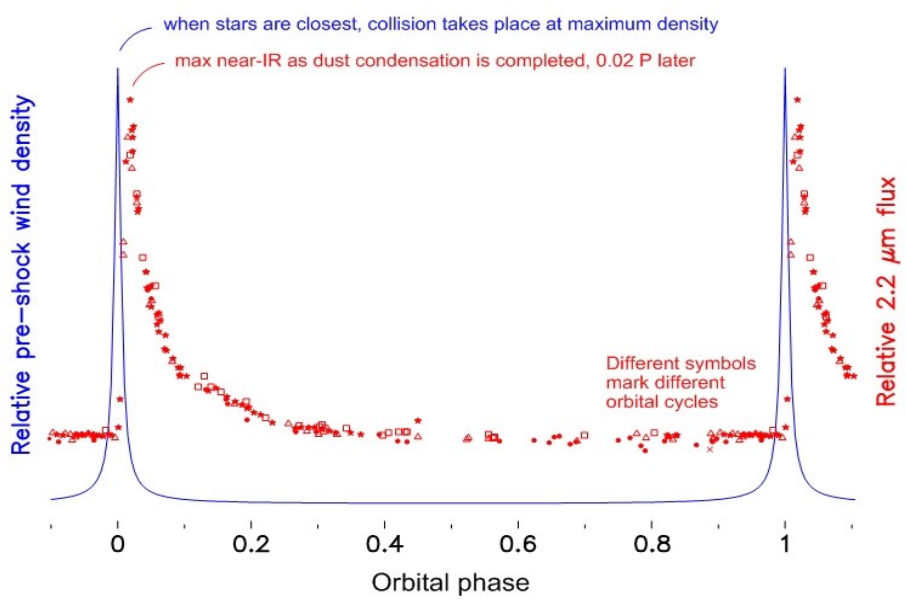
Variable dust emission by WC Wolf-Rayet stars observed in the NEOWISE-R survey

Peredur Williams, Institute for Astronomy, Royal Observatory Edinburgh

WR dust and colliding stellar winds

Formation of dust by WR stars requires over-density regions, provided in at least some stars by shock compression of the WR wind where it collides with that of a luminous binary companion. If stars are in a circular orbit, the dust is expelled in a spiral, as observed in IR images of WR104 showing a rotating pinwheel (Tuthill et al. 2008), while the flux level does not change. Stars in elliptical orbits show variable dust emission, spectacularly in stars with the most eccentric orbits, such as WR140, which shows brief episodes of dust formation at the time of periastron passage (Williams et al. 1990) when the stars are closest.



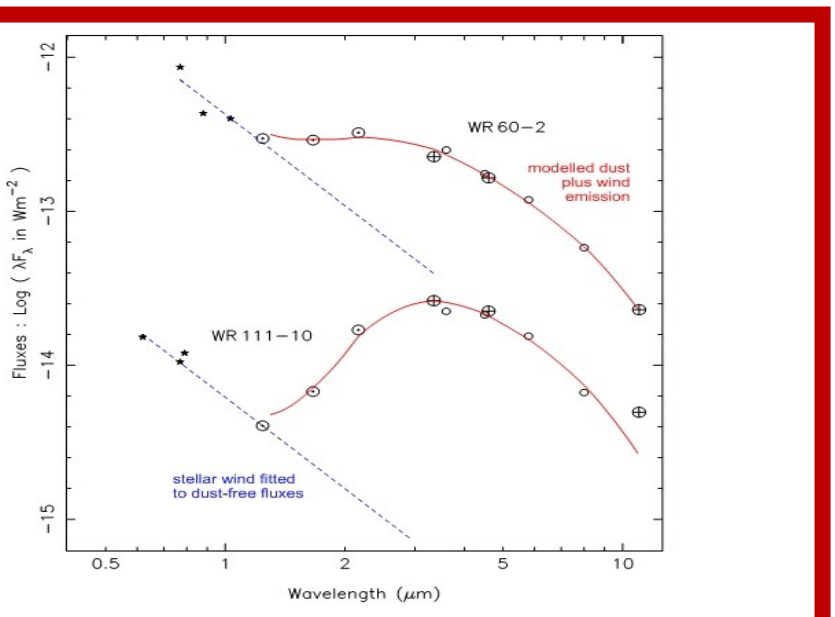
K flux of WR140 vs. density of wind at collision

