

ALMA sees most distant Milky Way look-alike

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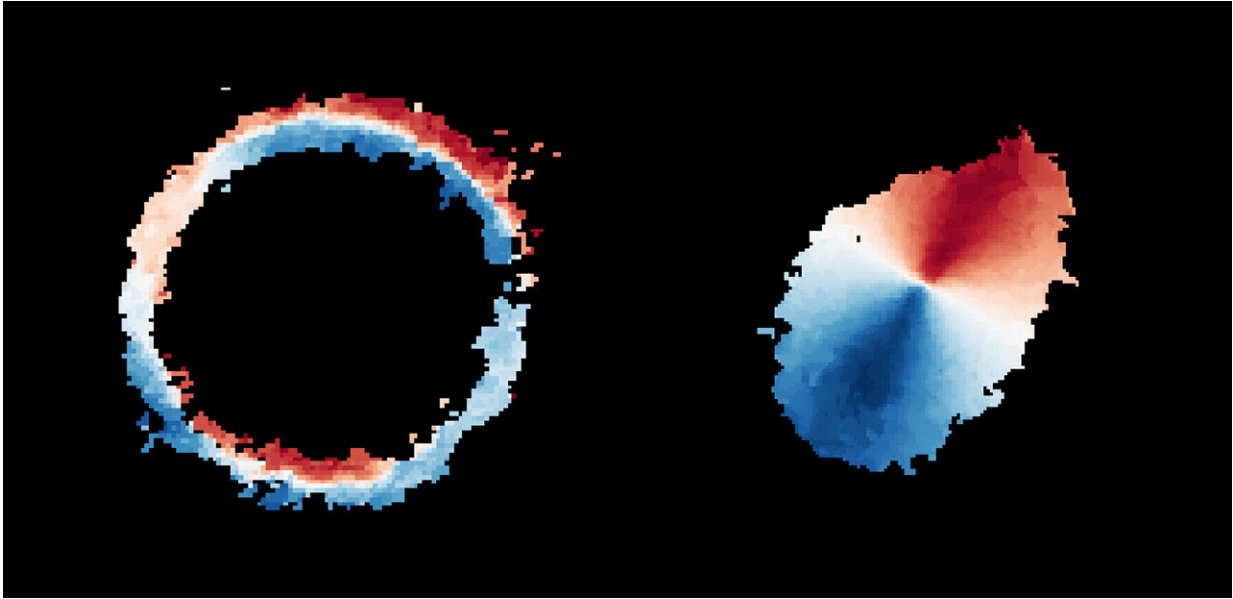
Astronomers using ALMA, in which the ESO is a partner, have revealed an extremely distant galaxy that looks surprisingly like our Milky Way. The galaxy, SPT0418-47, is gravitationally lensed by a nearby galaxy, appearing in the sky as a near-perfect ring of light. Credit: ALMA (ESO/NAOJ/NRAO), Rizzo et al.

Astronomers using the Atacama Large Millimeter/submillimeter Array (ALMA), in which the European Southern Observatory (ESO) is a partner, have revealed an extremely distant and therefore very young

galaxy that looks surprisingly like our Milky Way. The galaxy is so far away its light has taken more than 12 billion years to reach us: we see it as it was when the Universe was just 1.4 billion years old. It is also surprisingly unchaotic, contradicting theories that all galaxies in the early Universe were turbulent and unstable. This unexpected discovery challenges our understanding of how galaxies form, giving new insights into the past of our Universe.

"This result represents a breakthrough in the field of galaxy formation, showing that the structures that we observe in nearby spiral [galaxies](#) and in our Milky Way were already in place 12 billion years ago," says Francesca Rizzo, Ph.D. student from the Max Planck Institute for Astrophysics in Germany, who led the research published today in *Nature*. While the galaxy the astronomers studied, called SPT0418-47, doesn't appear to have spiral arms, it has at least two features typical of our Milky Way: a rotating disc and a bulge, the large group of stars packed tightly around the galactic centre. This is the first time a bulge has been seen this early in the history of the Universe, making SPT0418-47 the most distant Milky Way look-alike.

