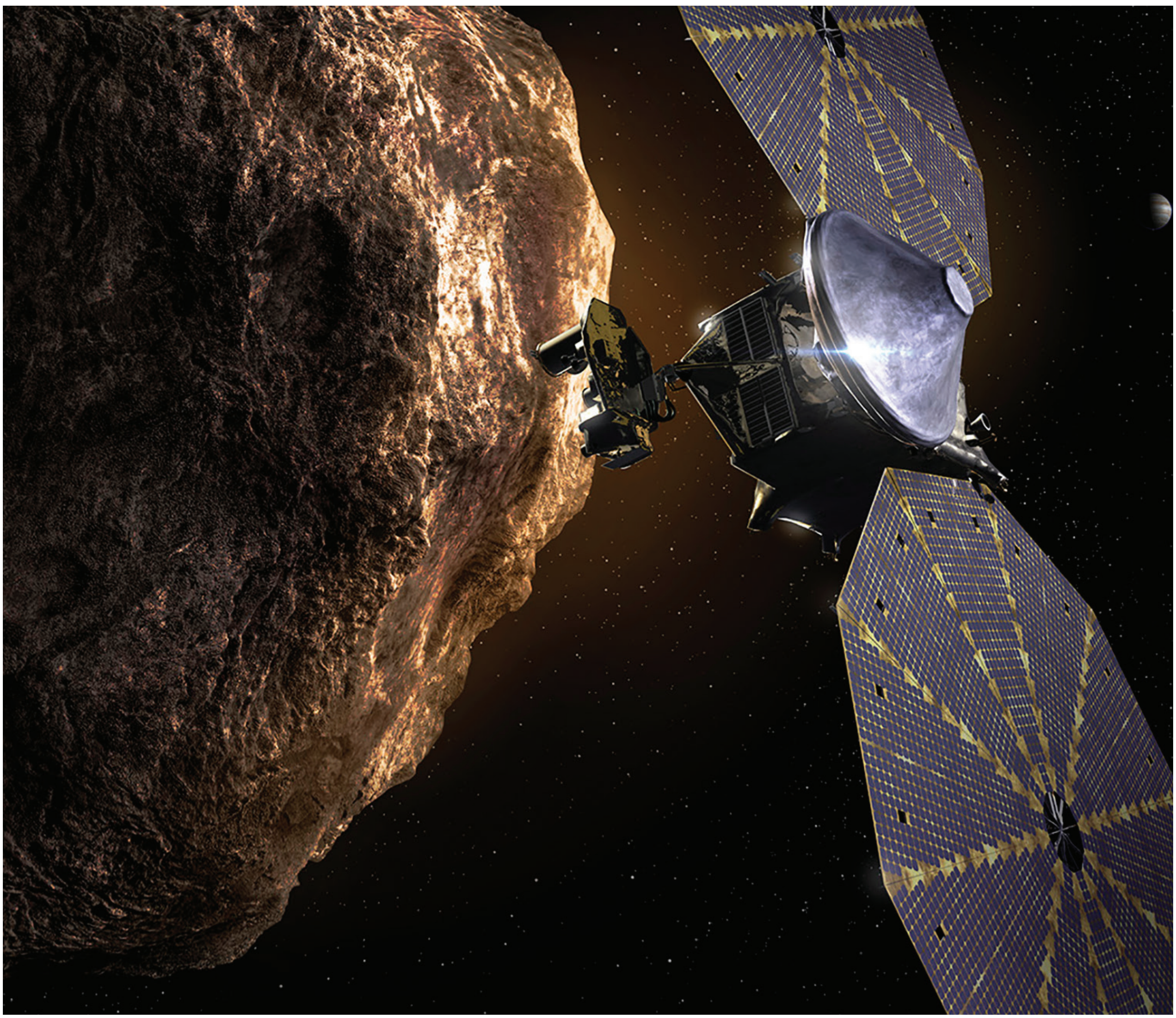
National Aeronautics and Space Administration

PRESS KIT / SEPTEMBER 2021

Lucy

The First Mission to the Trojan Asteroids



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MEDIA SERVICES

News briefings and launch commentary will be streamed on NASA TV and NASA.gov/live.

NASA TV channels are digital C-band signals carried by QPSK/DVB-S modulation on satellite Galaxy-13, transponder 11, at 127 degrees west longitude, with a downlink frequency of 3920 MHz, vertical polarization, data rate of 38.80 MHz, symbol rate of 28.0681 Mbps and 3/4 FEC. A Digital Video Broadcast-compliant Integrated Receiver Decoder is needed for reception. For more information about NASA TV's programming schedule, visit http://www.nasa.gov/ntv.

Audio Only

Audio only of launch coverage will be carried on the NASA "V" circuits, which may be accessed by dialing 321-867-1220, -1240, -1260 or -7135. On launch day, "mission audio," the launch conductor's countdown activities without NASA TV launch commentary, will be carried on 321-867-7135.

Media Accreditation and Access

News media representatives who would like to cover the launch in person must be accredited through the NASA News Center at Kennedy Space Center. To apply for credentials, visit https://media.ksc.nasa.gov.

Journalists may contact the KSC news media accreditation office at 321-867-6598 or 321-867-2468 for more information.

