

Searching for Cool Dust in the Mid-to-far Infrared: The Mass-loss Histories of the Hypergiants η Cep, VY CMa, IRC+10420, and η Cas

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We present mid- and far-IR imaging of four famous hypergiant stars: the red supergiants η Cep and VY CMa, and the warm hypergiants IRC +10420 and η Cas. Our 11–37 μ m SOFIA/FORCAST imaging probes cool dust not detected in visual and near-IR imaging studies. Adaptive optics 8–12 μ m imaging of η Cep and IRC +10420 with MMT/MIRAC reveals extended envelopes that are the likely sources of these stars' strong silicate emission features. We find η Cep's mass-loss rate to have declined by about a factor of five over a 13,000 year history, ranging from 5×10^{-6} down to $1 \times 10^{-6} M_{\odot} \text{ yr}^{-1}$. VY CMa indicates a cooler dust component coincident with the highly asymmetric reflection nebulae seen in the visual and near-IR. The lack of cold dust at greater distances around VY CMa indicates that its mass-loss history is limited to the last ~ 1200 years, with an average rate of $6 \times 10^{-4} M_{\odot} \text{ yr}^{-1}$. We find two distinct periods in the mass-loss history of IRC +10420 with a high rate of $2 \times 10^{-3} M_{\odot} \text{ yr}^{-1}$ until approximately 2000 years ago, followed by an order of magnitude decrease in the recent past. We interpret this change as evidence of its evolution beyond the RSG stage. Our new infrared photometry of η Cas is consistent with emission from the expanding dust shell ejected in its 1946 eruption, with no evidence of newer dust formation from its more recent events.

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