Clumping in Hot Star Winds
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Discussion: Binaries, colliding winds, LBVs and high energy radiation

Moderator: Nicole St-Louis

Hamann: I want to ask Andy Pollock one more question about the incredibly high mass obtained for WR 25 (344 $M_\odot$). What can be wrong with this mass estimate? And if the mass you get is not correct, will the mass loss rate still be okay?

Moffat: We now have binary-based masses of similar stars to WR 25, which have masses of order $100M_\odot$, not $> 300M_\odot$.

Gräfener: From our most recent spectral analyses we deduce a very large luminosity for WR 25. The result depends upon the adopted distance and the interstellar reddening law and lies between $10^{6.4}\,L_\odot$ and $10^{6.7}\,L_\odot$. From our hydrodynamic models we deduce masses of 110 and 210 $M_\odot$ respectively. This is not too far away from Andy's results.

Puls: In reply to Gräfener: When one believes in your hydrodynamic models, the mass should be quite constrained from the luminosity and the requirement that Γ is close to unity.

Moffat: The most massive, classical (He-burning) WR star has a mass of $\sim 20M_\odot$, while the most massive H-rich WR star is close to $120M_\odot$ (NGC 3603/AI).

Ignace: What actually constitutes a WR star?

Hillier: "Wolf-Rayet" is a spectral designation denoting the presence of certain emission lines; it is not an evolutionary designation. During the 1980ies, WR stars became associated with stars that were core He burning, and had lost much of their H envelope. However, in young massive clusters (e.g. 30 Dor, Carinae) many of the WR stars are H rich, and are probably still H-core burning. As emphasized by Stan, the reason for their emission lines are their high mass loss rates (and hence wind densities) which arise from their high luminosities.

Pollock: The abundances seem fairly well determined in the brightest WR 140 spectrum. The lines here are fairly regular in shape. After periastron, where the spectrum is much fainter, the lines are much more irregular, probably because there is now contribution from shocked O star material, which near periastron was seen through the shocked WR star material, which is probably optically thick.

Gull: Again, what is the definition of a clump? How long do clumps last? Are clumps we see in ejecta all from major events or do some originate from winds? η Carinae's Homunculus shows multiple absorption systems with velocities ranging from -128 km/s to -1500 km/s. The -513 km/s (Homunculus) and -146 km/s (little Homunculus) are clearly associated with historical events. Intermediate velocity systems are present from -385 to -508 km/s, almost periodically spaced. Excitation drops with increasing velocity and STIS nebular spectra show these absorptions to be associated with internal shells. Are these originating with each periastron event? Do they indicate decreasing activity after each major event leading up to new activity analogous to seismic activity? Does this provide insight to the periodic wind variations and a predictor of future events?

Moffat: The clumps we observe in WR stars have lifetimes of ~ 10 h in the observed lines. This does not exclude that the clumps continue to propagate without significant radiation in that line.

Pollock: The depth and shape of the eclipse depends very sensitively on the geometry. It would be essential to calibrate the method on objects for which the eccentricity and inclination are known by independent means. WR 133 is a possible example.

Weis: The classical picture of a nebula goes back to the Weaver et al. model in which a homogenous wind expands into an also homogenous medium. If the wind is already clumped, such a model is not valid anymore and the question is how large is the impact of those clumps onto the nebula formation.