News Conferences

September 28 at 1:00 pm – ~L-20 Lucy Mission Briefing
October 13 at 1:00 pm – Lucy Pre-launch Briefing
October 14 at 1:00 pm – Lucy Science Briefing
October 14 at 3:00 pm – Lucy Engineering Briefing

Online Information and Multimedia

Information about NASA's Lucy mission, including a copy of this press kit, press releases, status reports and images is available at: https://www.nasa.gov/lucy

Frequent updates about the mission, are available by following #LucyMission on @NASASolarSystem.

Mission images, video and animations can be found here: https://svs.gsfc.nasa.gov/Gallery/Lucy.html

GENERAL OVERVIEW

NASA's Lucy will launch from the Cape Canaveral Space Force Station, Florida on an Atlas V 401 rocket during a 23-day launch period starting October 16 and extending through November 7, 2021.

The 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 orbit in two "swarms" that lead and follow Jupiter in its orbit around the Sun and are thought to be comparable in number to the objects in the Main Asteroid Belt.

Over its 12-year primary mission, Lucy will explore a record-breaking number of asteroids, flying by one main belt asteroid and seven Trojan asteroids. Additionally, Lucy will have three Earth flybys for gravity assists, making it the first spacecraft ever to return to the vicinity of Earth from the outer Solar System.

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 paleoanthropologists who discovered it. And just as the Lucy fossil provided unique insights into human evolution, the Lucy mission promises to revolutionize our knowledge of planetary origins and the formation of the Solar System, including the Earth.

