



NASA's Lucy Mission

First to The Trojan Asteroids

NASA's Lucy mission is the first space mission to explore a diverse population of small bodies known as the Jupiter Trojan asteroids. These small bodies are remnants of our early solar system, now trapped on stable orbits associated with – but not close to – the giant planet Jupiter. The Trojan asteroids are in two “swarms” that lead and follow Jupiter in its orbit around the Sun, and are almost as numerous as the objects in the Main Asteroid Belt. Over its twelve-year primary mission, Lucy will explore a record-breaking number of asteroids, flying by one main belt asteroid and seven Trojan asteroids.

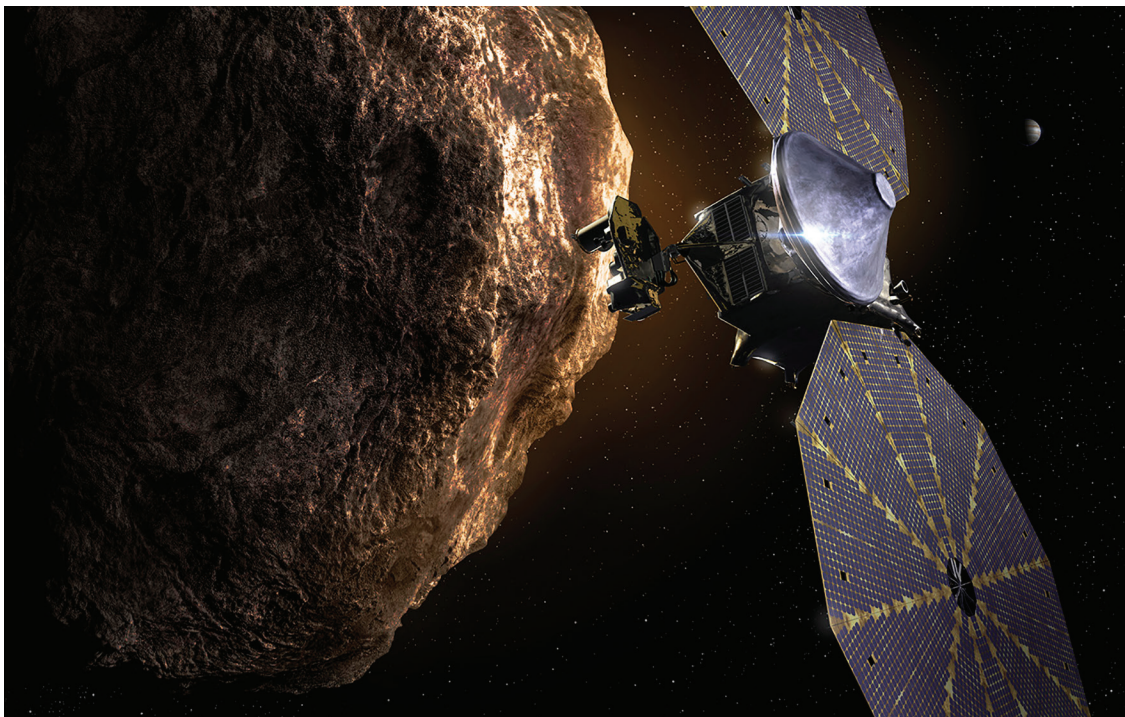
The Lucy mission is named after the fossilized skeleton of an early hominin (pre-human ancestor) that was found in Ethiopia in 1974 and named “Lucy” by the team of paleontologists who discovered it. And just as the Lucy fossil provided unique insights into humanity’s evolution, the Lucy mission promises to revolutionize our knowledge of planetary origins and the formation of the Solar System.

SCIENCE GOALS AND OBJECTIVES

Planet formation and evolution models suggest that the Trojan asteroids are likely to be remnants of the same primordial material that formed the outer planets, and thus serve as time capsules from the birth of our Solar System over four billion years ago. These primitive bodies hold vital clues to deciphering the history of our Solar System and may even tell us about the kinds of organic materials that may have been supplied to the early Earth.

The primitive bodies that built the planets were not uniform in their composition, and we see evidence of this diversity in the asteroids that have survived to the present. In order to understand the diversity of the Trojan asteroids, Lucy has the following science objectives at each of its destinations:

- *Surface Geology* – Lucy will map the shape, albedo, and crater spatial and size-frequency distributions; determine the nature of crustal structure and layering; and determine the relative ages of surface units.
- *Surface Color and Composition* – Lucy will map the color, composition and regolith properties of the surface, and determine the distribution of minerals, ices, and organic species.
- *Interiors and Bulk Properties* – Lucy will determine the masses and densities, and study sub-surface composition via excavation by craters, fractures, ejecta blankets, and exposed bedding.
- *Satellites and Rings* – Lucy will look for and study satellites and/or rings that might orbit the targeted Trojan asteroids.



