High-resolution image of the core of the Milky Way reveals surprisingly low star formation

February 28 2018, by Matt Williams

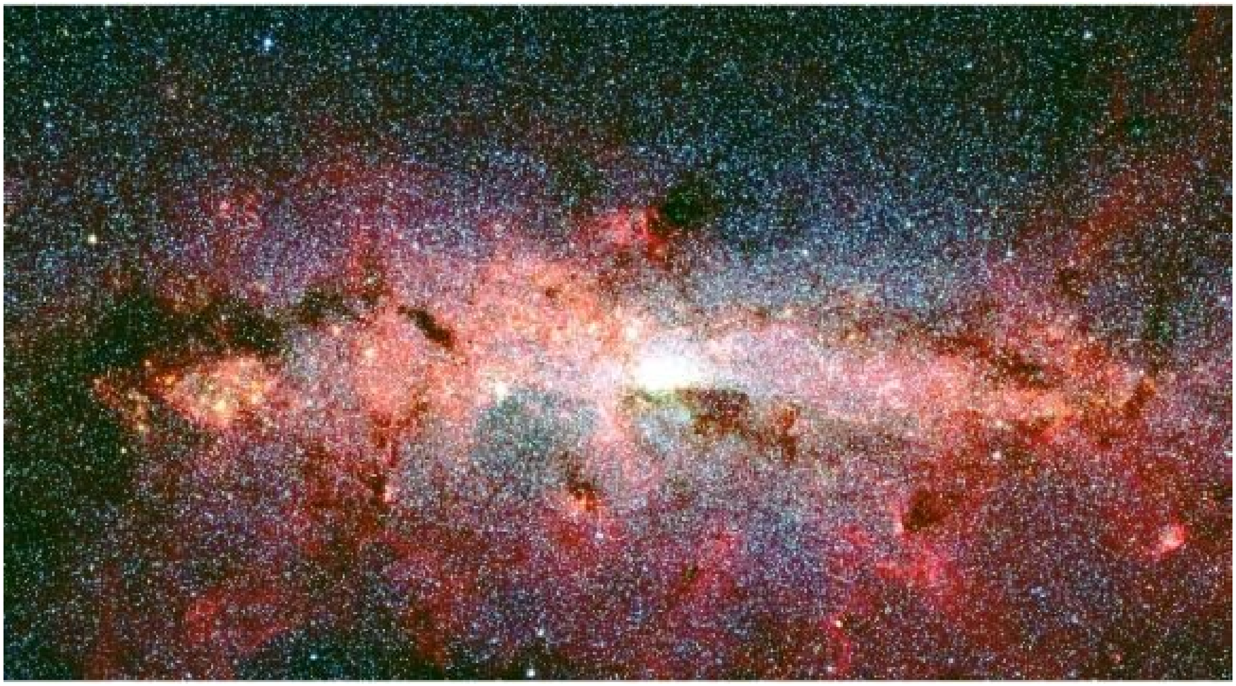
NASA's Spitzer Space Telescope captured this stunning infrared image of the center of the Milky Way Galaxy, where the black hole Sagitarrius A resides. Credit: NASA/JPL-Caltech

Compared to some other galaxies in our Universe, the Milky Way is a rather subtle character. In fact, there are galaxies that are a thousands times as luminous as the Milky Way, owing to the presence of warm gas in the galaxy's Central Molecular Zone (CMZ). This gas is heated by massive bursts of star formation that surround the Supermassive Black Hole (SMBH) at the nucleus of the galaxy.

The core of the Milky Way also has a SMBH (Sagittarius A*) and all the gas it needs to form new stars. But for some reason, star formation in our galaxy's CMZ is less than the average. To address this ongoing mystery, an international team of astronomers conducted a large and comprehensive study of the CMZ to search for answers as to why this might be.

The study, titled "Star formation in a high-pressure environment: an SMA view of the Galactic Centre dust ridge" recently appeared in the Monthly Notices of the Royal Astronomical Society. The study was led by Daniel Walker of the Joint ALMA Observatory and the National Astronomical Observatory of Japan, and included members from multiple observatories, universities and research institutes.

For the sake of their study, the team relied on the Submillimeter Array (SMA) radio interferometer, which is located atop Maunakea in Hawaii. What they found was a sample of thirteen high-mass cores in the CMZ's "dust ridge" that could be young stars in the initial phase of development. These cores ranged in mass from 50 to 2150 Solar Masses and have radii of 0.1 – 0.25 parsecs (0.326 – 0.815 light-years).