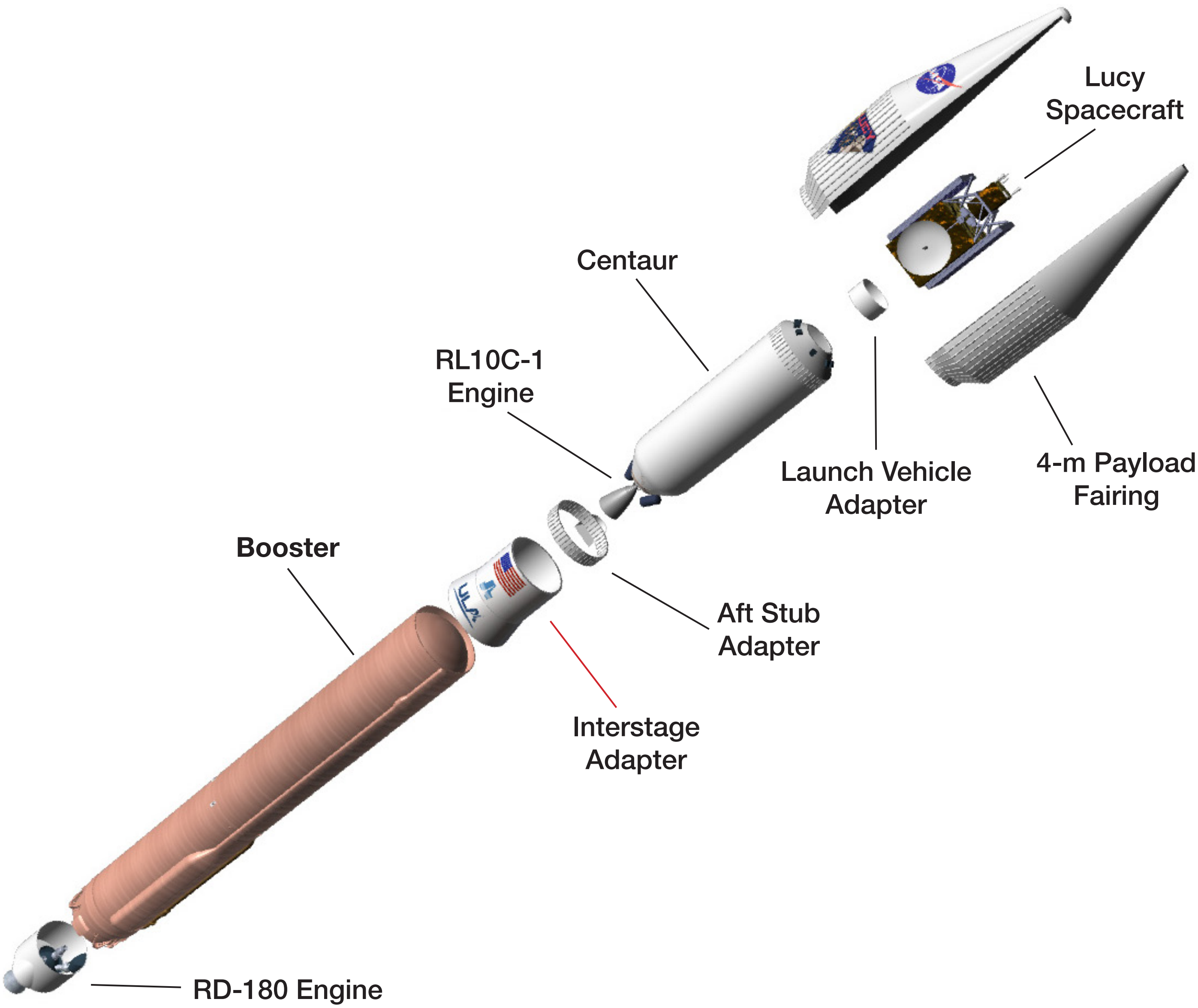
FUN FACTS

- Lucy's complex trajectory includes three Earth gravity assists and covers almost than 4 billion miles (6.3 billion km) over 12 years.
- Lucy will be operating out to approximately 530 million miles (850 million km) away from the Sun during its encounters with the Trojan asteroids. This is why it needs its two massive solar arrays (diameter 24 ft or 7.3 m each) to power its systems during its journey. With the arrays unfurled, Lucy, standing on one wingtip, would be as tall as a five-story building. It will break records traveling farther from the Sun than any previous solar-powered mission.
- Even though Lucy is going to objects that share an orbit with Jupiter, it isn't going to Jupiter; it's going in two completely different directions to visit the two Trojan asteroid swarms. The closest Lucy ever gets to Jupiter will be just before it swings by Earth for a gravity assist in October 2022!
- By end-of-mission in 2033, Lucy will have visited a record number of destinations in independent orbits around the Sun.
- Lucy's first encounter will be with the main belt asteroid known as (52246) Donaldjohanson. This previously unnamed asteroid has been named in honor of the paleoanthropologist who discovered the fossilized human ancestor, "Lucy," whose skeleton provided unique insight into humanity's evolution, and after whom the mission is named.
- Lucy's L'TES instrument has a diamond beamsplitter, so the Lucy will be carrying a diamond into the sky.
- After its mission is over, Lucy will remain in its orbit around the Sun, returning again and again to the Trojan asteroids, possibly for a million years or even longer.
- Lucy is carrying a time capsule in the form of a golden plaque with messages to any of our descendants who may one day find Lucy as a relic of the early days of our exploration of the Solar System

KEY MISSION DATES:

- Mission Selection: January 2017
- Launch: October 2021
- Earth Gravity Assists: October 2022, December 2024, and December 2030
- Main Belt Asteroid Encounter: (52246) Donaldjohanson, April 20, 2025.
- Trojan Asteroid Encounters: 2027-2033
    - L4 (leading) Swarm:
        - (3548) Eurybates and its satellite, Queta, August 12, 2027
        - (15094) Polymele, September 15, 2027
        - (11351) Leucus, April 18, 2028
        - (21900) Orus on November 11, 2028
    - L5 (trailing) Swarm:
        - (617) Patroclus and Menoetius, March 3, 2033

LAUNCH CONFIGURATION



#Atlas V #LucyMission

MISSION OVERVIEW

NASA's Lucy mission will launch from the Cape Canaveral Space Force Station, Florida on an Atlas V 401 rocket during a 23-day launch period starting October 16, 2021.
It will then fly by the Earth twice, in 2022 and 2024, to use Earth's gravitational field to assist it on its journey to the Trojan asteroids, which orbit the Sun at approximately the distance of Jupiter.

On its way out to the Trojan asteroids, Lucy will fly by and observe the Main Belt asteroid (52246) Donaldjohanson on April 20, 2025. Then, Lucy will proceed to fly by five of the 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.

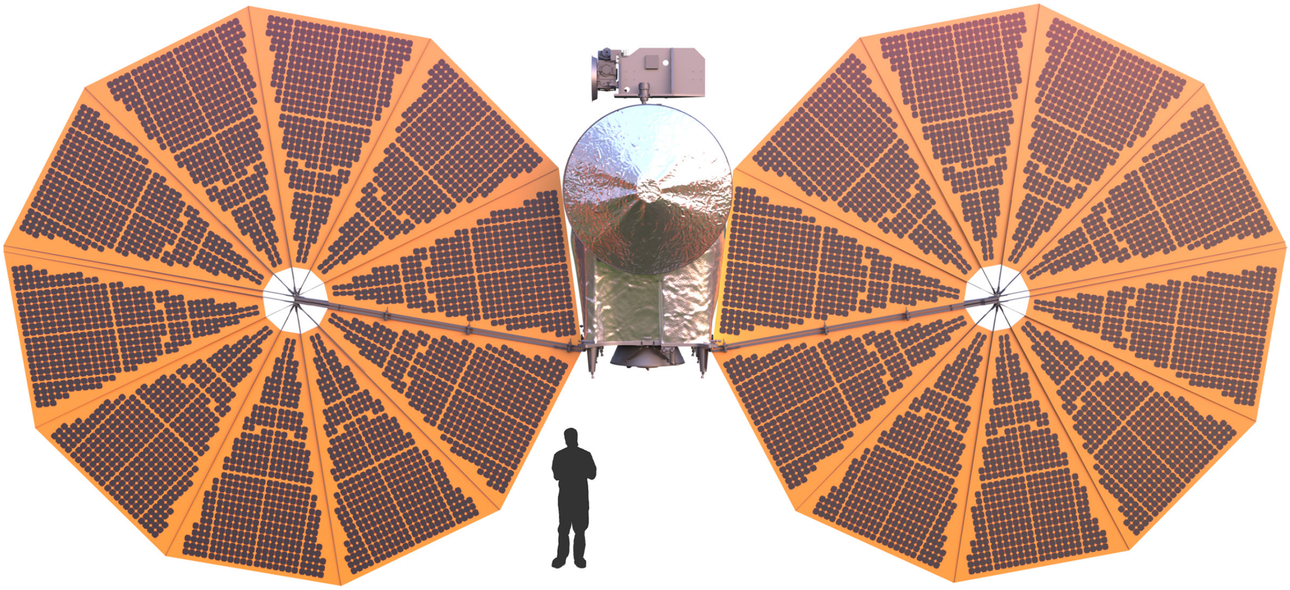
The spacecraft's trajectory will then bring Lucy back to the vicinity of the Earth in 2030 for another gravity assist, which will fine-tune its second swing out to the Trojans. In the meantime, the Trojan swarms will have moved in their own orbits around the Sun so that the Lucy spacecraft will pass through the L5 swarm. Arriving on March 3, 2033, Lucy will fly by (617) Patroclus and its near-twin binary companion Menoetius. While the close-up observations of this remarkable asteroid pair will complete the primary scientific goals of the mission. Lucy will remain in a stable orbit which will enable it to visit the Trojan swarms repeatedly for many thousands, and possibly millions, of years.

