Orbitally modulated dust formation by the WC7+O5 colliding-wind binary WR140

P. M. Williams^1, S. V. Marchenko^2, A. P. Marston^{3,4}, A. F. J. Moffat^5, W. P. Varricatt^{6}, S. M. Dougherty^7, M. R. Kidger^{4,8}, L. Morbidelli^9, M. Tapia$^{10)$

1. Institute for Astronomy, Scottish Universities Physics Alliance, University of Edinburgh, Royal Observatory, Edinburgh EH9 3HJ, United Kingdom
2. Dept of Physics and Astronomy, Western Kentucky University, 1906 College Heights Blvd #11077, Bowling Green, KY 42101, USA
3. SIRTF Science Center, IPAC, Caltech, Mail Stop 314-6, Pasadena, CA 91125, USA
4. Herschel Science Centre, European Space Astronomy Centre, Villafranca del Castillo, P.O.Box - Apdo.50727, 28080 Madrid, Spain
5. 'epartement de physique, Universit'e de Montr'eal, C.P. 6128, Succ. Centre-Ville, Montr'eal, QC, H3C 3J7, Canada
6. Joint Astronomy Centre, 660 N. A`oh=ok=u Place, Hilo, HI 96720, USA
7. National Research Council of Canada, Herzberg Institute for Astrophysics, Dominion Radio Astrophysical Observatory, P O Box 248, Penticton, B.C. V2A 6J9, Canada
8. Ingenieria y Servicios Aeroespaciales SA, ESAC, Villafranca del Castillo, P.O.Box - Apdo.50727, 28080 Madrid, Spain
9. INAF - Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy
10. Universidad Nacional Aut'{o}noma de M'{e}xico, Instituto de Astronom'{i}a, Apartado Postal 877, Ensenada B.C., Mexico

We present high-resolution infrared (2--18 umum) images of the archetypal periodic dust-making Wolf-Rayet binary system WR140 (HD 193793) taken between 2001 and 2005, and multi-colour (J -- [19.5]) photometry observed between 1989 and 2001. The images resolve the dust cloud formed by WR140 in 2001, allowing us to track its expansion and cooling, while the photometry allows tracking the average temperature and total mass of the dust. The combination of the two datasets constrains the optical properties of the dust, and suggest that they differ from those of the dust made by the WC9 dust-makers, including the classical `pinwheel', WR104. Photometry of individual dust emission features shows them to be significantly redder in (nbL^{prime}--[3.99]), but bluer in ([7.9]--[12.5]), than the binary, as expected from the spectra of heated dust and the stellar wind of a Wolf-Rayet star. The most persistent dust features, two concentrations at the ends of a `bar' of emission to the south of the star, were observed to move with constant proper motions of $324pm8$ and $243pm7$ mas y^{-1}. Longer wavelength (4.68-umum and 12.5-umum) images shows dust emission from the corresponding features from the previous (1993) periastron passage and dust-formation episode, showing that the dust expanded freely in a low-density void for over a decade, with dust features repeating from one cycle to the next. A third persistent dust concentration to the east of the binary (the `arm') was found to have a proper motion $sim$ 320 mas y$^{-1}$, and a dust mass about one-quarter that of the `bar'. Extrapolation of the motions of the concentrations back to the binary suggests that the eastern `arm' began expansion 4--5 months earlier than those in the southern `bar', consistent with the projected rotation of the binary axis and wind-collision region (WCR) on the sky. Comparison of model dust images and the observations constrain the intervals when the WCR was producing sufficiently compressed wind for dust nucleation in the WCR, and suggests that the distribution of this material was not uniform about the axis of the WCR, but more abundant in the following edge in the orbital plane.

Reference: MNRAS
Status: Manuscript has been accepted

Weblink: ftp://ftp.roe.ac.uk/pub/pmw/wr140dust.ps.gz

Comments:

Email: pmw@roe.ac.uk