VFTS 682: a surprisingly isolated twin of R136's WN5h core stars

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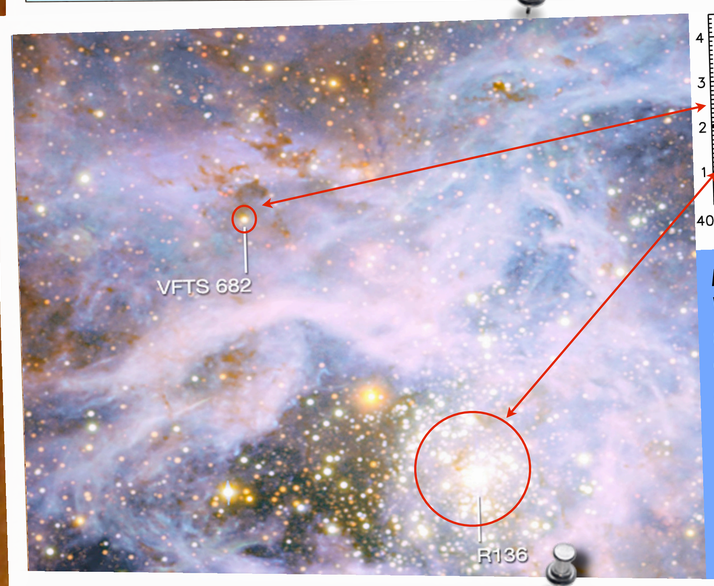
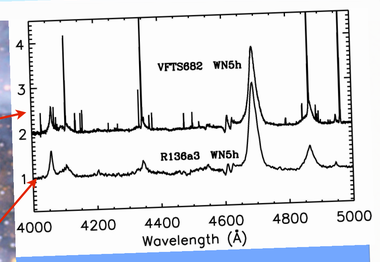
INTRODUCTION

The existence and quantification of an upper stellar mass cutoff of massive stars (~150 M⊙, Figer, 2005, Nat 434, 192) have been questioned by recent investigations base on optical and near infrared (NIR) spectra of the most massive members of R136a within 30 Dor in the LMC (Crowther et al. 2010, MNRAS 408, 731). Crowther et al. concluded that the four WN5h stars in the core of R136 were consistent with having initial masses in the range of 165-300 M⊙. Being placed at the dense cores of young clusters, deep analyses of the most massive members can be severely affected by crowding problems. Interestingly, a new, very massive (~ 150 M⊙) and isolated WN5h star (VFTS682) has been detected within the VLT-Flames Tarantula Survey (Evans et al., 2011, A&A 530, 108). The star is located within an active star forming region (Johansson et al. 1998, A&A 331, 857) 30 pc NE from R136 and is moderately obscured by interstellar dust. Being in isolation, the above mentioned crowding problems basically disappear. Further, since the distance to the LMC is well known, VFTS 682 may thus be a key object to confirm the existence of super-massive stars with initial masses above 150M⊙. Here, we present the preliminar results derived from the analisys of the UVB, VIS and NIR XSHOOTER spectra of VFTS 682 to address the nature and stellar properties of the object, its origin and birthplace.