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 (Jupiter, Saturn, Uranus, and Neptune), 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 the environments in which all of the planets, including Earth, formed and developed.

Surprisingly, Trojan asteroids have very different surface compositions from one another. This diversity likely means that they formed in different locations in the solar system and were transported to their current orbits as the planets formed and evolved. To understand what this diversity is telling us about the history of our planetary system, Lucy has the following science objectives at each of its destinations:

- *Surface Geology* – Lucy will map the shape, albedo (reflectivity), 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 (surface "soil") 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 rings and satellites of the Trojan asteroids.



SPACECRAFT OVERVIEW

Lucy will be over 52 feet (16 meters) from tip to tip, but most of that is the huge solar panels (each close to 24 feet, or over 7 meters, in diameter) needed to power the spacecraft's systems as it flies out to the orbit of Jupiter. All the instruments, and the 6.5 ft (2 meters) high gain antenna needed to communicate with Earth, will be located on the much smaller spacecraft body.

- Width: 51.89ft (15.82m)
- Height: 23.89 ft (7.28m) when solar arrays deployed or 12.95ft (3.95m) when Solar panels are stowed
- Depth: 6.57 ft (2.00m)
- Diameter of Solar Panels: 23.9 ft (7.3m)
- Dry Mass (Unfueled): 1700 lbs. (771kg)
- Wet Mass (Fueled): 3300 lbs. (1500 kg)
- Power: 504 Watts at the farthest encounter

INSTRUMENT OVERVIEW

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

L'LORRI

The Lucy LOng Range Reconnaissance Imager L'LORRI, is Lucy's most sensitive and highest resolution camera.

This panchromatic (black-and-white) camera is a type of Ritchey–Chrétien telescope, the same basic design as the Hubble Space Telescope. Light travels down the tube and is reflected by the hyperbolic primary mirror, then travels back up the tube and is reflected by the hyperbolic secondary mirror. The secondary mirror focuses the light through an opening in the primary mirror. It then passes through a set of lenses. The image is recorded with a charge-coupled device, the light-sensitive device used in some digital cameras.

One of L'LORRI's objectives is to produce clear images of the Trojan asteroids, despite their being extremely dark. From 1000 km away (621miles), L'LORRI will be able to clearly see craters with a diameter of 70 m or 229 ft (i.e.,14 m or 45 ft per resolution element), which is like standing at one end of a football field and being able to see a fly at the other end. L'LORRI's detailed images will help Lucy's science team understand the surface geology of the Trojan asteroids, including their craters, which record impacts by other asteroids over time. L'LORRI will also search for rings and satellites, as well as help with optical navigation.

L'LORRI is panchromatic (detecting the entire visible spectrum) and does not use optical filters. L'LORRI has no moving parts, not even a focusing mechanism, which reduces risk. Most of L'LORRI's optical system is made of silicon carbide.

L'LORRI was built by Johns Hopkins Applied Physics Laboratory, under the leadership of Harold Weaver (Instrument Principal Investigator) and Neil Dello Russo (Instrument Deputy Principal Investigator). The instrument is based on New Horizons' LORRI instrument, which collected most of the incredibly detailed images of Pluto (2015) and the Kuiper Belt object Arrokoth (2019). Though a few changes were made to New Horizons' LORRI for the Lucy mission (such as replacing its composite baffle with stronger aluminum, adding a second electronic pathway and more memory), L'LORRI retains much of its predecessor's tried-and-tested design.

L'Ralph

L'Ralph will search the Trojan asteroids' surfaces for organic compounds, ices, and hydrated minerals, and its images will help us determine the Trojans' surface compositions. L' Ralph is actually two instruments in one — MVIC (Multispectral Visible Imaging Camera), a color visible imager, and LEISA (Linear Etalon Imaging Spectral Array), an infrared spectrometer. A beamsplitter inside sends the infrared light to LEISA and reflects the visible light to MVIC.

MVIC has five color bands that cover the visible to near infrared spectrum. The bands are chosen to help scientists identify compositional elements on the surfaces of the Trojan asteroids. For example, the phyllosilicate band is sensitive to phyllosilicates, a kind of hydrated mineral scientists expect to find on the Trojans' surfaces while the other bands are sensitive to a range of materials. In addition, the slope of the reflected light measured in all the bands helps identify the color of the surface and gives clues to its history. There is also a panchromatic band that covers the entire visible/ near IR range that allows very sensitive comparisons to be made between the properties of different areas of the surface MVIC uses six CCDs arrays (the light-sensitive devices used in digital cameras in place of film), each with up to 64 rows of 5000 pixels each to take its images.

