SAMPLE

Solar System Missions: Lucy

Visiting the Trojan Asteroids

Aira Astralis

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Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

Lucy is the spacecraft built to visit the fossils of the solar system. Launched by NASA on 16 October 2021, Lucy is the first mission to the Jupiter Trojans, the two great swarms of asteroids that ride ahead of and behind the giant planet in its orbit, locked in the gravitational cul-de-sacs where the Lagrange points hold them, and by the time its twelve-year journey ends in 2033 it will have flown past more small worlds than any mission in history, an itinerary of nine numbered asteroids and the satellites that keep arriving as surprises.

The mission's name is its thesis. The Trojans, by the leading theory, are remnants from the outer solar system, captured when the giant planets migrated in the solar system's youth, and so they are fossils of the era of planet formation, preserved at Jupiter's stable points for four billion years. The mission was named for the Lucy fossil, the Australopithecus skeleton whose discovery rewrote the story of human origins, and the fossil was itself named for the Beatles song, so the spacecraft carries a three-generation lineage, a song, a skeleton, and a probe, each the naming of a discovery about where we came from. The pun the mission's team uses is exact: the Trojans are the fossils of planet formation, and Lucy is the paleontologist.

This book carries the whole narrative: the mission's beginnings in the Discovery program and the science of the migrating planets, the launch and the solar array drama, the Earth flybys and the first encounters, the surprise at Dinkinesh and the appointment with Donaldjohanson, the instruments and the questions each target was chosen to answer, the campaign ahead at the two Trojan swarms, and the mission's place in the era's exploration of the small worlds. Lucy is a twelve-year patience, and what follows is the story of what it has already found and what it is still flying toward.

A note on the mission's own record: the narrative across these chapters draws on the mission's published record, the encounter papers and the engineering reports, all public documents, and the dates and names quoted come from the mission itself. Where the science runs ahead of the spacecraft, the Trojan questions of 2027 onward, the text says so plainly, because a mission in flight deserves the honesty of its own schedule, and the reader who wants the frontier can find it in the mission's releases, the most public of any small mission's, an itinerary anyone can follow, window by window, for a dozen years.

A note on this book's own timing: Lucy is a mission in flight, its Trojan windows still ahead, and the account here covers the mission to its current position, the rehearsals flown and the tour's remaining years scheduled, with the

encounters of 2027 through 2033 presented as the itinerary the mission's own planning documents publish. The reader should treat the coming chapters' forward-looking passages as the mission's promises rather than its results, the same standard the field applies, and the second edition of this book, if the fossils have spoken by then, will tell the rest, the paleontology continued, as it always is, one dig at a time.

Chapter 1: The Discovery of Lucy

The discovery story of Lucy begins with a theory, because the mission exists to test one: the Nice model of the solar system's youth, the now-standard account in which the giant planets formed closer together and then migrated, scattering the small bodies that surrounded them.

The migration's predicted fingerprint is the Trojans. The asteroids trapped at Jupiter's Lagrange points, the L4 swarm ahead of the planet and the L5 swarm behind, are by the model's account not native to Jupiter's neighborhood but captives, outer solar system planetesimals swept up and locked in during the migration, and so the Trojans should be diverse, primitive, and chemically foreign, ice-and-organics worlds that formed far from where they now ride. The model's authors, among them the planetary dynamicists of the early 2000s, predicted that a spacecraft visiting the Trojans would find objects unlike the asteroid belt's, and the mission that became Lucy was proposed to check: a multiple-flyby tour of both swarms, sampling the Trojans' diversity with the instruments that had served New Horizons at Pluto, and answering the origin question with the only evidence that counts, close-up observation.

The proposal, led by Hal Levison of the Southwest Research Institute, one of the migration theory's own architects, won selection in NASA's Discovery competition in January 2017, the program's thirteenth mission, a cost-capped, focused, principal-investigator-led enterprise in the New Frontiers spirit. The winning concept's economy was its genius: a single spacecraft using Earth's own gravity, three flybys over the cruise, to fling itself across the solar system on a free-falling tour of nine asteroids, the most targets any planetary mission had ever promised, achieved with almost no fuel, the itinerary written in celestial mechanics rather than in propellant.

The name was chosen for the lineage this introduction has told, and the mission's targets honor it too: the fossil's discoverer, the paleoanthropologist Donald Johanson, has an asteroid named for him, and Lucy flies past it, a main belt appetizer before the Trojan feast, on the way. The launch, on 16 October 2021, an Atlas V lifting off from Cape Canaveral, began the twelve-year tour, and the discovery of Lucy, as this chapter frames it, is the discovery that the theory got a test: the solar system's best account of its own youth would finally meet the fossils it predicted, and the chapters that follow are what they said.

The account should credit the mission's people, because Discovery missions are personal enterprises: Hal Levison's team, the Southwest Research Institute leading and Lockheed Martin building the craft, the instrument teams from the

universities and institutes that built the cameras and spectrometers, and the operations crews who will staff the twelve years of mornings. The team's character shows in the mission's style, the public briefings that treat the tour like a dig, each target a stratum, each flyby a brush of the trowel, and the reader who has heard the team's presentations knows the style, the paleontologist's patience worn by the engineer's precision, the two disciplines the mission's name promised, working.

The launch deserves its own note as the mission's public beginning: the Atlas V rose on 16 October 2021, the dawn of the longest tour a Discovery spacecraft has flown, and the departure was watched by the era's space audience with the fondness the mission's story earned, a spacecraft named for a skeleton, carrying the era's biggest question, on a free fall that will not end until the calendar says 2033. The launch's success, the spacecraft healthy on the trajectory, was the mission's first kept promise, and the promises since, the arrays repaired, the rehearsals flown, have kept the account current, the mission's discipline visible from the first day.

This chapter closes with the mission's own favorite image, the one the team uses in every public talk: the solar system as a dig site, the planets as the buildings that still stand, and the asteroids as the bones in the strata, the Trojans the richest undisturbed bed, sealed at Jupiter's edge since the youth. The image is the mission's thesis as a picture, and the reader who holds it holds the whole mission, a paleontology of the sky, conducted by a spacecraft named for the field's most famous skeleton, the tools of the era pointed at the oldest bones there are, the discovery story ending where it began, with the question the skeleton asks, where did we come from, asked this time of the planets.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.