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STAR FORMATION IN A NEW LIGHT

JWST takes a penetrating look at stellar birth in 19 spiral galaxies.

BY RICHARD TALCOTT

ALTHOUGH ASTRONOMERS STUDY a broad range of topics, none plays a more prominent role than stars and their life cycles. The story begins deep inside molecular clouds, where gravity converts gas and dust into luminous beacons and their planetary systems. In middle age, stars can nurture any life that might develop on surrounding worlds. And once they exhaust their nuclear fuel, stars release heavy elements and energy back into their host galaxy, seeding and occasionally initiating future star formation.

It's not surprising that scientists made star formation and its role in shaping spiral galaxies a focus for the James Webb Space Telescope (JWST). The 6.5-meter instrument sees infrared radiation, which penetrates the dust that typically hides star birth from the prying eyes of optical telescopes. And no previous observatory had the infrared sensitivity and resolution to reveal details of this process much beyond our Local Group of galaxies.

JWST MAKES AN IMPACT

Astronomers released their initial findings on star formation in 19 nearby spiral galaxies in January. The spectacular photos combine observations made at eight wavelengths, ranging from 2 to 21 micrometers. Image processors mapped shorter (near-infrared) wavelengths to blue and longer (mid-infrared) wavelengths to red, to mimic human eyesight.

The near-infrared images show the sparkling blue hues of millions of stars. While some of them spread throughout the spiral arms, others congregate in dense clusters. In contrast, the mid-infrared photos reveal warm dust glowing around and between the stars.

The JWST images display stunning details thanks to resolutions of a few dozen light-years or better. The observatory sees such fine structures to distances of some 65 million light-years, which encompasses the Virgo Cluster.

Unexpectedly, the new images also reveal several large, spherical shells cut into the gas and dust. The researchers suggest one or more exploding stars created these holes.

The 19 galaxies include normal spirals, barred spirals, and ones with active galactic nuclei. They cover a wide range of masses and star-formation rates. The scientists chose only objects that appear either face-on or incline modestly to our line of sight, so that the spiral arms show up clearly.

PART OF A BIGGER PICTURE

Although the findings are important in their own right, they take on added significance when combined with observations at other wavelengths. The science team belongs to the PHANGS collaboration (an acronym for Physics at High Angular resolution in Nearby GalaxieS).

This program includes high-resolution optical images from the Hubble Space Telescope, optical spectra gathered with one of the 8-meter mirrors of the Very Large Telescope (VLT), and observations of carbon monoxide emission from the Atacama Large Millimeter/submillimeter Array (ALMA). Because the VLT and ALMA both reside in Chile, the 19 galaxies all lie in the southern sky or at low northern declinations.

This initial JWST release is just the tip of the iceberg. The team already has started observing 55 additional nearby spirals. When all is said and done, the PHANGS team will have produced the first complete set of high-resolution data that covers all key stages in the life cycles of stars at the universe's current age.

TOP LEFT: The Phantom Galaxy (M74) in Pisces explodes with detail when observed with JWST's infrared eye. Warm dust glows orange in this view, while old stars near the galactic center appear blue. Also notice the large spherical shell to the upper right of the galaxy's core. Astronomers suspect one or more supernovae excavated this hole and the many others JWST uncovered. M74 is a nearly face-on spiral located 32 million light-years from Earth. ALL IMAGES: NASA, ESA, CSA, STSCI, J. LEE (STSCI), T. WILLIAMS (OXFORD), PHANGS TEAM

TOP RIGHT: In sharp contrast, warm dust appears brownish in Hubble's visible-light view of M74. Notice how these dark lanes obscure a lot of the fine details JWST sees in star-forming regions.

LEFT: The barred spiral galaxy NGC 1672 in Dorado shows lots of fine structures to JWST's infrared sensors (top). The orange glow comes from dust that has absorbed starlight and then re-emitted it at longer wavelengths. Hubble's view of NGC 1672 in visible light (bottom) gives a clearer picture of the spiral's barred structure. NGC 1672 lies 60 million light-years from Earth.

Contributing Editor **Richard Talcott** *wrote about JWST's observations of Herbig-Haro object 797 in the May issue.*