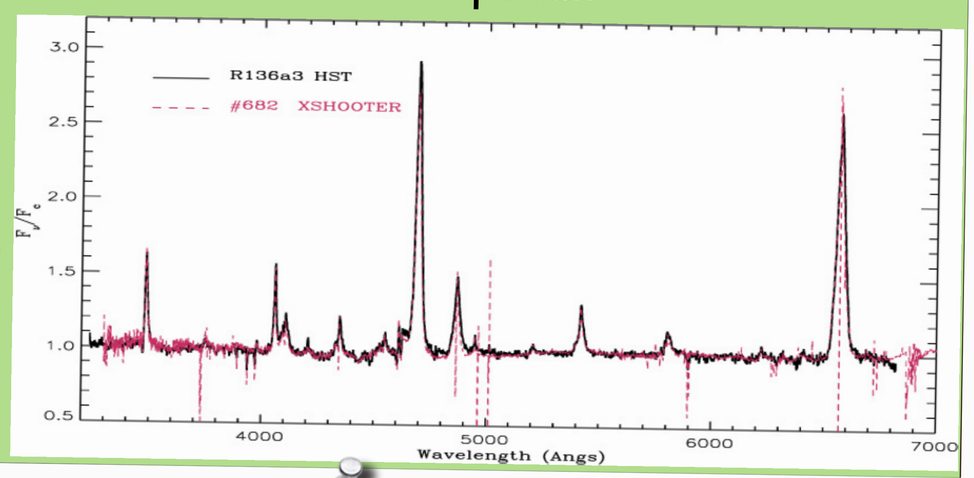




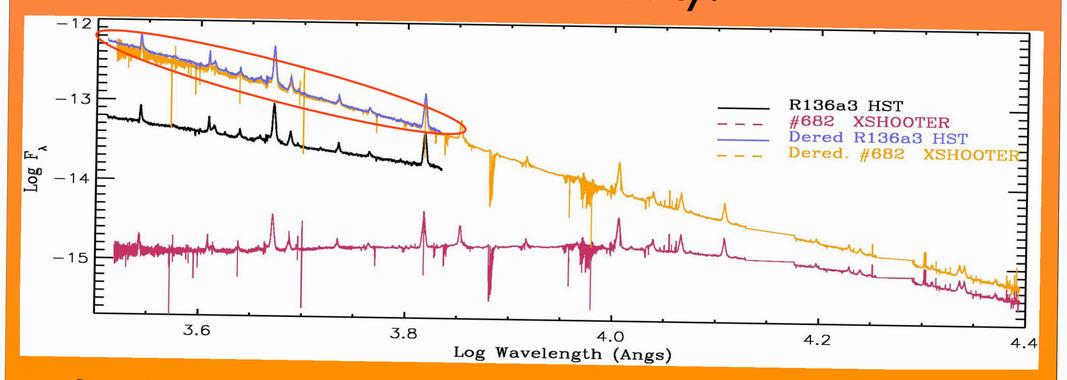
Left: Combined YJKs image from VISTA Magellanic Clouds survey (Cioni et al. 2011). The projected distance of VFTS 682 to the cluster R136 is 29 pc (distance to LMC 50 Kpc). Right: Comparison of the blue spectra of VFTS682 (contaminated by nebular emission) and R136a3, one of the WN5h stars in the core of R136.

Twins in the Optical?

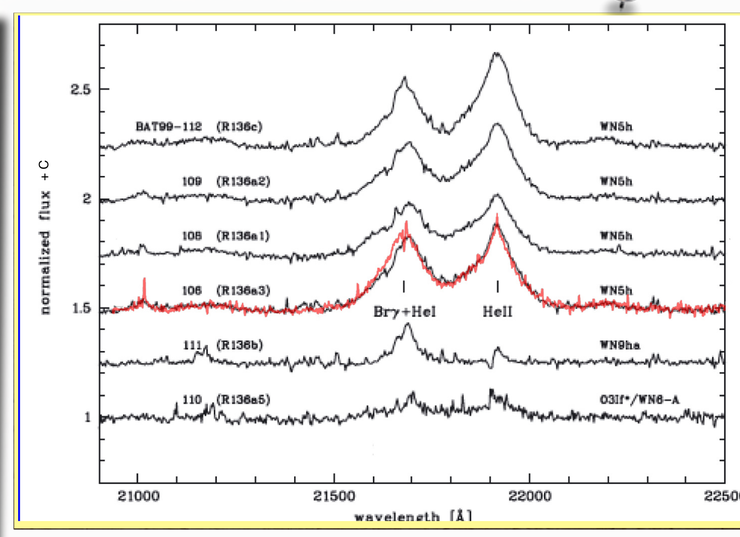
HST normalized optical spectrum of R136a3 (black solid line) and Xhsooter normalized optical spectrum of VFTS682 (magenta dashed line). Both objects are basically twins in the optical, except the nebular lines present in VFTS 682.



Twins in Luminosity?



Sepctral energy distributions vs wavelenght of VFTS 682 and R136a3 before (magenta and black lines) and after (yelow and blue lines) correction from reddening. Althoug R136a3 has higher reddened flux than VFTS 682, once corrected, both present nearly identical values.

