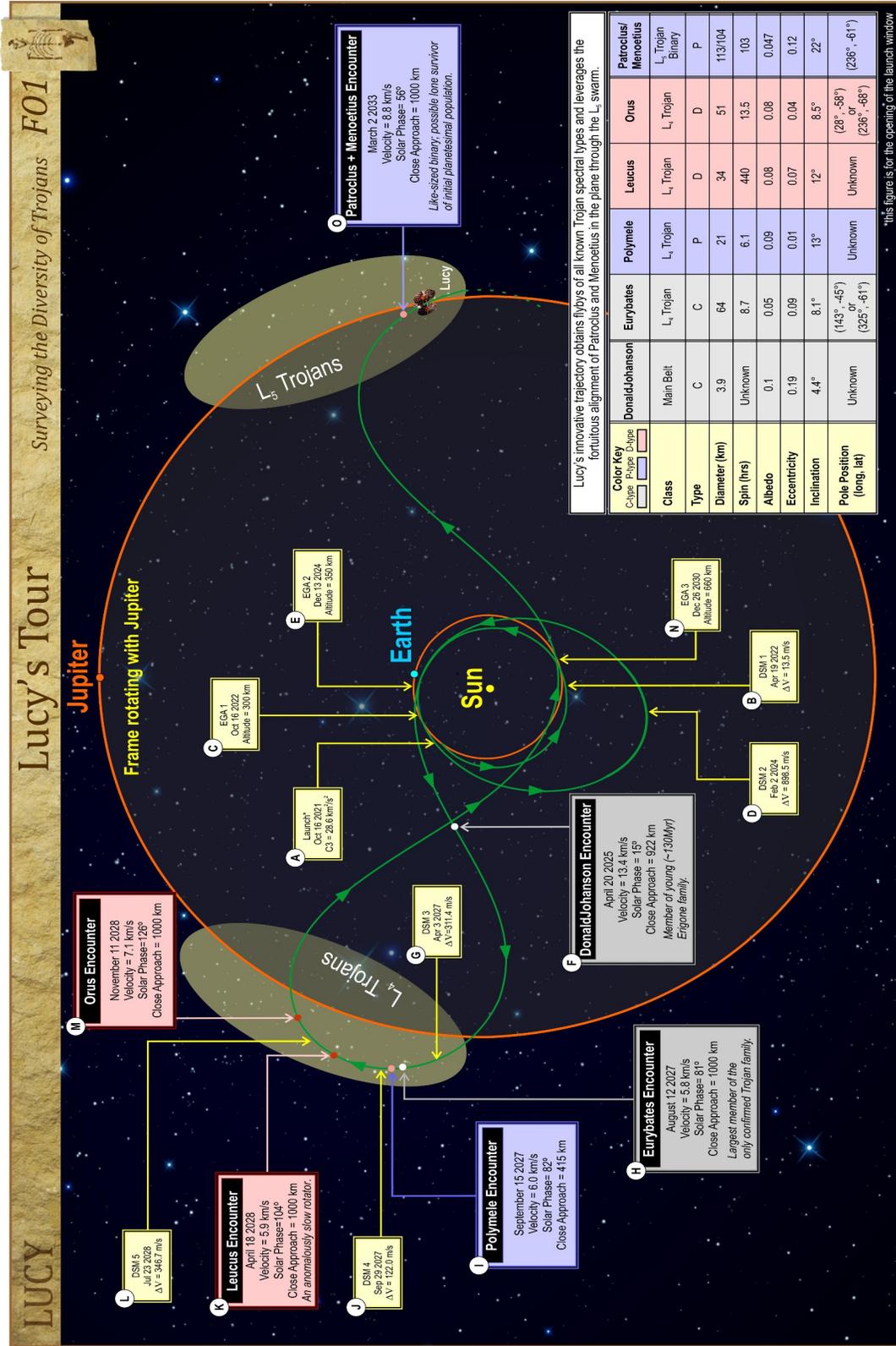


Fig. 2. Mission trajectory for Lucy shown in a frame fixed with respect to Jupiter. The physical parameters in the inset are current best estimates for the targets.

The yellow boxes represent launch and trajectory correction maneuvers.