Top space telescope from Europe seeks to solve riddles of the universe

December 5 2023, by Jonathan O'Callaghan

Euclid's view of hundreds of thousands of stars located about 7 800 light-years from Earth. Credit: © ESA/Euclid/Euclid Consortium/NASA

EU researchers expect unprecedented insights into galaxies from the study of a mysterious energy force.

A powerful new European space telescope will bring astronomers closer than ever to answering a longstanding question: will the universe, which is expanding, do so forever?

Called Euclid, the telescope was launched on 1 July 2023 and is observing the dark universe from its vantage point 1.5 million kilometers from Earth. Looking in near-infrared and visible light, Euclid will take images of some 10 billion galaxies in its quest to understand both dark energy—which drives the expansion of the universe—and dark matter, which accounts for three quarters of all matter in the universe.

Mysterious duo

Dark energy is a mysterious force that may have been driving the expansion of the universe since the Big Bang 13.8 billion years ago. Dark matter is an unseen form noticed by its gravitational effects on galaxies but never directly detected.

"Those are really two mystery components in our universe," said Professor Henk Hoekstra, a researcher in observational cosmology at Leiden University in the Netherlands. "We have no idea really what they are."

Of the mass-energy content of the universe, 68% comes from dark energy, 27% from dark matter and 5% from ordinary matter.

Euclid, named after a Greek mathematician who lived around 300 BC and founded geometry, is designed to tackle a physics challenge: to understand the structure of the universe resulting from dark matter and dark energy since the dawn of time with unprecedented precision.

Such is the power of the telescope that it will also reveal other mysteries of the universe—from studying planets orbiting distant suns to discovering objects smaller than stars found throughout the Milky Way.

"We are going to exploit Euclid's unique capabilities," said Professor Eduardo Martin, a principal investigator at the Institute of Astrophysics

of the Canary Islands in Spain.

Major map

Hoekstra leads a research project that received EU funding to use images that only Euclid can provide to shed light on the dark universe. Called Observational Cosmology Using Large Imaging Surveys, or OCULIS, the five-year project began in September 2023.

"We basically make a giant map of the matter distribution in the universe," Hoekstra said.

Euclid will build the map by gauging the bending of light around galaxies—a process called weak gravitational lensing. This makes it possible to measure the amount of dark matter surrounding galaxies and, by extension, its spread across the universe.

The result will be improved understanding of the links between galaxies and dark matter and of the number of stars and volume of gas in each galaxy.

A better measure of dark energy can be obtained thanks to the sheer volume of the universe that Euclid will observe—as much in two days as the Hubble Space Telescope in its full 30 years in space.

Measuring each galaxy will offer new information about the universe's expansion rate, which is roughly 70 kilometers per second, but appears to be getting faster as a result of dark energy.

At its core, Euclid addresses the fundamental question about why the expansion is accelerating, according to Hoekstra.

"There must be new physics there," he said. "We're testing this at the

next level."

Wider window

Euclid is a fully European mission that got underway in 2011. The original plan by the European Space Agency, or ESA, was to launch the telescope in 2022 on a Russian rocket.

After the Russian invasion of Ukraine in February 2022, ESA severed ties with Russia and the telescope was moved to a SpaceX Falcon 9 rocket.

Euclid studies the universe with a 1.2-meter-wide primary mirror and a wide field of view. These dimensions mean that, in every picture taken, the telescope covers an area 2.5 times larger than the size of the full moon.

That's useful for studying not just galaxies, but also much smaller objects—an area of interest to Martin at the Institute of Astrophysics of the Canary Islands.

He leads a separate EU-funded project to use Euclid to hunt for objects smaller than stars hiding in the Milky Way. Known as substellar objects, these include bodies such as brown dwarfs—failed stars that never gained enough mass to ignite fusion in their cores—and giant planets many times the mass of Jupiter.

New frontier

The project, called SUBSTELLAR, began in January 2023 and runs until the end of 2027.

"Euclid brings a new frontier in terms of the large area coverage and the exquisite image quality," Martin said.

Telescopes like Hubble and the James Webb Space Telescope have a much narrower window of view than Euclid. With its wider window, Euclid should be able to discover a vast number of substellar objects.

The project's projection is 500,000 such objects within five years—100 times more than have been seen before, according to Martin.

These could include the first substellar objects that are found in the outer regions of the Milky Way—its "halo"—and that may have formed very early in the galaxy's 13-billion-year history. Martin described substellar objects as a missing link between planets and stars.

"We don't have a full picture of star formation and planet formation until we understand what is in between," he said.

Euclid might even be able to discover planets down to the mass of Saturn orbiting some of these substellar objects—something never seen before—as well as planets floating freely in space rather than trapped by the gravity of a star or brown dwarf.

While other free-floating planets have been seen before, Euclid should greatly advance the number and variety found.

Great expectations

Euclid's primary mission will last six years, with the option of extending its observations in future. After some test images from the telescope were released in July 2023, its full science observations are now beginning.

"We expect more public releases in the coming months," Hoekstra said. "But for the real science results, we'll have to wait over a year because we're still in the early phases."

The bulk of Euclid's galaxy survey data will be released in three big batches, with the first in 2026.

As Hoekstra, Martin and plenty of other people look forward to the knowledge about the universe to be gained from the telescope, at least one anticipates plenty of surprises along the way.

"It's difficult to expect the unexpected, but my experience is that it happens," said Martin. "We will keep our minds open."

More information:

- OCULIS
- SUBSTELLAR

Provided by Horizon: The EU Research & Innovation Magazine

Citation: Top space telescope from Europe seeks to solve riddles of the universe (2023, December 5) retrieved 27 April 2024 from https://phys.org/news/2023-12-space-telescope-europe-riddles-universe.html