Artist concept of Lucy at a Trojan Asteroid. Credit: NASA/Lockheed Martin

NASAfacts

MISSION OVERVIEW

Lucy will launch from the Cape Canaveral Space Force Station, Florida on an Atlas V 401 rocket during a 21-day launch period starting Oct 16, 2021. It will then fly by the Earth twice in order to use the Earth's gravitational field to assist it on its journey to the Trojan asteroids.

On its way out to the Trojan asteroids, Lucy will fly by the main belt asteroid (52246) Donaldjohanson on April 20, 2025. There, Lucy will fly by five of these L4 Trojans: (3548) Eurybates and its satellite, Queta, on August 12, 2027, (15094) Polymele on September 15, 2027, (11351) Leucus on April 18, 2028, and (21900) Orus on November 11, 2028.

The spacecraft's orbit will then bring Lucy back to the vicinity of the Earth for another gravity assist, and will take it again out to the distance of Jupiter. In the meantime, the Trojan swarms will have moved in their own orbits around the Sun so that the spacecraft will pass through the Jupiter's trailing L5 swarm (near the 5th Lagrange point). Arriving on March 2, 2033, Lucy will fly by (617) Patroclus and its near-twin binary companion Menoetius. While the flyby of this remarkable asteroid pair will be the expected finale of the mission, Lucy will remain on a stable orbit which will enable it to visit the Trojan swarms over and over again for many thousands, and possibly millions, of years.

SCIENCE PAYLOAD

Lucy will explore the Trojan asteroids with a suite of remote sensing instruments:

- *L'Ralph* – an instrument provided by NASA's Goddard Space Flight Center in Greenbelt, Maryland, that consists of two parts:
 - L'Ralph Linear Etalon Imaging Spectral Array (LEISA), an infrared imaging spectrometer that will reveal the absorption lines that serve as the fingerprints for different silicates, ices and organics that may be on the surface of the Trojan asteroids, and
 - L'Ralph Multi-spectral Visible Imaging Camera (MVIC), that will take color images of the Trojans to help determine their composition and look for indications of surface activity.
- *Lucy Long Range Reconnaissance Imager (L'LORRI)* – a high resolution, panchromatic visible camera made by the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. L'LORRI will provide the most detailed images of the surface of the Trojan asteroids.
- *Lucy Thermal Emission Spectrometer (L'TES)* – an instrument built by Arizona State University in Tempe, Arizona, that will measure the surface temperature of the Trojan asteroids by observing the thermal infrared spectrum, helping to understand the physical properties of the surface material.

Additionally, the navigation cameras (Terminal Tracking Cameras, T2CAM) will be used to determine the shapes of the Trojan asteroids. The High Gain Antenna will be used to both communicate with Earth and to carry out radio science experiments to measure the masses of the Trojan asteroids. Lucy Radio science is led by a team from the University of Cologne, Germany.

SPACECRAFT

Lockheed Martin Space is building the spacecraft at its facility near Denver, Colorado.

Spacecraft Specifications:

- Width: 46.75 ft (14.25 m)
- Height: 23.6 ft (7.2 m) or 12.4 (3.8m) when solar panels are stored)
- Depth: 9.12 ft (2.78 m)
- Diameter of Solar Panels: 23.9 ft (7.3 m)
- Dry Mass (unfueled): 1810 lbs (821 kg)
- Wet Mass (fueled): 3417 lbs (1550 kg)
- Power: 504 watts at the furthest encounter

PROJECT TEAM & MISSION PARTNERS

NASA's Lucy mission is led by Hal Levison, the principal investigator, and Cathy Olkin, deputy principal investigator, both at the Boulder, Colorado, branch of Southwest Research Institute (SwRI), headquartered in San Antonio, Texas. Donya Douglas-Bradshaw and Arlin Bartels are the project manager and deputy project managers, respectively, at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

NASA Goddard will provide overall mission management, systems engineering, and safety and mission assurance. Lockheed Martin Space in Denver will build the spacecraft. KinetX in Simi Valley, California, will provide mission navigation. Launch operations will be conducted by NASA's Kennedy Space Center. As a Discovery Class mission, Lucy is overseen by the Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, for NASA's Planetary Science Division.

For more information, go to:

www.nasa.gov/lucy

or

www.lucy.swri.edu

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