LEISA contains a linear etalon, a thin, slightly sloped, transmitting layer of sapphire surrounded by a pair of reflective surfaces, slightly sloped on one sided, that separates light into a spectrum, like a prism. LEISA images can be analyzed based on how different substances on the asteroid's surface behave when absorbing different wavelengths of light, allowing the identification of the different kinds of rocks, ices, and organic compounds that could be present. From 1000 km (621 miles) away, LEISA will be able to resolve craters on the order of 500 m (1640FT) wide.

Like L'LORRI, L'Ralph does not have a focusing mechanism. To avoid defocusing or other problems caused by temperature changes, most of L'Ralph is made from a single block of aluminum. Even the mirrors are made of aluminum, and diamonds were used to turn the metal into finely polished surfaces. And because the images L'Ralph will take are so large, it also has 256 gigabits of onboard memory.

NASA's Goddard Space Flight Center built L'Ralph, under the leadership of Dennis Reuter (Instrument Principal Investigator) and Amy Simon (Instrument Deputy Principal Investigator). L'Ralph is based on the New Horizons instrument Ralph, as well as OSIRIS-REx's OVIRS. Ralph gathered New Horizons' incredible color images of Pluto, Charon (2015), and Arrokoth (2019). Lucy's new iteration of Ralph has several improvements from its New Horizons predecessor, such as a much broader IR spectral range, the addition of onboard memory, and a scanning mirror that allows images to be taken without additional spacecraft motion. Despite this, L'Ralph still runs on much less power than the average ceiling fan (less than 30 Watts).

L'TES

Though the Trojan asteroids are many hundreds of millions of kilometers from the Sun, sunlight still heats them up, and the warm surfaces naturally emit far infrared radiation. The Lucy Thermal Emission Spectrometer (L'TES) detects this radiation, using a telescope with diameter 15.2 cm (5.98 in) to focus the incoming energy onto a small detector. In this way, L'TES acts like a remote thermometer. L'TES is not an imager, but it can take temperature measurements at various points on an asteroid, which can be combined to produce a "picture" of the physical surface properties. While Lucy's other spectrometer (LEISA on L'Ralph) will probe the asteroids' surface composition, the temperature measurements from L'TES will help the science team deduce how quickly the surface heats up in sunlight and releases heat in shadow. Smaller surface particles, like sand on a beach, heat up and cool down quickly; larger particles, like a slab of concrete, do it more slowly. By measuring the temperature at different times of day, the team can deduce how much dust, sand, or rock is present in the regolith. L'TES could also detect any variation in thermal physical surface properties on a single asteroid, something an earthbound telescope would not be able to detect.

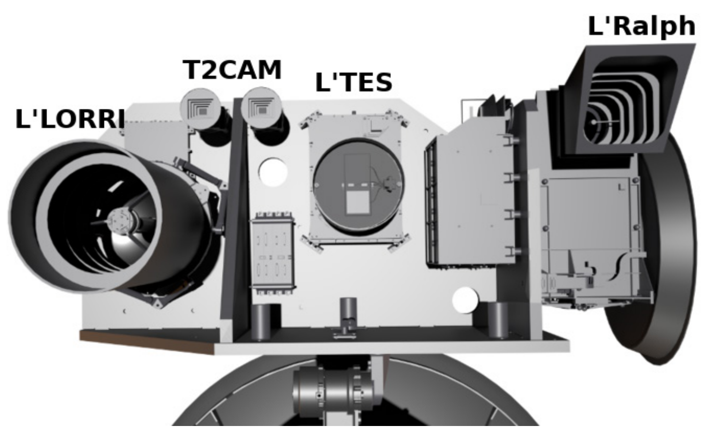
L'TES was built by Arizona State University, under the leadership of Phillip Christensen (Instrument Principal Investigator) and Victoria Hamilton (Instrument Deputy Principal Investigator). The instrument is based on OSIRIS-REx's OTES (OSIRIS-REx Thermal Emission Spectrometer). L'TES retained most of the hardware design, including its large diamond beamsplitter, from its predecessor, with electronics adapted from EMIRS (Emirates Mars Infrared Spectrometer), an instrument on the Emirates Mars Mission.

Mass determination via the Radio Science Experiment

In addition to these instruments, Lucy has a 6.5-ft-wide (2-meter) high gain antenna which will serve as the primary communications relay between the spacecraft and Earth. Designed and built by Lockheed Martin, this same style antenna has been used to return science data from Mars and transfer back photos of asteroid Bennu. With Lucy, the antenna will not only send back the first ever close-up images of the Trojan asteroids, but the team will also be able to use small velocity-induced shifts in the received radio frequency (the Doppler effect) to determine the masses of these never-before-visited space objects.

T2CAM

Lucy will use its terminal tracking camera (T2CAM) to help navigate the spacecraft and track the asteroids during encounters. In addition to keeping the asteroids in the field of view of the main instruments, T2CAM will take wide-field images of the asteroids to better ascertain their shapes. The shape, along with the radio measurement of mass, will allow the science team to determine the density of material inside.



