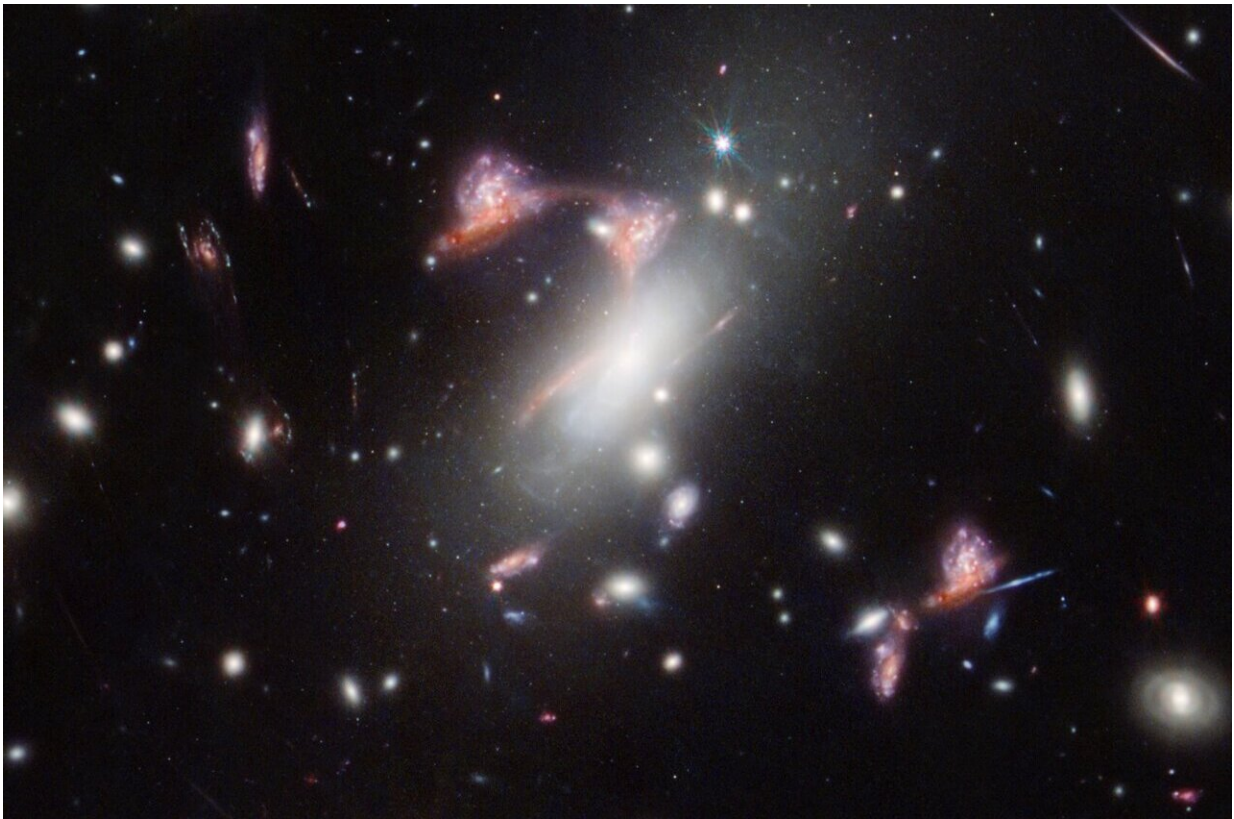


# Webb reveals distorted galaxy forming cosmic question mark

September 4 2024, by Laura Betz

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The galaxy cluster MACS-J0417.5-1154 is so massive it is warping the fabric of space-time and distorting the appearance of galaxies behind it, an effect known as gravitational lensing. This natural phenomenon magnifies distant galaxies and can also make them appear in an image multiple times, as NASA's James Webb Space Telescope saw here. Two distant, interacting galaxies — a face-on spiral and a dusty red galaxy seen from the side — appear multiple times, tracing a familiar shape across the sky. Active star formation, and the face-on galaxy's remarkably intact spiral shape, indicate that these galaxies' interaction is just

beginning. Credit: NASA, ESA, CSA, STScI, V. Estrada-Carpenter (Saint Mary's University).

