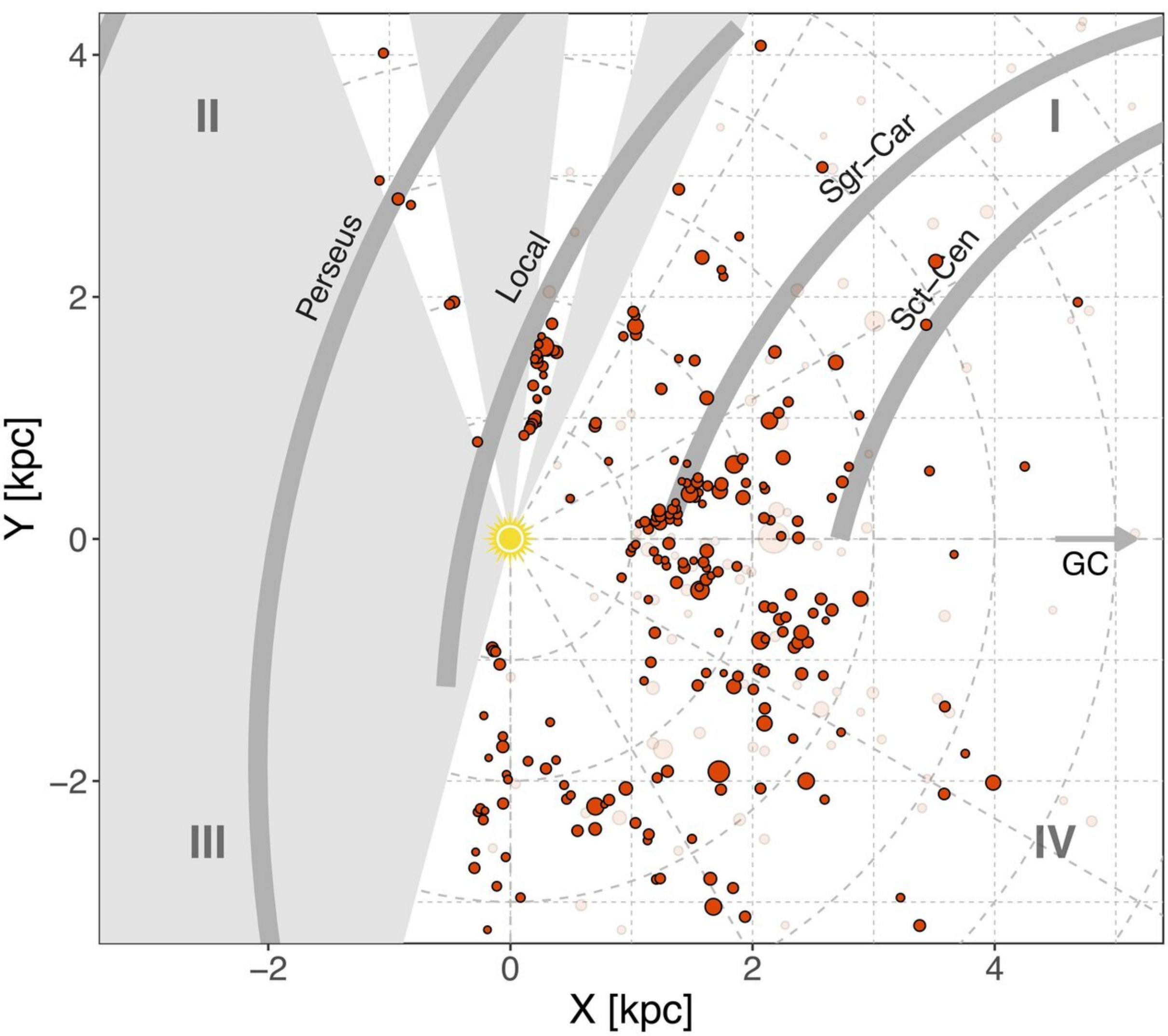
Mapping stellar nurseries in the Milky Way

December 1 2020, by Rafael S. De Souza



Spatial distribution of YSO candidates groups (red circles) in the Solar neighborhood. The Sun is represented by the yellow symbol in the center, and the segments of the Galactic disk that have been included in the SPICY study are white, while the others are gray. The approximate positions of the Milky Way's spiral arms are shown in darker gray. Credit: Cosmostatistics Initiative

