Astronomers look to neighboring galaxy for star formation insight

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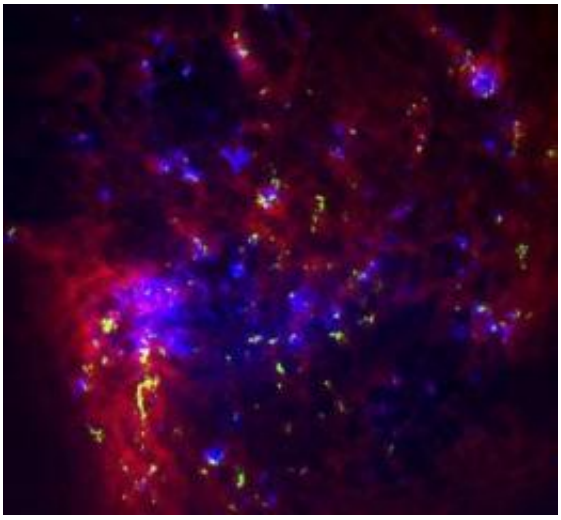

A color image of the Large Magellanic Cloud galaxy combining maps of neutral atomic hydrogen gas (red), hydrogen ionized by nearby young stars (blue), and new data from Wong's team which roughly trace dense clouds of molecular hydrogen (green). Credit: Tony Wong, University of Illinois

An international team of astronomers has mapped in detail the star-birthing regions of the nearest star-forming galaxy to our own, a step toward understanding the conditions surrounding star creation.

Led by University of Illinois astronomy professor Tony Wong, the researchers published their findings in the December issue of the Astrophysical Journal *Supplement Series*.

The Large Magellanic Cloud (LMC) is a popular galaxy among astronomers both for its nearness to our Milky Way and for the spectacular view it provides, a big-picture vista impossible to capture of our own galaxy.

"If you imagine a galaxy being a disc, the LMC is tilted almost face-on so we can look down on it, which gives us a very clear view of what's going on inside," Wong said.

Although astronomers have a working theory of how individual stars form, they know very little about what triggers the process or the environmental conditions that are optimal for star birth. Wong's team focused on areas called molecular clouds, which are dense patches of gas – primarily molecular hydrogen – where stars are born. By studying these molecular clouds and their relationship to new stars in the galaxy, the team hopes to learn more about the metamorphosis of gas clouds into stars.

"When we study star formation, an important question is, what is the environment doing? How does the location of star formation reflect the conditions of that environment? There's no better place to study the wider environment than the LMC."

Using a 22-meter-diameter radio telescope in Australia, the astronomers mapped more than 100 molecular clouds in the LMC and estimated their sizes and masses, identifying regions with ample material for making stars. This seemingly simple task engendered a surprising find.

Conventional wisdom states that most of the molecular gas mass in a galaxy is apportioned to a few large clouds. However, Wong's team found many more low-mass clouds than they expected – so many, in fact, that a majority of the dense gas may be sprinkled across the galaxy in these small molecular clouds, rather than clumped together in a few

large blobs.

"We thought that the big clouds hog most of the mass," Wong said, "but we found that in this galaxy, it appears that the playing field is more level. The low-mass clouds are quite numerous and they actually contribute a significant amount of the mass. This provides the first evidence that the common wisdom about molecular clouds may not apply here."

The large numbers of these relatively low-mass clouds means that star-forming conditions in the LMC may be relatively widespread and easy to achieve. The findings raise some interesting questions about why some galaxies stopped their star formation while others have continued it.

To better understand the connection between molecular clouds and star formation, the team compared their molecular cloud maps to maps of infrared radiation, which reveal where young stars are heating cosmic dust.

For the comparison, they exploited a carefully selected sample of newborn heavy stars compiled by U. of I. astronomy professor You-Hua Chu and resident scientist Robert Gruendl, who also were co-authors of the paper. These stars are so young that they are still deeply embedded in cocoons of gas and dust.

"It turns out that there's actually very nice correspondence between these young massive stars and molecular clouds," Wong said. "That's not entirely surprising, but it's reassuring. We assume that these stars have to form in molecular clouds, and it tells us that the molecular clouds do hang around long enough for us to see them associated with these massive young stars."

Wong hopes to continue to study the relationship between molecular

clouds and star formation in greater detail. If researchers can determine the relative ages of young stars, they can correlate these against molecular clouds to figure out which clouds have star formation, how long the clouds live and what eventually leads to their destruction. They also plan to use a newly constructed array of telescopes in Chile to see the cloud environment in higher resolution, pinpointing exactly where inside the molecular cloud star formation will occur.

"This study provides us with our most detailed view of an entire population of clouds in another galaxy," Wong said. "We can say with great confidence that these clouds are where the stars form, but we are still trying to figure out why they have the properties they do."

More information: The paper, "The Magellanic Mopra Assessment (MAGMA). I. The Molecular Cloud Population of the Large Magellanic Cloud," is available online at iopscience.iop.org/0067-0049/197/2/16

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