VOL. 98 • NO. 3 • MAR 2017

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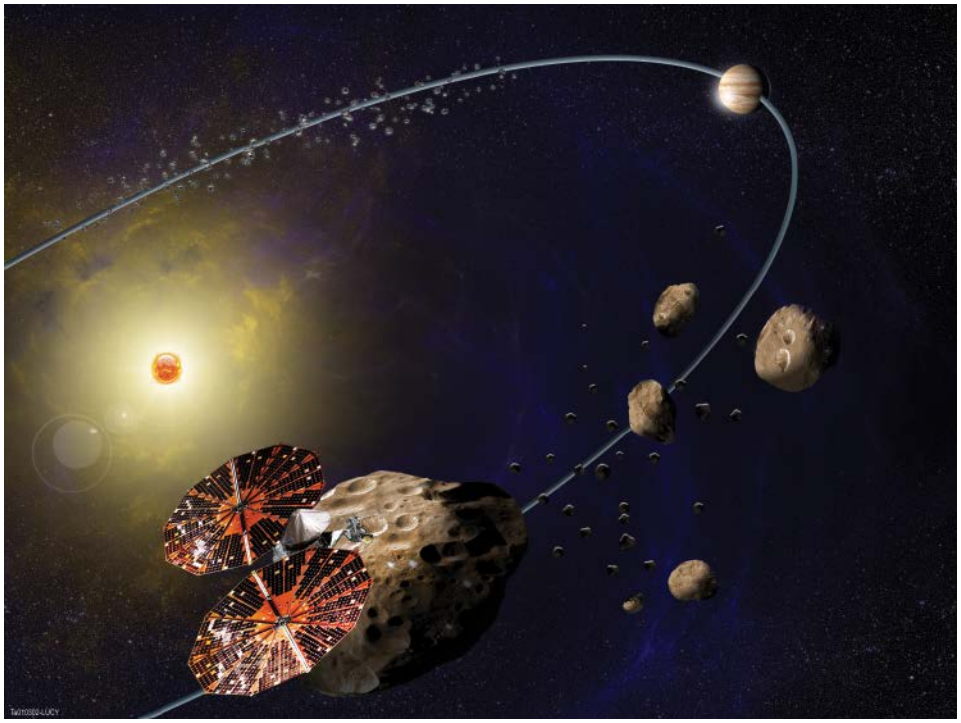
Upcoming Discovery Missions Will Look Back to Our Origins



Southwest Research Institute

Artist's conception of the Lucy spacecraft on its trajectory past several Trojan asteroids. Lucy is one of two proposed Discovery missions selected on 4 January to move ahead, after coming out on top in an intense competition.

NASA plans to kick off the 2020s with a return to our roots.

On 4 January, the space agency selected two Discovery missions to explore the earliest stages of our solar system. One mission, dubbed Lucy, will launch in October 2021 on a journey to the Trojans, an asteroid swarm that leads and trails Jupiter as it swings through its orbit. The other mission, called Psyche, will launch in 2023 toward the only metal asteroid in our solar system, potentially the frozen core of a long-dead planet.

Fierce Competition

These two missions (see http://go.nasa.gov/2jTPsSH) came out on top in a competition that started 3 years ago with a field of 28 proposed Discovery missions. Teams of scientists spent months preparing proposals for NASA to consider. The winners, chosen in a peer-review process, get funding, mission management, and systems engineering support from NASA.

NASA Planetary Science Division director Jim Green said that the process is extremely rigorous, putting proposals through "the toughest scrutiny you can possibly imagine. These teams are really put through the wringer."

"It was like a cross between the thesis defense from hell and some sort of Hollywood superproduction," commented Lindy Elkins-Tanton, principal investigator for the Psyche mission and director of the School of Earth and Space Exploration at Arizona State University in Tempe. The proposals are evaluated by a team of science, industry, and technical experts for the rigor of their science and their grounding in the National Academy of Sciences' decadal questions, the academy's list of broad issues to explore in planetary science over the next decade.

The panel evaluated the initial 28 proposals and selected five for the second round, which examined each proposal's implementation plan. Two proposals came out on top. "That whole process separates doing good science from doing the top science," Green said, "from going after the top questions that really move our field ahead." Lucy and Psyche were the best prepared to move ahead, he said.

Lucy in the Sky

The Lucy mission is named after the fossil that revolutionized our understanding of human origins. The mission team hopes to do the same for the origins of our solar system by exploring the Trojan population of asteroids, remnants from the solar system's formation.

Hal Levison, principal investigator for the Lucy mission and a planetary scientist at the Southwest Research Institute in Boulder, Colo., likened this goal to deciphering a crime scene. "Sometimes the blood splatter on the walls tells you more about what happened than the bodies on the floor," he said, "and in this case the splatters on the wall are the [asteroid] populations."

We know little about the Trojans, Levison said, but we do know that they exhibit great diversity. This variation likely stems from a wide range of origins: The asteroids developed in different parts of the solar system, then migrated to their present positions. "By studying those differences," Levison continued, "we're going to try to untangle how the planets moved around."

