

NASA's Webb telescope reveals intricate networks of gas, dust in nearby galaxies

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The Mid-Infrared Instrument (MIRI) on NASA's James Webb Space Telescope took this image of NGC 1433, a barred spiral galaxy with a particularly bright core surrounded by double star-forming rings. The observations reveal cavernous bubbles of gas where forming stars have released energy. Credit: NASA, ESA, CSA, and J. Lee (NOIRLab). Image processing: A. Pagan (STScI)

Researchers using NASA's James Webb Space Telescope are getting their first look at star formation, gas, and dust in nearby galaxies with unprecedented resolution at infrared wavelengths. The data has enabled an initial collection of 21 research papers which provide new insight into how some of the smallest-scale processes in our universe—the beginnings of star formation—impact the evolution of the largest objects in our cosmos: galaxies.

The largest survey of [nearby galaxies](#) in Webb's first year of science operations is being carried out by the Physics at High Angular resolution in Nearby Galaxies (PHANGS) collaboration, involving more than 100 researchers from around the globe. The Webb observations are led by Janice Lee, Gemini Observatory chief scientist at the National Science Foundation's NOIRLab and affiliate astronomer at the University of Arizona in Tucson.

The team is studying a diverse sample of 19 spiral [galaxies](#), and in Webb's first few months of [science operations](#), observations of five of those targets—M74, NGC 7496, IC 5332, NGC 1365, and NGC 1433—have taken place. The results are already astounding astronomers.

"The clarity with which we are seeing the fine structure certainly caught us by surprise," said team member David Thilker of Johns Hopkins University in Baltimore, Maryland.

"We are directly seeing how the energy from the formation of [young stars](#) affects the gas around them, and it's just remarkable," said team member Erik Rosolowsky of the University of Alberta, Canada.

The images from Webb's Mid-Infrared Instrument (MIRI) reveal the presence of a network of highly structured features within these galaxies—glowing cavities of dust and huge cavernous bubbles of gas that line the spiral arms. In some regions of the nearby galaxies

observed, this web of features appears built from both individual and overlapping shells and bubbles where young stars are releasing energy.

"Areas which are completely dark in Hubble imaging light up in exquisite detail in these new infrared images, allowing us to study how the dust in the interstellar medium has absorbed the light from forming stars and emitted it back out in the infrared, illuminating an intricate network of gas and dust," said team member Karin Sandstrom of the University of California, San Diego.

The high-resolution imaging needed to study these structures has long evaded astronomers—until Webb came into the picture.



In this MIRI image of galaxy NGC 1365, clumps of dust and gas in the interstellar medium have absorbed the light from forming stars and emitted it

back out as infrared light. This illuminates an intricate network of cavernous bubbles and filamentary shells. Credit: NASA, ESA, CSA, and J. Lee (NOIRLab). Image processing: A. Pagan (STScI)

"The PHANGS team has spent years observing these galaxies at optical, radio, and ultraviolet wavelengths using NASA's Hubble Space Telescope, the Atacama Large Millimeter/Submillimeter Array, and the Very Large Telescope's Multi Unit Spectroscopic Explorer," added team member Adam Leroy of the Ohio State University. "But the earliest stages of a star's life cycle have remained out of view because the process is enshrouded within gas and dust clouds."

Webb's powerful infrared capabilities can pierce through the dust to connect the missing puzzle pieces.

For example, specific wavelengths observable by MIRI (7.7 and 11.3 microns) and Webb's Near-Infrared Camera (3.3 microns) are sensitive to emission from [polycyclic aromatic hydrocarbons](#), which play a critical role in the formation of stars and planets. These molecules were detected by Webb in the first observations by the PHANGS program.

Studying these interactions at the finest scale can help provide insights into the larger picture of how galaxies have evolved over time.

"Because these observations are taken as part of what's called a treasury program, they are available to the public as they are observed and received on Earth," said Eva Schinnerer of the Max Planck Institute for Astronomy in Heidelberg, Germany, and leader of the PHANGS collaboration.

The PHANGS team will work to create and release [data sets](#) that align

Webb's data to each of the complementary data sets obtained previously from the other observatories, to help accelerate discovery by the broader astronomical community.

"Thanks to the telescope's resolution, for the first time we can conduct a complete census of star formation, and take inventories of the interstellar medium bubble structures in nearby galaxies beyond the Local Group," Lee said. "That census will help us understand how [star formation](#) and its feedback imprint themselves on the [interstellar medium](#), then give rise to the next generation of stars, or how it actually impedes the next generation of stars from being formed."

The team's initial findings, composed of 21 individual studies, were recently published in a special focus issue of *The Astrophysical Journal Letters*.

More information: Results: [iopscience.iop.org/collections ... S-JWST-First-Results](https://iopscience.iop.org/collections/.../S-JWST-First-Results) (multiple DOIs)

Provided by NASA

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