It's 7 billion years ago, and the universe's heyday of star formation is beginning to slow. What might our Milky Way galaxy have looked like at that time? Astronomers using NASA's James Webb Space Telescope have found clues in the form of a cosmic question mark, the result of a rare alignment across light-years of space. The research paper is [published](#) in the *Monthly Notices of the Royal Astronomical Society*.

"We know of only three or four occurrences of similar gravitational lens configurations in the [observable universe](#), which makes this find exciting, as it demonstrates the power of Webb and suggests maybe now we will find more of these," said astronomer Guillaume Desprez of Saint Mary's University in Halifax, Nova Scotia, a member of the team presenting the Webb results.

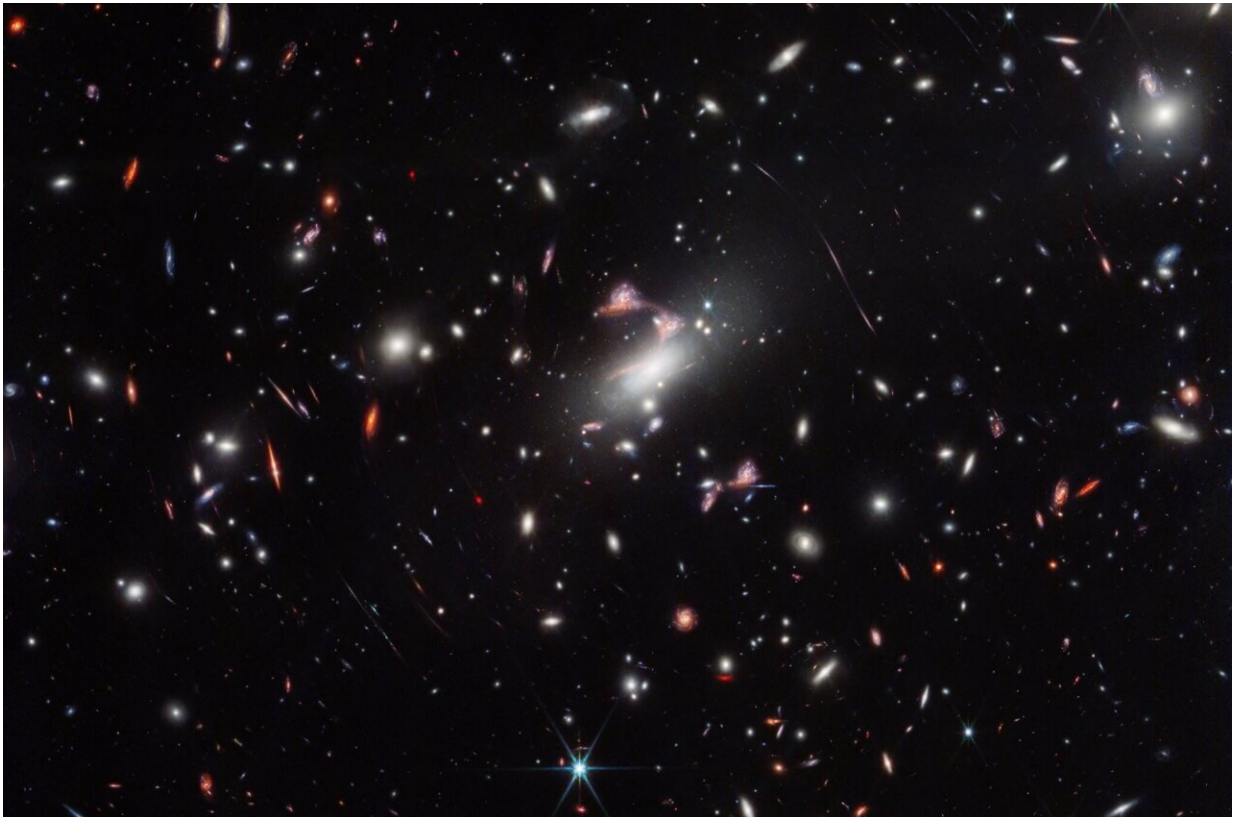
While this region has been observed previously with NASA's Hubble Space Telescope, the dusty red galaxy that forms the intriguing question-mark shape only came into view with Webb. This is a result of the wavelengths of light that Hubble detects getting trapped in cosmic dust, while longer wavelengths of infrared light are able to pass through and be detected by Webb's instruments.

