As They Form, Stars Shape Their Womb from Within

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Star formation is an even more intense and dynamic process than previously thought, according to research based on data from one of the world's newest and most powerful telescopes.

As stars form in clouds of gas and dust, they shoot powerful jets of gas and other raw material outward. Analysis of fresh high-resolution images of fast-moving emissions from a well-known protostar refines the existing picture of the outflows' size, shape, and motion, and shows that they are moving at greater velocities than previously measured, researchers report Aug. 20 in Astrophysical Journal [http://iopscience.iop.org/0004-637X/774/1/39; preprint: http://arxiv.org/abs/1304.0674].

The outflows have a pronounced effect on the host cloud, pushing dense raw materials away and affecting cloud properties, such as turbulence, according to the research team, led by Yale University astronomer Héctor Arce. This in turn affects development of the protostar itself, possibly influencing the star's ultimate characteristics and the cloud's ability to form other stars.

"If we can see these interesting features for this 'run-of-the-mill' protostar, we should expect to see similar features in other protostars," said Arce, associate professor of astronomy at Yale. Astronomers from the Universidad de Chile and other institutions were also part of the team.

Their research is part of a broad effort by astronomers to better understand formation of stars like Earth's Sun and the environment where this happens.

"The Sun is a star, so if we want to understand how our solar system was created, we need to understand how stars are formed," said Arce.

The new research focuses on HH 46/47, the bipolar outflow from a protostar forming on the outskirts of the Gum Nebula, at about 1,400 light-years away. The researchers used observations from the Atacama Large Millimeter/submillimeter Array (ALMA), in Chile.

Assuming HH 46/47 is broadly representative of protostellar outflows, said Arce, "Our results imply that outflows have much more momentum and kinetic energy, and therefore significantly more impact on their surroundings, than previously thought. This indicates that protostellar outflows could provide the energy to sustain turbulence in the clouds where stars form and even help in dispersing the gas around newly formed stars."

The recent paper describes the two lobes of the HH 46/47 outflow in detail, noting striking differences in size, shape, and complexity. The research shows the outflow is episodic, suggesting that star growth itself may be episodic, researchers said.

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"The mass of the star does not increase smoothly over time as disk material accretes at a constant rate onto the star," Arce said. "Instead, the star mostly gathers mass through episodes of high mass-accretion rates, separated by periods of low accretion rates." The paper is titled "ALMA Observations of the HH 46/47 Molecular Outflow."

"Because of the location of this protostar at the edge of the molecular cloud, one outflow lobe interacts with the interior, or denser part, of the cloud on one side of the protostar, and the other lobe emerges on the other side," said co-author Diego Mardones of the Universidad de Chile. "This makes it an excellent system to study the impact of stellar winds on different kinds of environments."

Co-author Stuartt Corder of ALMA notes, "Soon, ALMA will be imaging many outflows, spanning a range of evolutionary states. We will be able to not only resolve the history of the outflow bursts, like we have done in our study, but we will shed light on the details of the interaction between the material in the cloud and the matter ejected by the young star."

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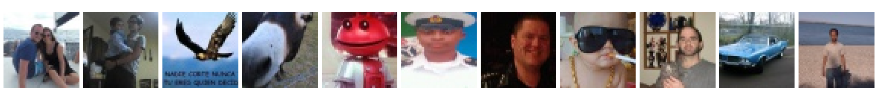

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