Webb reveals new features in heart of Milky Way

November 20 2023, by Leah Ramsay

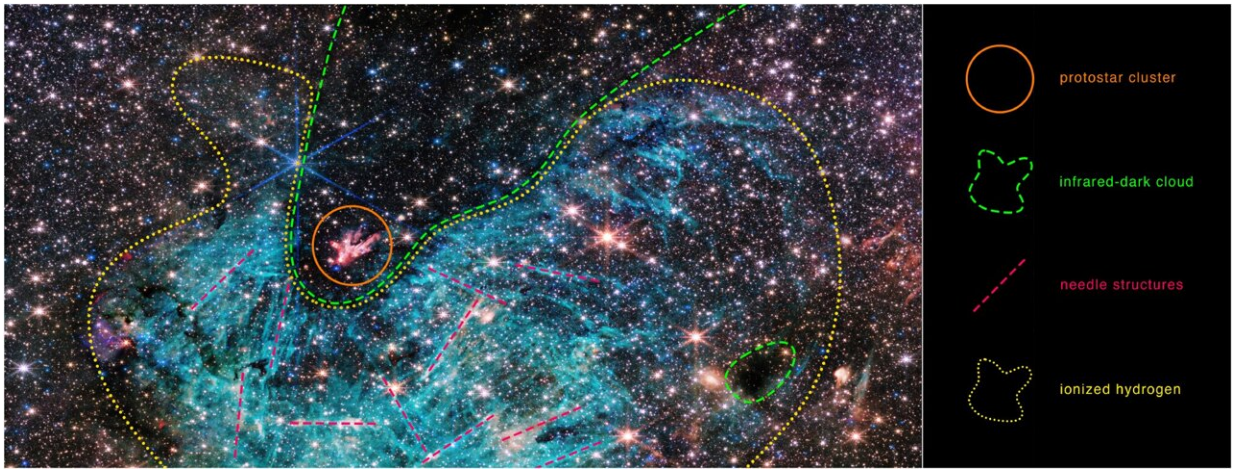
The full view of the James Webb Space Telescope's NIRCam (Near-Infrared Camera) instrument reveals a 50 light-years-wide portion of the Milky Way's dense center. An estimated 500,000 stars shine in this image of the Sagittarius C (Sgr C) region, along with some as-yet-unidentified features. A vast region of ionized hydrogen, shown in cyan, wraps around an infrared-dark cloud, which is so dense that it blocks the light from distant stars behind it. Intriguing needle-like structures in the ionized hydrogen emission lack any uniform orientation. Researchers note the surprising extent of the ionized region, covering about 25 light-years. A cluster of protostars—stars that are still forming and gaining mass—are producing outflows that glow like a bonfire at the base of the large infrared-dark cloud, indicating that they are emerging from the cloud's protective cocoon and will soon join the ranks of the more mature stars around them. Smaller infrared-dark clouds dot the scene, appearing like holes in the starfield. Researchers say they have only begun to dig into the wealth of unprecedented high-resolution data that Webb has provided on this region, and

many features bear detailed study. This includes the rose-colored clouds on the right side of the image, which have never been seen in such detail. Credit: Image NASA, ESA, CSA, STScI, Samuel Crowe (UVA)

The latest image from the James Webb Space Telescope shows a portion of the dense center of our galaxy in unprecedented detail, including never-before-seen features astronomers have yet to explain. The star-forming region, named Sagittarius C (Sgr C), is about 300 light-years from the Milky Way's central supermassive black hole, Sagittarius A*.

"There's never been any infrared data on this region with the level of resolution and sensitivity we get with Webb, so we are seeing lots of features here for the first time," said the observation team's principal investigator, Samuel Crowe, an undergraduate student at the University of Virginia in Charlottesville. "Webb reveals an incredible amount of detail, allowing us to study star formation in this sort of environment in a way that wasn't possible previously."

"The galactic center is the most extreme environment in our Milky Way galaxy, where current theories of star formation can be put to their most rigorous test," added Professor Jonathan Tan, one of Crowe's advisors at the University of Virginia.



Approximate outlines help to define the features in the Sagittarius C (Sgr C) region. Astronomers are studying data from NASA's James Webb Space Telescope to understand the relationship between these features, as well as other influences in the chaotic galaxy center. Credit: Image NASA, ESA, CSA, STScI, Samuel Crowe (UVA)

Amid the estimated 500,000 stars in the image is a cluster of protostars—stars that are still forming and gaining mass—producing outflows that glow like a bonfire in the midst of an infrared-dark cloud. At the heart of this young cluster is a previously known, massive protostar over 30 times the mass of our sun.

The cloud the protostars are emerging from is so dense that the light from stars behind it cannot reach Webb, making it appear less crowded when it is one of the most densely packed areas of the image. Smaller infrared-dark clouds dot the image, looking like holes in the starfield. That's where future stars are forming.

Webb's NIRCam (Near-Infrared Camera) instrument also captured large-scale emission from ionized hydrogen surrounding the lower side of the

dark cloud, shown cyan-colored in the image. Typically, Crowe says, this is the result of energetic photons being emitted by young massive stars, but the vast extent of the region shown by Webb is something of a surprise that bears further investigation. Another feature of the region that Crowe plans to examine further is the needle-like structures in the ionized hydrogen, which appear oriented chaotically in many directions.

"The galactic center is a crowded, tumultuous place. There are turbulent, magnetized gas clouds that are forming stars, which then impact the surrounding gas with their outflowing winds, jets, and radiation," said Rubén Fedriani, a co-investigator of the project at the Instituto Astrofísica de Andalucía in Spain. "Webb has provided us with a ton of data on this extreme environment, and we are just starting to dig into it."

Around 25,000 light-years from Earth, the galactic center is close enough to study individual stars with the Webb telescope, allowing astronomers to gather unprecedented information on how stars form and how this process may depend on the cosmic environment, especially compared to other regions of the galaxy. For example, are more massive stars formed in the center of the Milky Way, as opposed to the edges of its spiral arms?

"The image from Webb is stunning, and the science we will get from it is even better," Crowe said. "Massive stars are factories that produce heavy elements in their nuclear cores, so understanding them better is like learning the origin story of much of the universe."

Provided by Space Telescope Science Institute