"The big surprise was to find that this galaxy is actually quite similar to [nearby galaxies](#), contrary to all expectations from the models and previous, less detailed, observations," says co-author Filippo Fraternali, from the Kapteyn Astronomical Institute, University of Groningen in the Netherlands. In the early Universe, young galaxies were still in the process of forming, so researchers expected them to be chaotic and lacking the distinct structures typical of more mature galaxies like the Milky Way.



Astronomers using ALMA, in which the ESO is a partner, have revealed an extremely distant galaxy that looks surprisingly like our Milky Way. The galaxy, SPT0418-47, is gravitationally lensed by a nearby galaxy, appearing in the sky as a near-perfect ring of light (left). The research team reconstructed the distant galaxy's true shape and the motion of its gas (right) from the ALMA data using a new computer modelling technique. The observations indicate that SPT0418-47 is a disc galaxy with a central bulge and the material in it rotates around the centre. Gas moving away from us is shown in red, while gas moving in the direction of the observer is shown in blue. Credit: ALMA (ESO/NAOJ/NRAO), Rizzo et al.

Studying distant galaxies like SPT0418-47 is fundamental to our understanding of how galaxies formed and evolved. This galaxy is so far away we see it when the Universe was just 10% of its current age because its light took 12 billion years to reach Earth. By studying it, we are going back to a time when these baby galaxies were just beginning to develop.

Because these galaxies are so far away, detailed observations with even the most powerful telescopes are almost impossible as the galaxies appear small and faint. The team overcame this obstacle by using a nearby galaxy as a powerful magnifying glass—an effect known as [gravitational lensing](#)—allowing ALMA to see into the distant past in unprecedented detail. In this effect, the gravitational pull from the nearby galaxy distorts and bends the light from the distant galaxy, causing it to appear misshapen and magnified.

The gravitationally lensed, distant galaxy appears as a near-perfect ring of light around the nearby galaxy, thanks to their almost exact alignment. The research team reconstructed the [distant galaxy](#)'s true shape and the motion of its gas from the ALMA data using a new computer modelling technique. "When I first saw the reconstructed image of SPT0418-47 I could not believe it: a treasure chest was opening," says Rizzo.

"What we found was quite puzzling; despite forming stars at a high rate, and therefore being the site of highly energetic processes, SPT0418-47 is the most well-ordered galaxy disc ever observed in the early Universe," stated co-author Simona Vegetti, also from the Max Planck Institute for Astrophysics. "This result is quite unexpected and has important implications for how we think galaxies evolve." The astronomers note, however, that even though SPT0418-47 has a disc and other features similar to those of spiral galaxies we see today, they expect it to evolve into a galaxy very different from the Milky Way, and join the class of elliptical galaxies, another type of galaxies that, alongside the spirals, inhabit the Universe today.

This unexpected discovery suggests the early Universe may not be as chaotic as once believed and raises many questions on how a well-ordered galaxy could have formed so soon after the Big Bang. This ALMA finding follows the earlier discovery announced in [May](#) of a massive rotating disc seen at a similar distance. SPT0418-47 is seen in

finer detail, thanks to the lensing effect, and has a bulge in addition to a disc, making it even more similar to our present-day Milky Way than the one studied previously.

Future studies, including with ESO's Extremely Large Telescope, will seek to uncover how typical these 'baby' disc galaxies really are and whether they are commonly less chaotic than predicted, opening up new avenues for astronomers to discover how galaxies evolved.

More information: A dynamically cold disk galaxy in the early Universe, *Nature* (2020). [DOI: 10.1038/s41586-020-2572-6](https://doi.org/10.1038/s41586-020-2572-6) , www.nature.com/articles/s41586-020-2572-6

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