WHY EXPLORE THE TROJAN ASTEROIDS

The Jupiter Trojan asteroids are leftover raw materials from the formation of our Solar System's giant planets (Jupiter, Saturn, Uranus, and Neptune) over 4.5 billion years ago. They hold a record of the composition and physical conditions in the protoplanetary disk from which all the Sun's planets, including Earth, formed. At some time in the distant past, the Trojan asteroids became trapped in their current locations, orbiting the Sun approximately at the distance of Jupiter in two broad swarms associated with the L4 and L5 Lagrange points. These are locations where the combined effects of the Sun's gravity, Jupiter's gravity, and orbital motion create an equilibrium, such that objects orbiting near these points will stay near them indefinitely. The "L4 swarm" leads, one-sixth of a lap ahead of Jupiter, while the "L5 swarm" trails one-sixth of a lap behind. Current scientific theories indicate that the Trojan asteroids could have been trapped in these stable orbits early in the Solar System's history, at the end of an era of giant planet "migration" during which the planets' orbits shifted substantially.

The foremost theory for how the Trojan asteroids came to be where they are involves a dynamical instability which caused sudden, large changes in the orbits of the giant planets. In this scenario, small objects from across the outer Solar System were widely scattered, most being ejected to the far reaches of the Solar System or beyond, and a few lucky survivors making their way into Trojan orbits near the Lagrange points or other stable niches like the Kuiper Belt. If this picture is correct, Lucy will encounter objects that originally formed in different parts of the Sun's outer protoplanetary disk, where the first solid bodies condensed. Lucy will give us insights into the dynamical and physical processes that affected these planetary building blocks and will help us untangle the Solar System's early history at the time when planet formation was ending, and the planets were moving into the orbital configuration we see today.

Although all Trojan asteroids share similar dark, reddish surfaces, they are not all the same. There are distinct differences in color and spectral reflectance, suggesting different compositions, different histories, or both. Why such a diverse population of asteroids is found in the Trojan swarms is a key question to understand the evolution of our planetary neighborhood. Data from Lucy's instruments will help discern the origin and evolution of this diversity.

ASTEROID ENCOUNTERS

Lucy's first encounter (2025), on the way out to the L4 Trojan swarm, is with the Main Belt (that is, non-Trojan) asteroid Donaldjohanson, named for the discoverer of the Lucy fossil at the Lucy team's suggestion. This will be a "dress rehearsal" for the primary encounters to follow. However, Donaldjohanson is very interesting, since it is believed to be a fragment of a recent collision in the Main Belt, making it one of the younger asteroids in the zone between Mars and Jupiter.

Lucy's complex path will take it to both clusters of Trojans and give us our first close-up view of all three major types of bodies in the swarms (so-called C-, P- and D-types). The dark-red P- and D-type Trojans resemble those found in the Kuiper Belt of icy bodies that extends beyond the orbit of Neptune. The C-types are found mostly in the outer parts of the Main Belt of asteroids, between Mars and Jupiter. All of the Trojans are thought to be abundant in dark carbon compounds. Below an insulating blanket of dust, scientists hypothesize they are rich in water and other volatile substances.

Eurybates and Queta (August 2027)

Lucy's first Trojan asteroid encounter, in the L4 swarm, will be with Eurybates, the biggest member (40 miles [64 km] in diameter) of the largest collisional family in the Trojans. Collisional families are groups of asteroids whose similar orbits indicate that they are likely all fragments resulting from a past catastrophic collision. Eurybates and its family members are doubly interesting because their spectroscopic classification (C-type) is shared by only 7% of Trojans. Lucy will be the first spacecraft to examine a large remnant of a known catastrophic collision.

Using the Hubble Space Telescope, the Lucy Team discovered in 2020 that Eurybates has a small moonlet. Less than a mile in diameter, the moonlet, named Queta (after Olympic athlete Norma Enriqueta Basilio Sotelo), likely formed during the catastrophic collision. It poses no danger to Lucy. During the encounter, Lucy will fly close enough to Queta to open new opportunities to observe another tiny Trojan and at the same time meet all science goals at Eurybates.

Polymele (September 2027)

Polymele, also in the L4 swarm, has a diameter of approximately 15 miles (24 km) and a spectrum indicating it a P-type asteroid. Earth-based observations conducted by the Lucy science team determined that its rotational period is 6.1 hours.

Leucus (April 2028)

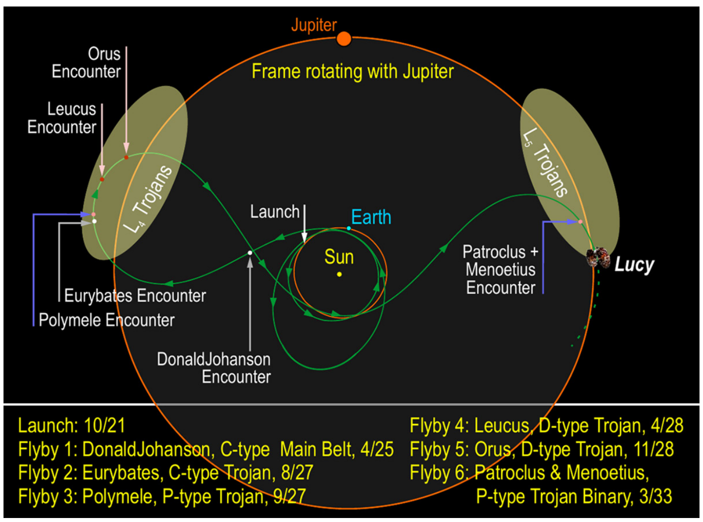
Leucus is a D-type asteroid in the L4 swarm with an effective diameter of 13 miles (20 km). It is particularly interesting because it has a very long rotational period (440 hr), as well as a highly elongated shape. It is football shaped with a long axis of 31 km and a short axis of 15 km.

