Cold gas in hot star clusters: the wind from the red supergiant W26 in Westerlund 1

Jonathan Mackey (1,2), Norberto Castro (2), Luca Fossati (2), Norbert Langer (2)

(1) I. Physikalisches Institut, UniversitÃ¤t zu KÃ¶ln, ZÃ¼lpicher StraÃŸe 77, 50937 KÃ¶ln, Germany
(2) Argelander-Institut fÃ¼r Astronomie, Auf dem HÃ¼gel 71, 53121 Bonn, Germany

The massive red supergiant W26 in Westerlund 1 is one of a growing number of red supergiants shown to have winds that are ionized from the outside in. The fate of this dense wind material is important for models of second generation star formation in massive star clusters. Mackey et al. (2014) showed that external photoionization can stall the wind of red supergiants and accumulate mass in a dense static shell. We use spherically symmetric radiation-hydrodynamic simulations of an externally photoionized wind to predict the brightness distribution of Halpha and [N II] emission arising from photoionized winds both with and without a dense shell. We analyse spectra of the Halpha and [N II] emission lines in the circumstellar environment around W26 and compare them with simulations to investigate whether W26 has a wind that is confined by external photoionization. Simulations of slow winds that are decelerated into a dense shell show strongly limb-brightened line emission, with line radial velocities that are independent of the wind speed. Faster winds (>22 km/s) do not form a dense shell, have less limb-brightening, and the line radial velocity is a good tracer of the wind speed. The brightness of the [N II] and Halpha lines as a function of distance from W26 agrees reasonably well with observations when only the line flux is considered. The radial velocity of the simulated winds disagrees with observations, however: the brightest observed emission is blueshifted by 25 km/s relative to the radial velocity of the star, whereas a spherically symmetric wind has the brightest emission at zero radial velocity because of limb brightening. Our results show that the bright nebula surrounding W26 must be asymmetric, and we suggest that it is confined by external ram pressure from the extreme wind of the nearby supergiant W9. We obtain a lower limit on the nitrogen abundance within the nebula of 2.35 times solar. The line ratio strongly favours photoionization over shock ionization, and so even if the observed nebula is pressure confined there should still be an ionization front and a photoionization-confined shell closer to the star that is not resolved by the current observations, which could be tested with better spectral resolution and spatial coverage.

Reference: DOI:10.1051/0004-6361/201526159, arXiv:1508.07003
Status: Manuscript has been accepted

Weblink: http://adsabs.harvard.edu/abs/2015arXiv150807003M

Comments: Astronomy & Astrophysics, in press

Email: mackey@ph1.uni-koeln.de