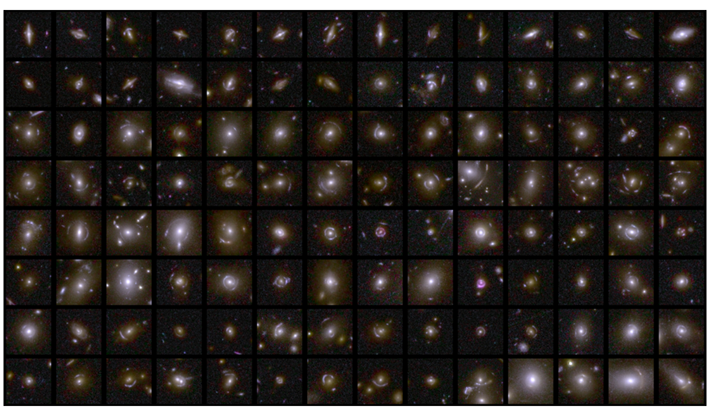
Lensing Candidates Stand Out in Euclid Mission’s First Data Release

The Euclid satellite released its first trove of galaxy data based on seven days of deep-field observations in three sky areas.

By **Katherine Wright**

The European Space Agency’s (ESA’s) Euclid mission has today released its first survey data, which include images of 26 million galaxies from three deep-field surveys. The data, which contain 35-terabytes worth of information (equivalent to 200 days’ worth of streaming high-definition TV), were collected as part of Euclid’s main objective to uncover fresh clues about the dark matter and its effects on the Universe’s galactic network, or “cosmic web.” “Today is a milestone for our dark matter ‘detective,”’ says Carole Mundell, the science director at ESA. “The community has been waiting a long time for this day to come.”

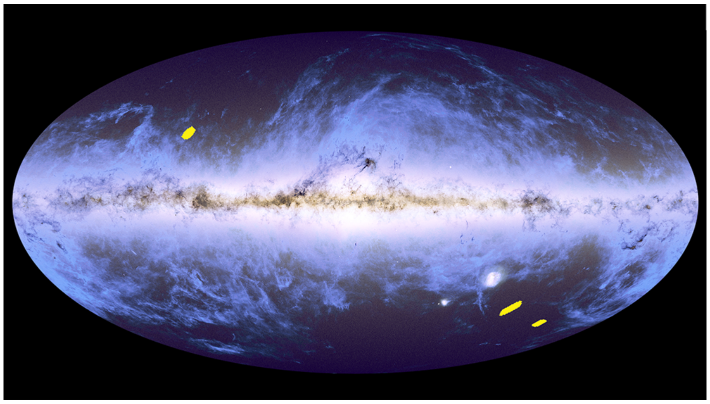


A sample of the 500 strong-lensing galaxy candidates that have so far been classified by the Euclid Consortium.
Credit: ESA; Euclid; Euclid Consortium; NASA; image processing by M. Walmsley, M. Huertas-Company, and J.-C. Cuillandre

The Euclid Space Telescope was designed to explore the composition and evolution of the dark energy and dark matter that makes up 95% of the Universe. Launched on July 1, 2023, Euclid is equipped with a 600-mexapixel camera that records visible light, a spectrometer that records near-infrared light, and a photometer that can determine the redshift of galaxies. From its viewing location at the second Lagrange point (a point of gravitational equilibrium between Earth and the Sun), the satellite will scan the sky for six years. During this period, Euclid will reimage its three deep-field survey areas at least 30 times, with each image increasing the resolution with which scientists can view those areas and the number of objects they can see. Details about the surveys and other mission objectives are included in 34 papers that are being published on arXiv today in conjunction with the data release.

The data release includes a catalog of 380,000 galaxies, which have been classified according to features such as spiral arms, central bars, and tidal tails (elongated star regions seen around merging galaxies). Of these galaxies, 500 are identified as strong-lensing candidates, which means that the candidate galaxy’s image appears to have been distorted by the gravitational effect of a foreground galaxy and its accompanying dark matter.

Until now, most strong-lensing candidates have been found by ground-based telescopes. That’s because they are comparatively rare, requiring big chunks of sky to find them. Previous space telescopes have not had the viewing area, the resolution, or the sensitivity to find them in large numbers, says



A map of the sky, where the “equator” is the plane of our Galaxy. Euclid is targeting three deep-field areas, shown in yellow.
Credit: ESA, Euclid, and Euclid Consortium; NASA, ESA, and Gaia; DPAC, ESA, and Planck Collaboration

The Euclid Space Telescope’s view of the Cat’s Eye Nebula, which lies in Euclid’s “Deep Field North” survey area.
Credit: ESA; Euclid; Euclid Consortium; NASA; image processing by J.-C. Cuillandre, E. Bertin, and G. Anselmi

Mike Walmsley, a researcher at the University of Toronto and a member of the Euclid Consortium. Euclid is the first telescope that can find large numbers of strong-lensing systems from space. With just one week’s worth of data “we’ve more than doubled the number of likely [strong] lenses” he says. “And that matters, because we can see really important details in these lenses that are blurred out from the ground.”

Finding the strongly lensed systems, as well as producing the catalog of galaxies, was made possible using a combination of citizen science and artificial intelligence (AI). Volunteers were asked to classify galaxies in Euclid data, and this information was then fed into an AI algorithm as training data. “A large sample [of galaxies] is necessary to let us untangle all the different factors—supernova, supermassive black holes, cosmic web, dark matter—that shape each galaxy…but it’s impossible [for a human] to look at all of them,” Walmsley says. He estimates it would take him 150 years, working eight hours a day, seven days a week to catalog every object that Euclid will find. AI helps solve that problem. “We only needed about a month’s worth of volunteer effort…to create enough examples to fine-tune our models to work well for Euclid,” he says.

The catalog of strong gravitational lenses is a highlight of this first data release for the scientists involved. “It was not obvious we would be able to detect so many of them,” says Valeria Pettorino, one of Euclid’s project scientists. “Seeing them…it’s quite impressive.”

While this data release has not yet been used to explore the nature of dark energy and dark matter, Pettorino notes that its impact can already be seen in the distribution of galaxies: Rather than fill up space uniformly, galaxies group into filaments that crisscross the Universe. “Already, we can see a hint of the cosmic web,” Pettorino says. The shape of this web depends on dark matter’s gravity and dark energy’s expansion.

Euclid will take more detailed images of this cosmic web over the next six years, but Pettorino says that this first data should already be enough to get a “hint” about how galaxies behave depending on how close they lie to a filament. Scientists can also explore other objects, such as supernovae and quasars—the data contain one quasar that is 12 billion years old. “Scientists have a lot of work ahead of them in the next six years, but it is going to be phenomenally exciting and groundbreaking work,” Mundell says.

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