

ALMA REVEALS THE MOLECULAR OUTFLOWS IN THE ENVELOPE OF HYPERGIANT VY CANIS MAJORIS

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Extreme supergiant stars, or hypergiants, are thought to undergo extensive, chaotic mass loss events in their later stages, with complex envelope structures composed of arcs, clumps, and knots. The red hypergiant VY CMa is one of the best examples of these types of stars. Previous studies in the infrared of VY CMa of dust emission have shown the presence of distinct arcs to the southwest (Arc 1, Arc 2), a NW arc, and another clumps and knots, many extending several arcseconds from the central star. Using ALMA, we imaged the envelope of VY CMa in multiple molecular lines at Band 6 (1 mm) with 0.25 arcsecond resolution and with the sensitivity to structures as large as 3-4 arcseconds. While some observations are still in progress, preliminary maps of SO₂, H¹³CN, and PO have been produced. From SO₂ emission, a map of the global molecular outflow structure of VY CMa has been obtained for the first time on scales of 6-8 arcseconds. These molecular data show the striking morphology seen in dust emission in VY CMa, including Arc 1, Arc 2, and the NW Arc, among other features. These new images will be presented, as well as other new data, and the implications for the evolution of massive stars will be discussed.