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NASA?s James Webb Space Telescope

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The Milky Way galaxy continues to produce the equivalent of one Sun every year, in the past, that rate was up to 100 times greater.
To understand how stars like our Sun formed, it’s necessary to look billions of years into the past. The NASA’s James Webb Space Telescope will act as a time machine to look keenly back into the early universe. To look back even further, astronomers will also take advantage of natural,

cosmic telescopes called gravitational lenses, which make appear larger the light from distant galaxies that are at or near the peak of star formation. The effect enables researchers to study the details of early galaxies too far away to be seen with even the most powerful space telescopes.

Led by principal investigator Jane Rigby of NASA’s Goddard Space Flight Center in Greenbelt, Maryland, and co-principal investigator Joaquin Vieira of the University of Illinois, Champaign, the team will utilize natural, cosmic telescopes called gravitational lenses. These large celestial objects will magnify the light from distant galaxies that are at or near the peak of star formation.
When the phenomenon of gravitational lensing occurs

this effect enables researchers to study the details of early galaxies too far away to be seen with even the most powerful space telescopes.
A considerable amount of matter, such as a massive galaxy or cluster of galaxies, creates a gravitational field that distorts and magnifies the light from objects behind it, but in the same line of sight.
“We’re studying four galaxies that appear much, much brighter than they actually are, because they’ve been highly magnified up to 50 times. We’ll use gravitational lenses to study how those galaxies are forming their stars, and how that star formation is distributed across the galaxies,” explained Rigby.

“The nice thing about using lensed sources is that it’s like a cosmic magnifying glass, where the galaxy is stretched out, so it enhances the resolution of your telescope,” said Vieira.
The program is called Targeting Extremely Magnified Panchromatic Lensed Arcs and Their Extended Star Formation, or TEMPLATES. Although TEMPLATES is an acronym, its meaning goes deeper. The word “template” refers to something used as a pattern, mold, or guide for designing or constructing similar items.
“We want to make these four targets incredibly well-studied, and to have really good data, so other Webb

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researchers can use them as templates, or good examples, when they are working to understand data for a large number of galaxies that are much fainter,"

declared Rigby.

One of the main reasons these four galaxies were chosen is because they're very bright, making them easy to study. "All of these galaxies are forming stars like crazy," said Vieira.
These targets also represent much of the variety of galaxies in the universe in terms of how dusty they are, how bright they are, and how many stars they've already made. Astronomers call galaxies "dusty" when their images show dark, often fuzzy patches that come from dust in the galaxy blocking starlight.
Two of the galaxies are very dusty, and two of them are not dusty at all. The two dusty galaxies are each lensed by another, single galaxy. The two galaxies that are not very dusty are lensed by galaxy clusters.

From very dusty galaxies, scientists have one picture of how galaxies evolved. From surveys of non-dusty galaxies, they have a different picture. Those pictures don't always match. Webb is expected to provide a more complete story of star formation because it has the sensitivity to see the light from dust heated by young stars—even in galaxies that don't have a lot of dust—as well as the sensitivity to see visible light even from the dusty galaxies.

The TEMPLATES team will use three of the four instruments aboard Webb, as well as many of the telescope's filters and settings, to get as much data as possible on these galaxies. In addition to taking pictures, the team will use spectroscopy, a technique that will reveal the chemical composition of the galaxies, how gas is moving, and how dense and hot that gas is.
Webb will allow the team to make those measurements across each galaxy. "It's like dissection," explained Rigby. "We'll pick apart every piece of the galaxy, rather than just getting one average measurement."

The team's observations will be part of the Director's Discretionary-Early Release Science program, which provides time to selected projects early in the telescope's mission. This program allows the astronomical community to quickly learn how best to use Webb's capabilities, while also generating robust science. The team is also helping other researchers to understand the best way to take data with this telescope.
"TEMPLATES really just scratches the surface of what you can do with Webb," Rigby continued. "It definitely will not be the last word—it's one of the first words of what this telescope will be able to do, how we can understand galaxies.

What we're doing with TEMPLATES is we want to make sure we're hitting the ground running with gorgeous data early in the mission to really understand how to make the most of Webb's amazing

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capabilities."
The James Webb Space Telescope will be the world's premier space science observatory when it launches in 2021. Webb will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Webb is an international program led by NASA with its partners, ESA (European Space Agency) and the Canadian Space Agency.

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