

Hubble Discovers 67 New Gravitationally Lensed Galaxies in the Distant Universe

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Credit: NASA, ESA, C. Faure (Zentrum für Astronomie, University of Heidelberg) and J.P. Kneib (Laboratoire d'Astrophysique de Marseille)

Astronomers using NASA's Hubble Space Telescope have compiled a large catalog of gravitational lenses in the distant universe. The catalog contains 67 new gravitationally lensed galaxy images found around massive elliptical and lenticular-shaped galaxies. This sample demonstrates the rich diversity of strong gravitational lenses. If this sample is representative, there would be nearly half a million similar gravitational lenses over the whole sky.

The lenses come from a recently completed, large set of observations as part of a huge project to survey a single 1.6-square-degree field of sky (nine times the area of the full Moon) with several space-based and Earth-based observatories. The COSMOS project, led by Nick Scoville at the California Institute of Technology, used observations from several observatories including the Hubble Space Telescope, the Spitzer Space Telescope, the XMM-Newton spacecraft, the Chandra X-ray Observatory, the Very Large Telescope (VLT), the Subaru Telescope, and the Canada-France-Hawaii Telescope.

A team of European astronomers led by Jean-Paul Kneib (Laboratoire d'Astrophysique de Marseille) and Cecile Faure (Zentrum für Astronomie, University of Heidelberg) analyzed the results from Hubble's Advanced Camera for Surveys (ACS). From ACS high-resolution images, complemented by the extensive ground-based follow-up observations, astronomers have identified 67 strong gravitationally lensed galaxies. These lenses were found around very massive galaxies that are usually elliptical or lenticular in shape and have a deficiency of gas and dust.

The strong lensing produced by massive galaxies are much more common than the usual giant "arc" gravitationally lensed galaxies that Hubble has previously observed; but they are generally more difficult to find as they extend over a smaller area and have a wide variety of shapes.

Gravitational lensing occurs when light traveling toward us from a distant galaxy is magnified and distorted as it encounters a massive object between the galaxy and us. These gravitational lenses often allow astronomers to peer much farther back into the early universe than they would normally be able to do.

The massive objects that create the lenses are usually huge clusters of

massive galaxies. "We typically see the gravitational lens create a series of bright arcs or spots around a galaxy cluster. What we are observing here is a similar effect but on a much smaller scale — happening only around a single but very massive galaxy," said Kneib.

Of the 67 gravitational lenses identified in the COSMOS survey, the most impressive lenses show the distorted and warped light of one or two background galaxies. At least four of the lenses produce Einstein rings, a complete circular image of a background galaxy, which is formed when the background galaxy, a massive, foreground galaxy, and the Hubble Space Telescope are all aligned perfectly.

Hubble astronomers went through a unique process to identify these incredible natural lenses. First, possible galaxies were identified from a galaxy catalog, comprising more than 2 million galaxies. "We then had to look through each individual COSMOS image by eye and identify any potential strong gravitational lenses," said Faure. Finally, checks were made to see if the foreground galaxy and the lensed galaxy were really different or just one galaxy with an odd shape. "With this sample of gravitational systems identified by the human eye, we now plan to use the sample of lenses to train robot software to find more of these lenses across the entire Hubble image archive, and we may find even more strong lensing systems in the COSMOS field," added Kneib.

The new results confirm that the universe is filled with gravitational lensing systems. Extrapolating these new findings to the whole sky predicts no less than half a million similar lenses in total.

The study of these gravitational lenses will give astronomers a first-rate opportunity to probe the dark matter distribution around galactic lenses. Once astronomers find even larger numbers of these smaller, stronger lenses, they can be used to create a census of galaxy masses in the universe to test the predictions of cosmological models.

Source: Hubble Centre

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