AMBER+FINITO+UT Science Demonstration Proposal

Wind stratification and perturbations of the prototype WN star WR 6

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Abstract:
We propose to use VLTI/AMBER with FINITO to observe the continuum and emission lines in H and K the intriguing Wolf-Rayet (WR) star WR6 (EZ CMa, HD50896). These observations will allow for the first time an in-depth study of the spatial structure of the wind stratification in the continuum and in strong emissive lines, for a WR star of the sub-type WN. Moreover the mysterious periodic (P=3.76d) modulation of the wind will also be investigated.

Scientific Case:
The Wolf-Rayet stars, which represent the end stage of massive stars, exhibit the strongest wind manifestations in terms of wind density and terminal velocity. Such a dense wind is optically thick near the star. WN stars exhibit spectra dominated by emission lines of nitrogen and helium, and WC/WO stars, dominated by lines of carbon, oxygen and helium (See review of Crowther, 2007, ARA&A, 45, 177). In addition to the key role of the stellar mass and metallicity on stellar evolution, rotation has proven to be also an essential parameter. There are numerous indications that hot star winds are quite structured and variable. Cranmer & Owocki (1996, CrOw) studied the impact of some perturbation located at the surface of a rotating star on a radiatively driven wind, that were found to induce the so-called co-rotating interaction regions (CIR) in the stellar outflow, characterized by a velocity plateau and a density compression. Dessart & Chesneau (2002, A&A, 395, 209), using the CrOw model, predicted the AMBER signal directly applied to two famous stars: the O5I ζ Pupis, and the WN4 WR6 (EZ CMa, HD50896).

WR 6 is the prototype of the WN4 type, and as such has been extensively studied (Morris et al., 2004, ApJS, 154, 413). In addition, the star exhibits spectral variability at a period of 3.765 days whose cause is unknown. Binarity may be responsible, but the existence of a companion has not been proven. This star has naturally been included in the GTO list of AMBER (program 65, P.I.: O. Chesneau), but we awaited the increase the AMBER sensitivity to observe it.

These pionner observations can directly provide a result. The continuum should be unresolved, but the emission lines with the most extended line forming regions will be chosen. Note for instance, that WR79a (WN9) has been resolved by AMBER, but, in absence of FINITO, the level of accuracy is such that better measurements are needed before publishing these results. Moreover, we expect to detect variable wind perturbations like the ones detected recently in Rigel (Kaufer, Chesneau et al. 078.D-0355).

Calibration strategy:
We need differential accuracy as the main effects will be seen inside the emission lines. Full window exposures will be suitable to have both large continuum zones and emission lines.

Targets and number of visibility measurements

Target	**RA**	**DEC**	**V** mag	**H** mag	**K** mag	**Size** (mas)	**Vis.**	**Mode**	**# of** Vis.
WR 6 (HD50896)	06 54 13	-23 55 42	6.8	6.3	5.9	2.0	1.0/0.95/0.85	MR 2.3	3

The Helium lines HeII2.17 and 2.19μm are first priority. If the observers wish to test H-band medium resolution, a strong Helium line, formed at 10-20 stellar radii can be studied, HeII1.87μm, and the gain in spatial resolution will be welcome. The visibility estimations were obtained with a distance of 1kpc, a core radius Rc of 3 solar radii, the optically thick frontier at 3 Rc, and the line forming regions at 10 Rc.

Time Justification:
We request 1 triplet of observation per night, using medium resolution in K. Assuming 1h30 per triplet (using) and three nights of observations, we request 4h30 of observation.