Orus (November 2028)

Orus is a D-type asteroid in the L4 swarm with an approximate diameter of 38 miles (62 km). It is similar in size to Eurybates but is not associated with any known collisional family, giving Lucy the opportunity to compare and contrast objects of a similar size but different colors and collisional history. This will enable scientists to sort out the processes that affected these objects.

Patroclus and Menoetius (March 2033)

Patroclus and Menoetius are a near-equal binary system. Each component is about 60 miles (100 km) in average diameter and both orbit about a point in space roughly halfway between the two. Binaries like this are relatively rare in the Trojans but are very common in the Kuiper Belt (located beyond the orbit of Neptune), a fact that may prove to be an important link between these two very distantly separated populations of objects.



HOW TO PRONOUNCE THE ASTEROIDS' NAMES

Most of the Trojan asteroids are named for heroes in Homer's The Illiad. Below are some of the pronunciations most frequently used. Note: these are anglicized versions, not what a modern (nor classical) Greek speaker would say.

Asteroid and Pronunciation

- Eurybates: "yoo-RIB-a-teez" or "you-ri-BAY-teez"
- Queta: "KEH-tah" (named in honor of modern Olympian Norma Enriqueta Basilio Sotelo)
- Polymele: "pah-li-MEH-lee" or "pah-LIM-ah-lee"
- Leucus: "LYOO-kus" or "LOO-kus"
- Orus: "OR-us"
- Patroclus: "pa-TROH-klus" or "PAT-roh-klus"
- Menoetius: "men-EE-shus"

SELECTING ASTEROIDS TO VISIT

The Lucy mission takes advantage of a unique and "opportunistic trajectory", dictated by celestial mechanics, that allows one single spacecraft to visit a record number of asteroids. Lucy's first Trojan target, Eurybates, was selected because it differs from most of the other Trojan asteroids in two ways: it is both the largest remnant of a rare massive collision, and it has a neutral-colored C-type spectrum.

Scientists hypothesize these two facts may be related, and that by exploring Eurybates we may get a glimpse of the internal structure and composition of C-Type Trojan asteroids which today is exposed on the surface. However, comparisons are important, and so the team looked for a red object of a similar size and on a similar orbit as Eurybates. This led to Orus. Then with a little luck, the team found a trajectory passing objects spanning the full range of colors (including both D and P spectral-types) and with different sizes (from less than a mile (approximately 1 km) to around 70 miles (over 100 km) in diameter).

Fun fact: the Lucy team realized they could add the L5 binary asteroid Patroclus/Menoetius as a destination only when they extrapolated the trajectory of the spacecraft forward to make sure it wouldn't collide with Earth, Mars, or Jupiter's moon Europa!

PUBLIC ENGAGEMENT OPPORTUNITIES

Lucy Plaque

NASA's Lucy spacecraft will carry a plaque containing messages from prominent members of our society; individuals who have asked us to contemplate the state of the human condition as well as our place in the universe. These thoughtful leaders were asked to provide words of advice, words of wisdom, words of joy, and words of inspiration to those who may read this plaque in the distant future. These messages were solicited from Nobel Laureates in Literature, United States Poet Laureates, and other inspirational figures including the members of the band that indirectly inspired the Lucy mission's name.

To date this time-capsule, the plaque also includes a depiction of the Solar System on the day of Lucy's anticipated launch of October 16, 2021. The original trajectory of the Lucy spacecraft, traveling between the Trojan swarms and the Earth's orbit, is shown as well.

NASA places this plaque with the hope that space exploration continues and someday astro-archeologists may travel among the planets and retrieve this spacecraft as an artifact of the early days when humanity took its first steps to explore our Solar System.

For more information about the plaque participants, visit: http://lucy.swri.edu/lucy-plaque

Lucy Time Capsule

The public is invited to join Lucy on this 12-year journey by making their own Lucy Time Capsules. Inspired by the fact that Lucy will be visiting time capsules of our early Solar System, as well as the fact that Lucy will carry a plaque to serve as a time capsule from our present era, the Lucy team invites the public to create their own time capsules as they follow along with on Lucy's epic voyage.

These time capsules can consist of any objects, sounds, ideas or words, either in the form of a physical or digital time capsule. At each major mission milestone people will be encouraged to revisit and add to the time capsule. We encourage the public post a photo, drawing, video or other description of their Lucy Time Capsule on social media using the hashtag **#LucyTimeCapsule**.

NASA's Lucy Mission invites the public to follow along with Lucy on its 12-year journey by building Lucy Time Capsules. Inspired by Jupiter's Trojan asteroids as ancient time capsules of our early Solar System and a plaque on the spacecraft that carries a message from our present era to our descendants, the public is invited to create their very own time capsules to mark the mission at launch.

Time capsules may consist of objects, sounds, ideas, or words and may be physical or digital. At each major mission milestone people will be encouraged to revisit and add to their time capsules. We invite the public to share their Lucy Time Capsule by posting a photo, drawing, video or other description on social media using the hashtag **#LucyTimeCapsule**.

Lucy Soundscape

Lucy Soundscape, rolled out in May, is an outreach effort that engages with musicians and composers around the world, inviting them to create and share original music inspired by the Lucy mission. The connection to Lucy comes through the *Lucy Motif*, a three-note figure that the mission leadership adopted in 2019 as a "musical mission patch."