Survey for variable dust emission

Changes in physical conditions in stellar wind-collision regions in well specified binaries as dust condensation varies provide clues to dust formation, prompting a search for variable WR dust emission to find more cases. The NEOWISE Reactivation mission (Mainzer et al. 2014), provides 3.4-μm (*W1*) and 4.5-μm (*W2*) photometry, well-suited for measuring 1000-K dust emission, over a period of years – initially three, now extended. Photometry for 135 Galactic and LMC WC stars not too bright for the instrument nor suffering source confusion was examined for variation. Spectral energy distributions (SEDs) were formed using available *bvrIZY* data to define stellar winds and measure reddening, allowing examination of IR fluxes for dust emission. Earlier data from the *GLIMPSE* and *WISE surveys* were used to characterise the variability and search for periodicity.

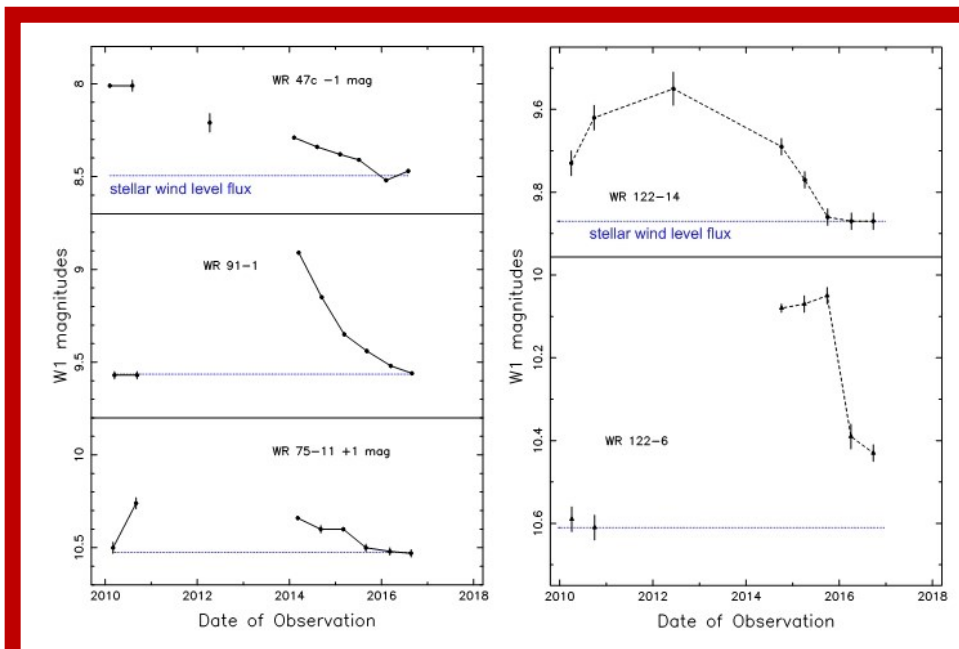
Results from the 2014—16 data

So far, 15 new WR dust makers have been identified, seven apparently constant (one of which, WR 111-10, is the first WC7 star to show this phenomenon) and eight variable. An upward revision of the incidence of dust formation amongst Galactic WC type stars to over 30% is suggested.



SEDs of two newly identified 'constant' dust makers

Of the new variable dust makers, it is possible to assign a period of 274 d. to the WC5-7 system WR46-7; it is hoped to determine more following further data releases. Some variables show no dust emission for some of the time, characterising them as episodic dust makers.



3.4-μm light curves of new episodic dust-makers

References:
Mainzer, A. et al. 2014, ApJ 792, 30
Tuthill, P.G., et al. 2008, ApJ 675, 698
Williams, P.M. et al. 1990, MNRAS, 243, 662