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International Astronomy Research Team
Find Key Information about Formation of Massive Stars

An international team of astronomers including Ramprasad Rao from the Institute of Astronomy and Astrophysics (ASIAA) have confirmed that the process of formation of massive stars is governed by the interstellar magnetic fields. Their research will be published in "Science" on June 12.

Massive stars (stars that are more massive than 8 solar masses) represent only l% of the stellar population of our galaxy; however, they dominate the appearance and evolution of the interstellar medium composed of gas and dust grains and are responsible for the production of heavy elements. The question of how such massive stars form has been a matter of discussion for decades.

Stars form within molecular clouds and one of the biggest unknowns has been the role of magnetic fields during the collapse of a molecular cloud. Up until now, the lack of direct measurements has led to the assumption that turbulence dominates the fragmentation of the cloud.

The team of astronomers, which included head scientist Josep Miquel Girart of the Institue of Space Sciences, (CSIC-IEEC, Spain); Maria Teresa Beltrán of the Arcetri Observatory (Italy); Qizhou Zhang of the Harvard-Smithsonian Center for Astrophysics (USA); and Robert Estalella of the University of Barcelona (Spain), as well as Rao, were able to take detailed images of a dense, hot molecular cloud named G31.41+0.31, the home of very young massive stars.

The observations were made using the Submillimeter Array (SMA), which is the first interferometer array to operate at submillimeter wavelengths. It consists of 8 antennas of 6 meters in diameter and is a joint project between the Smithsonian Astrophysical Observatory (SAO) in the U.S. and the ASIAA in Taiwan. It is located near the summit of Mauna Kea in Hawaii at 4,080 meters.

The region where the G31.41+0.31 molecular cloud is located is about 23,000 light years from Earth in the Serpens Constellation. The dust grains in the cloud are partially aligned with the magnetic field lines, so the dust emission arises partially polarized.

"From the dust polarized emission detected with the SMA, we derived the structures of the magnetic field that threads the cloud. We found that it has an hourglass shape, similar to what we found three years ago around a Sun-like stellar embryo. However, G31.41+0.31 is 20 times larger, 200 times more massive and one hundred thousand times brighter," said Josep Miquel Girart.

"In addition, we found that the magnetic field is the main agent controlling the collapse of the cloud." said Maria Teresa Beltran.

"There are still many questions to answer. In this massive cloud is very likely to form hundreds of stars. And how this happens is not clear," added Robert Estalella.

ASIAA director Paul Ho, who was the Ph.D. supervisor of Dr. Girart, Dr. Beltran, and Dr. Zhang and also the project scientist for the Submillimeter Array, notes: "The SMA was built to study the dust polarization and the magnetic fields in molecular clouds. Our ability to resolve the magnetic field

structures is really an important step in understanding the magnetic field as the controlling process in star formation. These results are some of the most important ones achieved so far with the SMA. Their further studies with the Atacama Large Millimeter/Submillimeter Array (ALMA), now under construction in northern Chile, will be very powerful."

Says world renowned astrophysicist, Academician Frank Shu: "It is gratifying to see the development of a sudden unity in the formation of stars of low and high masses. This breakthrough will provide a tremendously important link to the study of star formation in external galaxies, where, unlike the solar neighborhood, of our own galaxy, we are able to see only the "tip of the iceberg," i.e., the formation of the most massive stars, which contain most of the light, but not most of the material, which is always in low-mass stars. Using the stepping stone of nearby galaxies, we can then hope to venture out to the distant universe, which promises to connect the science of star formation to the science of galaxy formation. We are on the threshold of another exciting unification in science."

The ALMA Project is a partnership between the scientific communities of East Asia, Europe and North America with Chile and is the largest ground-based astronomical project ever carried out. Built at an altitude of 5,000 meters, it promises to revolutionize our understanding of the formation of planets, stars, and galaxies when it begins full scientific operations early in the next decade. Taiwan has been a member of the project since 2005.

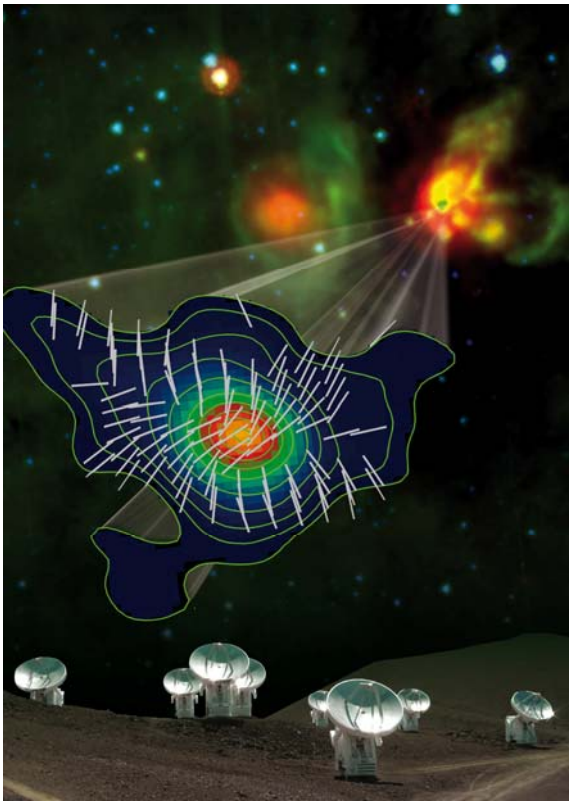

Fig 1
The background shows a false-color Spitzer image of the massive star-forming region G31.41. Blue color indicates regions of the image at a wavelength of 3.6 micrometer, green at 8 micrometer, and red at 24 micrometer. The zoom-in region depicts the dust emission from the massive hot core (color and contour image) superposed with bars showing the magnetic field morphology. Pictured in the bottom of the image is the Submillimeter Array in Hawaii.
Credit: Josep Miquel Girart (CSIC-IEEC), Nimesh Patel (Harvard-Smithsonian Center for Astrophysics) and Manel Carrillo

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