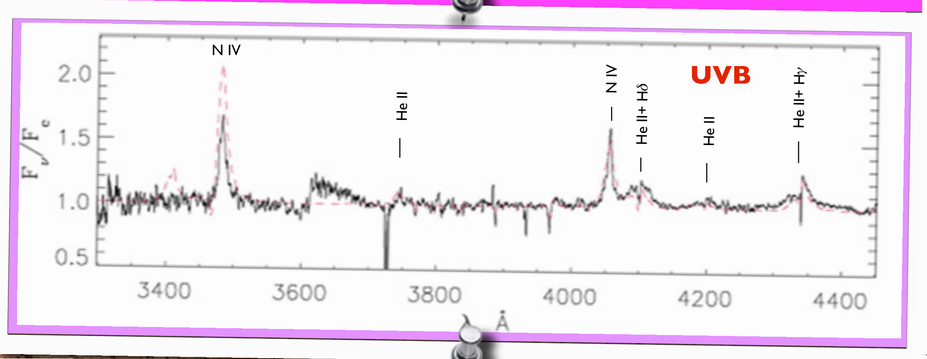


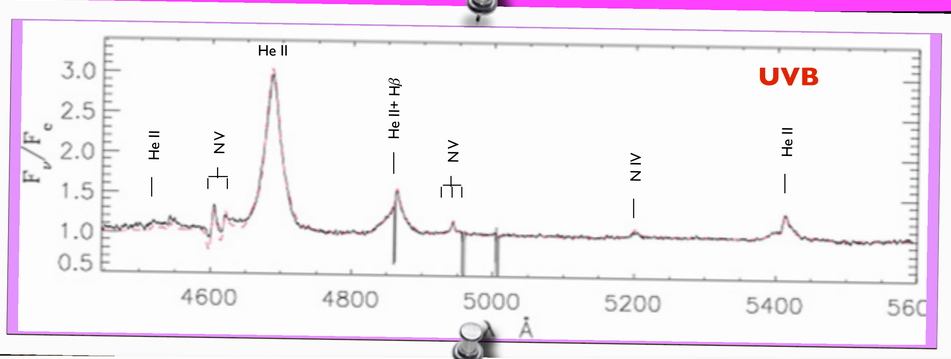
Twins in the NIR?

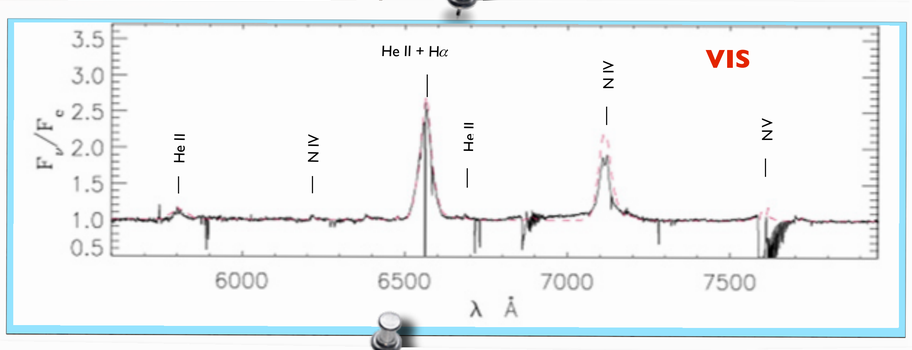
Montage of average VLT/SINFONI NIR spectra of the six WN5h members of R136, arranged by spectral type (adapted from Schnurr et al. 2009, MNRAS 397, 2049). Overlayed, in red color, the same section of the VLT/XSHOOTER NIR spectrum of VFTS 682. Note how the two strongest emission lines in this range, Brγ/HeI (2.166 μm) and HeII (2.188 μm), of R136a3 and VFTS 682 match up in width and intensity.

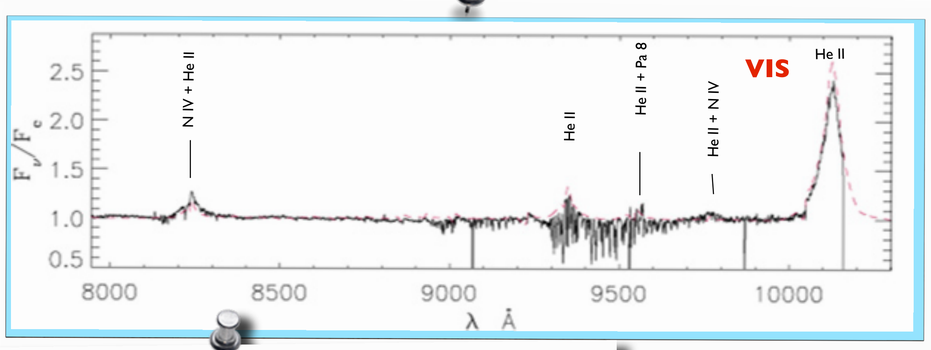
A quantitative spectroscopic model to the full optical-NIR XSHOOTER observations of VFTS 682

XSHOOTER optical to NIR normalized spectra of the source (black solid line) vs non-LTE stellar atmosphere code (CMFGEN) model spectrum (magenta dashed line). From top to bottom UVB, VIS and J, H and K bands. spectra.