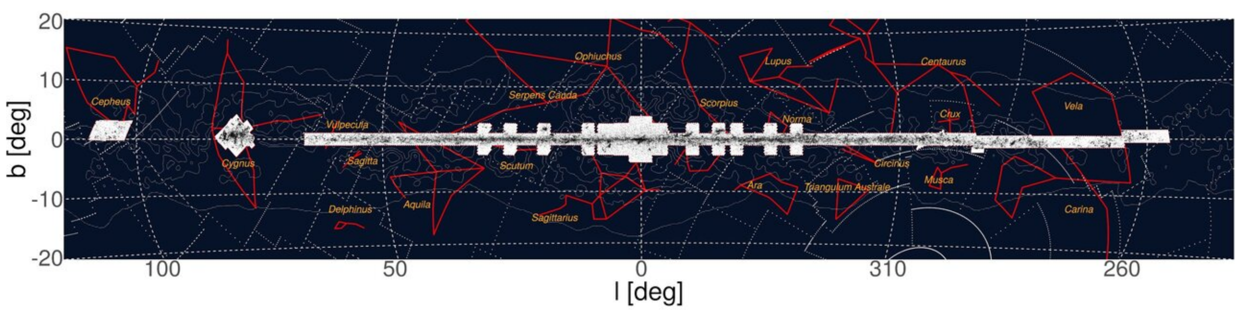
An international team of Astronomers from the Cosmostatistics Initiative (COIN) identified nearly 120,000 new young stellar objects (YSOs) based on data from the Infrared Array Camera of NASA's Spitzer Space Telescope. The final catalog, named SPICY (Spitzer/IRAC Candidate YSO Catalog), is publicly available to anyone who wishes to study the first stages of stellar development.

Stars are the building blocks of all structures in our universe. They are responsible for producing the more complex chemical elements, spreading them through space, igniting the formation of planets and ultimately, forming the necessary environment for the development of life. Understanding the earlier stages of stellar evolution is the first step towards a better comprehension of how our own Sun was formed and may provide important clues on which regions of our Milky Way have the potential to host planetary systems similar to our own.

The Spitzer Space Telescope devoted significant time to scanning large areas of our Galaxy in a hunt for YSOs. Our galaxy is shaped like a disk, with both our Sun and star-forming regions located inside the disk, meaning that most star-forming regions can be found in a thin strip that circles the sky. During an observing campaign named GLIMPSE, Spitzer took high resolution images of this strip revealing tens of millions of stars. However, this posed another very difficult question: how to find young stars among the tens of millions of objects present in such a large data set?

Infrared Spitzer images centered on several YSO candidates. Nebulosity is found around many of the objects. A few of the stars may be difficult to see due to the high contrasts that must be accommodated in making these false-colored images. Credit: Cosmostatistics Initiative

To solve this puzzle, members of the Cosmostatistics Initiative employed a [classification scheme]() that uses the flexibility of cutting edge machine learning and curated YSO datasets to take full advantage of IRAC's [spatial resolution]() and sensitivity in the mid-infrared ~3–9 µm range. Multi-wavelength color/magnitude distributions provide intuition about how the classifier separates YSOs from other red IRAC sources and validate that the sample is consistent with expectations for disk/envelope-bearing pre–main-sequence stars.



Spatial distribution of the SPICY YSO candidates among the constellations of the Milky Way. Credit: Cosmostatistics Initiative

Located in the inner region of the Galactic midplane, most of the candidates are in regions with mid-IR nebulosity, associated with star-forming clouds, but others appear distributed in the field. Using distance estimates from the ESA Gaia satellite, the researchers found groups of YSO candidates associated with the Local Arm, the Sagittarius-Carina Arm, and the Scutum-Centaurus Arm. Candidate YSOs visible to the Zwicky Transient Facility tend to exhibit higher variability amplitudes than randomly selected field stars of the same magnitude, with many high-amplitude variables having light-curve morphologies characteristic of YSOs.

According to the team, given that no current or planned instruments will significantly exceed IRAC's spatial resolution while possessing its wide-area mapping capabilities, Spitzer-based catalogs such as this one will remain the main resources for mid-infrared YSOs in the Galactic midplane for the near future.

More information: SPICY: The Spitzer/IRAC Candidate YSO Catalog for the Inner Galactic Midplane, arXiv:2011.12961 [astro-ph.GA] arxiv.org/abs/2011.12961

Provided by Cosmostatistics Initiative