ALMA takes close look at drama of star birth

New observations of young star region Herbig-Haro 46/47 revealed that some of the ejected material had velocities much higher than had been measured before.

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Young stars are violent objects that eject material at speeds as high as 620,000 mph (1 million km/h). When this material crashes into the surrounding gas, it glows, creating a Herbig-Haro object. A spectacular example is named Herbig-Haro 46/47 and is situated about 1,400 light-years from Earth in the southern constellation Vela the Sails. This object was the target of a study using the Atacama Large Millimeter/submillimeter Array (ALMA) during the early science phase while the telescope was still under construction and well before the array was completed.

This unprecedented image of Herbig-Haro object HH 46/47 combines radio observations acquired with the Atacama Large Millimeter/submillimeter Array (ALMA) with much shorter wavelength visible light observations from ESO's New Technology Telescope (NTT). The ALMA observations (orange and green, lower right) of the newborn star reveal a large energetic jet moving away from us, which in the visible is hidden by dust and gas. To the left (in pink and purple), the visible part of the jet is seen streaming partly towards us. // *ESO/ALMA (ESO/NAOJ/NRAO)/H. Arce. Acknowledgements: Bo Reipurth*

The new images reveal fine detail in two jets, one coming toward Earth and one moving away. The receding jet was almost invisible in earlier pictures made in visible light due to obscuration by the dust clouds surrounding the newborn star. ALMA has not only provided much sharper images than earlier facilities, but also allowed astronomers to measure how fast the glowing material is moving through space.

These new observations of Herbig-Haro 46/47 revealed that some of the ejected material had velocities much higher than had been measured before. This means the outflowing gas carries more energy and momentum than previously thought.

"The detail in the Herbig-Haro 46/47 images is stunning. Perhaps more stunning is the fact that, for these types of observations, we really are still in the early days. In the future, ALMA will provide even better images than this in a fraction of the time," said Stuartt Corder from the Joint ALMA Observatory in Chile.

"This system is similar to most isolated low-mass stars during their formation and birth," said Diego Mardones from the University of Chile. "But it is also unusual because the outflow impacts the cloud directly on one side of the young star and escapes out of the cloud on the other. This makes it an excellent system for studying the impact of the stellar winds on the parent cloud from which the young star is formed."

The sharpness and sensitivity achieved by these ALMA observations also allowed the team to discover an unsuspected outflow component that seems to be coming from a lower mass companion to the young star. This secondary outflow is seen almost at right angles to the principal object and is apparently carving its own hole out of the surrounding cloud.

"ALMA has made it possible to detect features in the observed outflow much more clearly than previous studies," said Arce. "This shows that there will certainly be many surprises and fascinating discoveries to be made with the full array. ALMA will certainly revolutionize the field of star formation!"