"Basically, the planets are aligning for us to do this mission," Levison said. Lucy's trajectory will carry it past six Trojan asteroids, including the Patroclus-Menoetius binary, a pair of asteroids whose high-inclination orbit prevents them from being studied easily. "It just so happens to be traveling through the plane of the solar system at the time the spacecraft is going by," said Levison, referring to the asteroid pair. "We have this unique list of targets that would be very hard to reproduce in the future."

Psyche: A New World of Metal

The Psyche mission will look at a feature that is the only one of its kind in our solar system: an asteroid made completely of metal. "This is not just a unique object," Elkins-Tanton said of the Psyche asteroid; "it's not just the only object like it in the solar system, but it's also an improbable object."

Psyche is most likely the core of a planet that formed early in the solar system but was so pounded by other objects that it lost its outer layers. This sort of occurrence could happen once or twice in a solar system but often doesn't happen at all, Elkins-Tanton explained. If it is a core, it will give insight into the early solar system as well as the cores of our own planets.

Elkins-Tanton said that the first job of the mission is to determine whether Psyche is, in fact, a naked core. "If it's not a core, then

it's something so exotic that it actually hasn't even been thoroughly hypothesized about," she remarked, "and that would be even more exciting."

In the course of the mission, the spacecraft will examine Psyche's magnetic field, composition, and surface topography. Elkins-Tanton is most interested in that final point. We don't know what metal craters look like, she said. On impact, molten metal could freeze into tall spires before it has the chance to fall back to the ground, or the surface could shatter like glass. It will be an unexplored metal world. "Everything we measure will be new," she said.

Peter Rubin (Arizona State University)

Artist's conception of Psyche's surface. Scientists are familiar with craters in rock and ice; the Psyche mission will reveal crater dynamics for metal surfaces.

A Snapshot of Our Beginnings

Both missions will trace the earliest stages of our solar system's formation. "It just so happens the two [missions] we picked go after completely different regimes in our solar system, but in the first 10 million years," said Green. Lucy will give us insight into the formation of the outer part of the solar system, whereas Psyche will tell us about early terrestrial planet formation.

As in the summer 2015 New Horizon flyby of Pluto, the scientists have a basic idea of what to expect, but they also anticipate surprises. These missions will examine objects that have never been studied in such detail, and they intend to live up to the program's name: Discovery.

Elkins-Tanton hopes that the missions will move beyond even our scientific knowledge of the solar system to affect people around the world at a deeper level. "If it can inspire people to stand up and start solving problems that they are not now solving," she said, "that would be the greatest outcome."

By **Elizabeth Jacobsen,** Staff Writer

Geoscientist-Rich Crew Slated for Space Station Next Year

In spring 2018, an extraordinary crew is expected to assemble far above our planet on the International Space Station (ISS). The crew will include two geophysicists, which will make the group exceptional, said Drew Feustel, a seasoned astronaut with a Ph.D. in geological sciences who will serve as a flight engineer for the station's Expedition 55 and commander for its Expedition 56.

NASA

Geophysicists (left) Drew Feustel and (right) Alex Gerst train underwater for their off-world duties. Starting in spring 2018, they'll begin their 6-month stays on the International Space Station. The sign they are holding says "underwater geophysics."

Two geophysicists on one space station crew is hardly the norm. "I believe this will be the first time in history that two geophysicists will be in space together," Feustel told *Eos*.

Feustel will launch from Kazakhstan in March 2018 on a Russian Soyuz rocket, NASA announced on 4 January. Two months later, European Space Agency astronaut Alexander Gerst, a volcanologist, will join the crew and remain on the space station through November. Gerst will serve as commander for Expedition 57. Both he and Feustel are AGU members.

A third new crew member will make another kind of history. Jeanette Epps, an aerospace engineer and veteran technical intelligence officer for the U.S. Central Intelligence Agency (CIA), will become the first African American, man or woman, to join an ISS crew.

Doing Earth Science from Space

Although the official duties of the crew's geoscientists will be outside their research specialties, the scientists will still monitor the globe using Earth observation photography, Feustel said. Such images help geoscientists "study long-term changes in morphology of the Earth," he noted.

"I am honored to have the opportunity to visit space again and to have a chance to actually live there for nearly 6 months," Feustel added. He first soared into space in 2009 aboard the space shuttle *Atlantis* for the final servicing mission to the Hubble Space Telescope. He was also on the penultimate space shuttle flight in May 2011, that time on *Endeavor* (see http://bit.ly/eos-in-space).

"Returning to space means that I can continue to contribute to the exploration of the cosmos by humans and for humans," he continued.

Fulfilling a Dream

Epps will fly to the ISS in May 2018. Selected as one of nine out of 3500 applicants for NASA's 2009 class of astronauts, she will serve as a flight engineer for Expeditions 56 and 57.

When Epps was 9 years old, her older brother told her she was smart enough to be an aerospace engineer, even an astronaut. She went on to study physics at Le Moyne College in her hometown of Syracuse, N.Y., then aerospace engineering at the University of Maryland in College Park. After an engineering stint with the Ford Motor Company and 7 years at the CIA, Epps decided to apply in 2008 for NASA's then upcoming astronaut class.

By **JoAnna Wendel** (@JoAnnaScience), Staff Writer