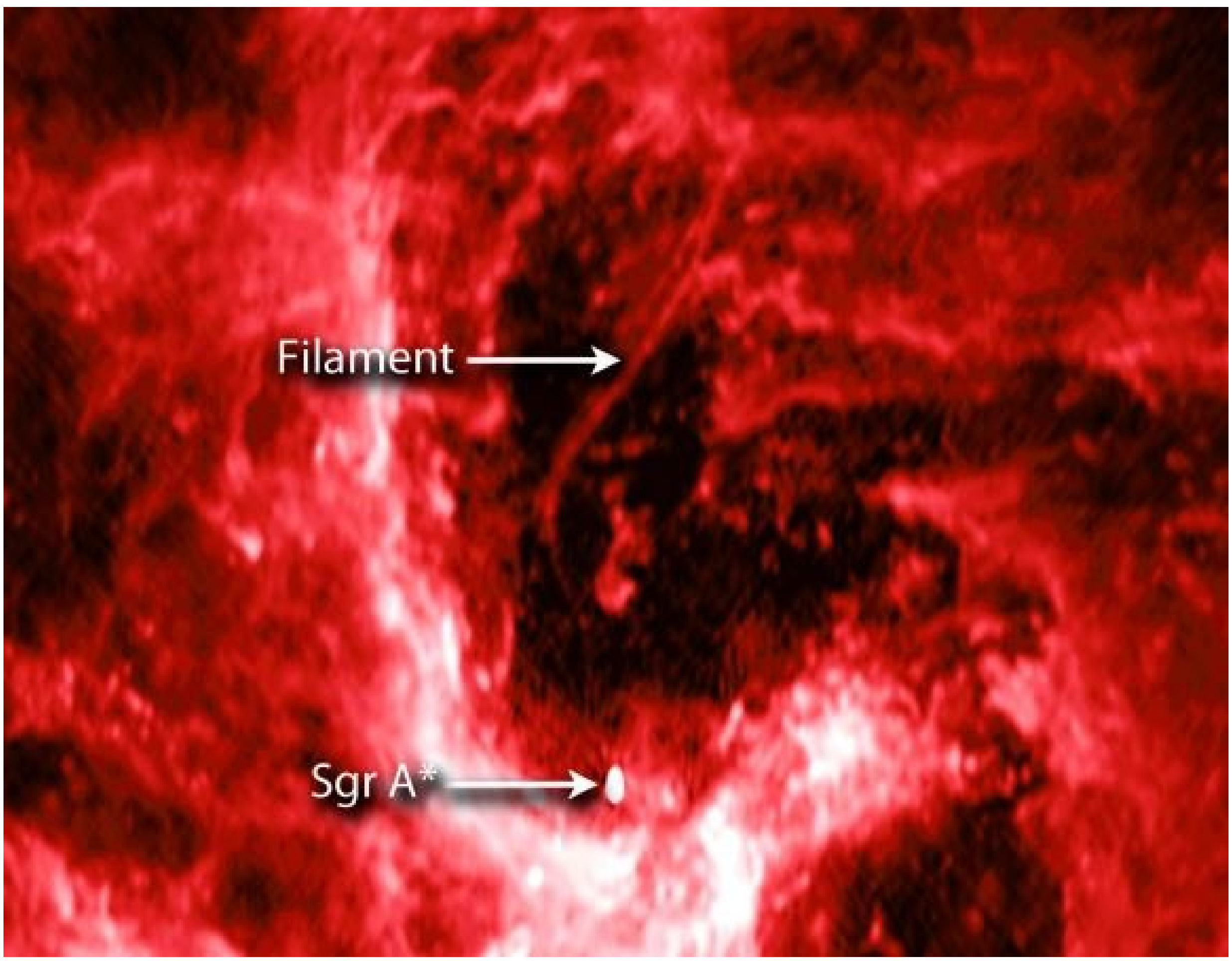
A false color Spitzer infrared image of the Milky Way's Central Molecular Zone (CMZ). Credit: Spitzer/NASA/CfA

They also noted the presence of two objects that appeared to be previously unknown young, high-mass protostars. As they state in their study, all of this indicated that stars in CMZ had about the same rate of formation as those in the galactic disc, despite their being vast pressure differences:

"All appear to be young (pre-UCHII), meaning that they are prime candidates for representing the initial conditions of high-mass stars and sub-clusters. We compare all of the detected cores with high-mass cores and clouds in the Galactic disc and find that they are broadly similar in terms of their masses and sizes, despite being subjected to external pressures that are several orders of magnitude greater."

To determine that the external pressure in the CMZ was greater, the team observed spectral lines of the molecules formaldehyde and methyl cyanide to measure the temperature of the gas and its kinetics. These indicated that the gas environment was highly turbulent, which led them to the conclusion that the turbulent environment of the CMZ is responsible for inhibiting star formation there.

As they state in their study, these results were consistent with their previous hypothesis:



A radio image from the NSF's Karl G. Jansky Very Large Array showing the center of our galaxy. Credit: NSF/VLA/UCLA/M. Morris et al.

"The fact that >80 percent of these cores do not show any signs of star-forming activity in such a high-pressure environment leads us to conclude that this is further evidence for an increased critical density threshold for star formation in the CMZ due to turbulence."

So in the end, the rate of star formation in a CMZ is not only dependent on their being a lot of gas and dust, but on the nature of the gas environment itself. These results could inform future studies of not only the Milky Way, but of other galaxies as well – particularly when it comes to the relationship that exists between supermassive black holes (SMBHs), star formation, and the evolution of galaxies.

For decades, astronomers have studied the central regions of galaxies in the hopes of determining how this relationship works. And in recent years, astronomers have come up with conflicting results, some of which indicate that star formation is arrested by the presence of SMBHs while others show no correlation.

In addition, further examinations of SMBHs and Active Galactic Nuclei (AGNs) have shown that there may be no correlation between the mass of a galaxy and the mass of its central black hole – another theory that astronomers previously subscribed to.

As such, understanding how and why [star formation] appears to be different in galaxies like the Milky Way could help us to unravel these other mysteries. From that, a better understanding of how stars and galaxies evolved over the course of cosmic history is sure to emerge.

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