Astronomers used both telescopes to observe the galaxy cluster MACS-J0417.5–1154, which acts like a magnifying glass because the cluster is so massive it warps the fabric of space-time. This allows astronomers to see enhanced detail in much more distant galaxies behind the cluster. However, the same gravitational effects that magnify the galaxies also cause distortion, resulting in galaxies that appear smeared across the sky in arcs and even appear multiple times. These [optical illusions](#) in space

are called gravitational lensing.

The red galaxy revealed by Webb, along with a [spiral galaxy](#) it is interacting with that was previously detected by Hubble, are being magnified and distorted in an unusual way, which requires a particular, rare alignment between the distant galaxies, the lens, and the observer—something astronomers call a hyperbolic umbilic gravitational lens.

This accounts for the five images of the galaxy pair seen in Webb's image, four of which trace the top of the question mark. The dot of the question mark is an unrelated galaxy that happens to be in the right place and space-time, from our perspective.



Wide Field View: The galaxy cluster MACS-J0417.5-1154 is so massive it is

warping the fabric of space-time and distorting the appearance of galaxies behind it, an effect known as gravitational lensing. This natural phenomenon magnifies distant galaxies and can also make them appear in an image multiple times, as NASA's James Webb Space Telescope saw here. Two distant, interacting galaxies — a face-on spiral and a dusty red galaxy seen from the side — appear multiple times, tracing a familiar shape across the sky. Active star formation, and the face-on galaxy's remarkably intact spiral shape, indicate that these galaxies' interaction is just beginning. Credit: NASA, ESA, CSA, STScI, V. Estrada-Carpenter (Saint Mary's University).

In addition to producing a case study of the Webb NIRISS (Near-Infrared Imager and Slitless Spectrograph) instrument's ability to detect [star formation](#) locations within a galaxy billions of light-years away, the research team also couldn't resist highlighting the question mark shape.

"This is just cool looking. Amazing images like this are why I got into astronomy when I was young," said astronomer Marcin Sawicki of Saint Mary's University, one of the lead researchers on the team.

"Knowing when, where, and how star formation occurs within galaxies is crucial to understanding how galaxies have evolved over the history of the universe," said astronomer Vicente Estrada-Carpenter of Saint Mary's University, who used both Hubble's ultraviolet and Webb's infrared data to show where new stars are forming in the galaxies. The results show that star formation is widespread in both. The spectral data also confirmed that the newfound dusty galaxy is located at the same distance as the face-on spiral galaxy, and they are likely beginning to interact.

"Both galaxies in the Question Mark Pair show active star formation in several compact regions, likely a result of gas from the two galaxies colliding," said Estrada-Carpenter. "However, neither galaxy's shape

appears too disrupted, so we are probably seeing the beginning of their interaction with each other."

"These galaxies, seen billions of years ago when star formation was at its peak, are similar to the mass that the Milky Way galaxy would have been at that time. Webb is allowing us to study what the teenage years of our own galaxy would have been like," said Sawicki.

The Webb images and spectra in this research came from the [Canadian NIRISS Unbiased Cluster Survey](#) (CANUCS).

**More information:** Vicente Estrada-Carpenter et al, When, where, and how star formation happens in a galaxy pair at cosmic noon using CANUCS JWST/NIRISS grism spectroscopy, *Monthly Notices of the Royal Astronomical Society* (2024). [DOI: 10.1093/mnras/stae1368](https://doi.org/10.1093/mnras/stae1368)

Provided by NASA

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