A Symmetric Bipolar Nebula Around MWC 922

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The Be star MWC 922 has previously been noted for its spectral features: unusually strong forbidden [Fe II] in emission (1) and more recently the dust mineralogy and chemistry of its rich infrared spectrum (2). The distance to this object is unknown (it may lie within the Ser OB1 association at 1.7 kpc), as is its evolutionary status (both pre- and postmain sequence have been suggested).

Here, we report high angular resolution observations in the infrared H band made with the adaptive optics system on the 200" Palomar telescope [detailed further in (3)]. An image showing the extended Red Square nebula surrounding MWC 922 is given in Fig. 1, together with a highpass filtered image that reveals underlying structural elements and a model describing the key features. The box-shaped X structure necks down into twin opposing hyperbolic bicones separated by 0°.34 at the center, where they are crossed by an equatorial dark band running northeast to southwest. Along the principle axis of symmetry (PA = 46°), a remarkable series of orthogonal linear rungs appear at 1°.77 and 3°.1 arc sec (northwest bicone) and at −1°.44 and −3°.2 arc sec (southeast bicone). Where the rungs meet the bicone surfaces, we find bright vortices that subtend an opening angle of 105° at the origin.

In addition, we have established the presence of a series of radial linear features resembling a comb and appearing to lie along both bicone surfaces between the second bright rung and the outer edge of the nebula. One possibility is that the comb may be the outcome of a projected illumination effect as light from the central star system. The clearly demarked narrow rungs reported here do not exhibit multiple rings and a wealth of other structures. Around MWC 922 should make an excellent example of a symmetric bipolar nebula with perhaps the largest departure being the axial displacement of the innermost rung, which appears 20% further out in the northwest than the southeast bicone. This high degree of correspondence between structures in the two bicones argues for common creation in episodic eruptions within the central star system. This result also has implications for other bipolar systems, such as the Red Rectangle, where direct correspondence between pairs of rungs in the two bicones could not be established (5), arguing against models with one-sided mass ejections.

Adopting the (speculative) distance of 1.7 kpc, the linear size of the Red Square is twice as large as the Red Rectangle at the same dynamic range in surface brightness. If we further speculate that outflow velocities are not dissimilar (~7 km/s (5)), then the dynamical ages of the two major rung systems are ~3000 and 6000 years. However, given the significantly hotter spectrum of MWC 922’s central star [B3-B6 (6)] as compared with the Red Rectangle [peculiar A supergiant in a 319-day binary (5)], basic parameters such as wind speeds may differ substantially. The finding of a cousin to the Red Rectangle, but with differing spectrum and a hotter central star, implies that the conditions of formation for these elegant bipolar ladders may not be so singular and unique as formerly thought.

The clearly demarked narrow rungs reported here places MWC 922 in rare company with only two other known systems [Sher 25 and HD168625 (7)] that support ringed bipolar nebulae, structures which make them viable progenitors for polar ring systems like that seen in SN1987A. As the only one of the three to exhibit multiple rings and a wealth of other forms, MWC 922 should make an excellent laboratory for the study of the creation of such structures.

References and Notes
3. Materials and methods are available on Science Online.
8. We thank Palomar Observatory and its dedicated staff for help with the observations.

Supporting Online Material
www.sciencemag.org/cgi/content/full/316/5822/247/DC1
Materials and Methods
References
5 October 2006; accepted 11 January 2007
10.1126/science.1135950

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