Any original music, composed or improvised, instrumental or vocal, that uses the Lucy Motif in some way to express a feeling or tell a story of inspiration and discovery can be shared through the Lucy Soundscape. With the combined creativity of participating artists, all starting from the same three notes, the Soundscape has the potential to become an evolving musical ecosystem developing in unforeseeable ways as the mission itself develops and yields unforeseeable discoveries.

Musicians can still join the Lucy Soundscape by sharing their original compositions and improvisations online using the #NASALucySoundscape. More information on how to participate can be found here: https://www.nasa.gov/lucy-soundscape.

Lucy in Space Contest

Just months before the launch of NASA's Lucy mission, winners of the Lucy in Space Contest were selected by NASA and Arizona State University's Institute for Human Origins (IHO). First place winners and their teachers have received invitations to attend the spacecraft launch from Cape Canaveral Space Force Station in Florida.

Middle and high school students across the U.S. were challenged to produce creative works of art and writings to make a connection between our human drive for discovery and exploration of our origins on Earth and in our Solar System. Through sculpture, drawings, poetry, and even haiku, students drew connections between the NASA Lucy mission and the Lucy fossil.

Middle school students created a mission "patch" design, and high school students were encouraged to create any type of art or video as a message to the "future finders" of the Lucy Mission spacecraft, imagining what our decedents might one day find or recover as a relic of humanity's early exploration of the Solar System. Student entries also included an essay or poem explaining their submission.

To see a list of contest winners, go to: https://www.nasa.gov/feature/goddard/2021/nasa-celebrates-lucy-in-space-contest-winners

Lucy Student Collaboration - L'SPACE Program

The L'SPACE (Lucy STEM Pipeline Accelerator and Competency Enabler) Program is a free, virtual NASA workforce development program that is open to undergraduate STEM students who are interested in pursuing a career in space exploration and who are attending a US college or university. The L'SPACE Program consists of two academies that are each 12 weeks long and are offered each spring, summer, and fall. Each interactive academy provides technical instruction and long-term mentoring to the participants. Students learn NASA mission procedures and protocols from industry professionals as they collaborate with fellow team members to complete mission-related team-projects.

After participating in the academy, L'SPACE students remain connected through the alumni program. Alumni have the opportunity to deepen their training experiences as paid summer interns at Lucy partner institutions or as volunteer Lucy Asteroid Ambassadors---trained in public outreach to share the excitement, science, and story of the Lucy Mission.

To date, the L'SPACE Academies have had over 4,000 participants representing over 650 US colleges and universities. Students come from all 50 states, Puerto Rico, and Guam. The L'SPACE Program model is inclusive and accessible to those who are underrepresented in the current STEM workforce and includes 40% women and 41% students of color, helping NASA to gain in diversity within its emerging STEM workforce.

To learn more about the L'Space Program, visit: https://www.lspace.asu.edu.

NASA'S LAUNCH SERVICES PROGRAM

The Launch Services Program, known as LSP, is based at NASA's Kennedy Space Center in Florida and boasts a roster of engineers and subject matter experts who specialize in all aspects of rocketry and spacecraft integration. Based on requirements supplied by the mission team, LSP selects the appropriate launch vehicle for a customer's spacecraft, in this case the United Launch Alliance Atlas V-401, for Lucy. This selection process takes place years before launch.

Established in 1998, the Launch Services Program is a superior collection of state-of-the-art technology, business, procurement, engineering best-practices, strategic planning, studies, and techniques – all instrumental for the United States to have access to a dependable and secure bridge to space, launching spacecraft to orbit our planet, or fly much further into the cosmic deep.

Capitalizing on a half-century of expertise and collaboration with NASA, LSP is striving to facilitate and reinvigorate America's space effort broadening the unmanned rocket and satellite market by providing reliable, competitive, and user-friendly services.

Working with commercial launch providers, LSP has several rocket models to choose from, ranging from the small, Northrop Grumman Innovation Systems (NGIS) Pegasus XL, to the United Launch Alliance powerhouse Atlas V, or Space X's powerful operational rocket the Falcon Heavy.

Spacecraft destination requirements coupled with the mass and volume of the spacecraft determine the launch vehicle required. The destination may be an orbit or even another planet. Additionally, spacecraft must survive ground handling and launch environments such as vibration, contamination, electromagnetic, thermal, and structural loads to get to their destination. Engineers and analysts with LSP ensure the optimal launch vehicle is used to deliver a healthy spacecraft to the correct orbit or destination. LSP launches from Cape Canaveral Space Force Station in Florida, Vandenberg Space Force Base in California, Kwajalein in the Marshall Islands, Kodiak Island, Alaska, and NASA's Wallops Flight Facility on Virginia's Eastern Shore.

PROJECT TEAM AND 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 (Goddard), Arlin Bartels (Goddard), John Andrews (SwRI), and Vince Elliott (Goddard) are the project manager and deputy project managers, respectively. NASA Goddard Space Flight Center in Greenbelt, Maryland provides overall mission management, systems engineering, and safety and mission assurance. Lockheed Martin Space in Denver, Colorado built and will operate the spacecraft for NASA. 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, the Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, provides program management. Lucy is part of the NASA Science Mission Directorate, Planetary Science Division at Washington DC, which has the overall responsibility for the Discovery Program, and its missions. Lucy is the thirteenth standalone mission in the Discovery Program.