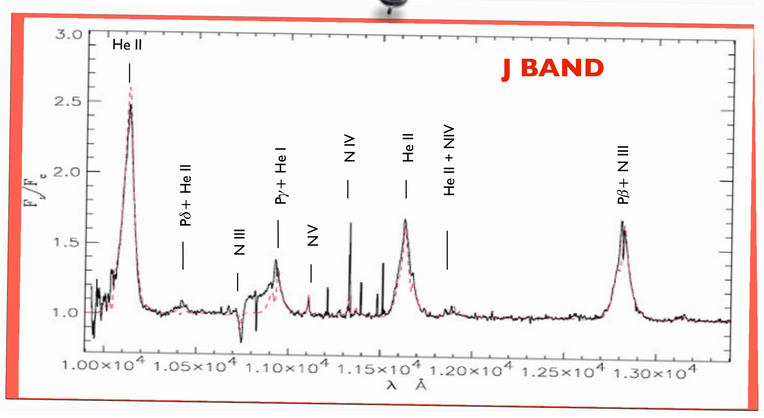


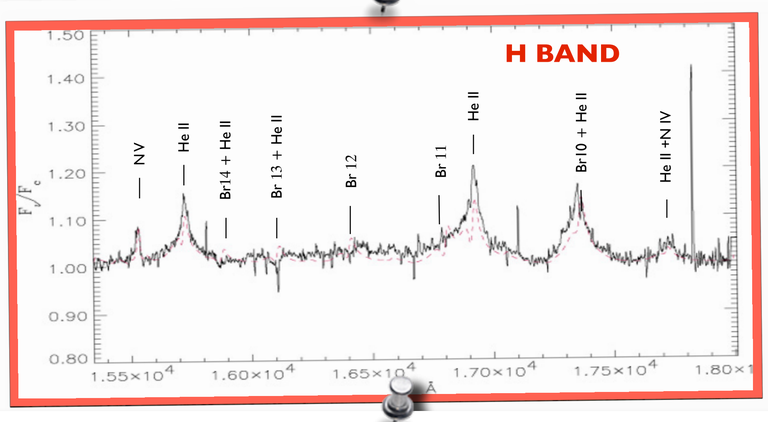


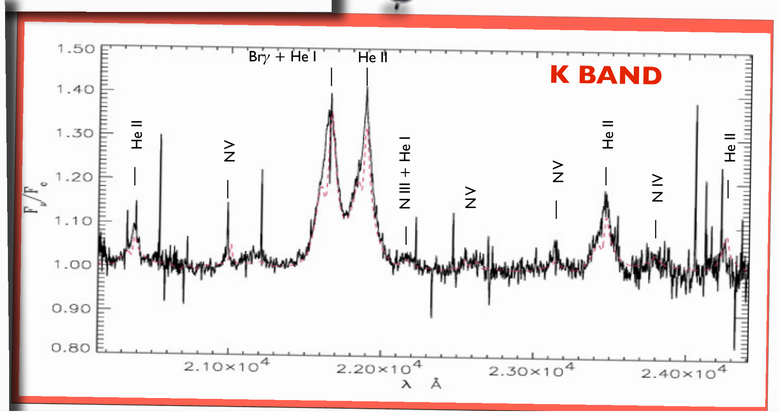
Stellar Parameters of VFTS682 obtained from model optical spectral with the non-LTE stellar atmosphere code CMFGEN.

Parameter	Value
Tc	54.4 +- 3 kK
T_{eff}	51.3 +- 2.5 kK
log (L/L⊙)	6.5 +- 0.2
$\dot{M}$ (M⊙ yr^{-1})	(3.5 +- 0.2)e-05
β	1.55
f	0.25
v_{inf}	2600 +- 200 km/s
Y[1]	0.44

Note. [(1)] *Y is the helium mass fraction*







Concluding Remarks

From the preliminary analisys of the full optical to NIR XSHOOTER line spectra of VFTS 682 we have obtained accurate stellar parameters of the source. With a stellar mass of ~150 $M_{\odot}$ and a luminosity of Log ($L/L_{\odot}$) ~ 6.5, VFTS 682 is one of the most massive stars known in isolation. Futhermore, this WN5h star is basically twin, in terms of stellar parameters, to one of the most massive members of the nearly cluster R136 (R136a3). The resemblance between both objects is striking as inferred from their optical and NIR normalized spectra as well as from their deredded spectral energy distributions . Thus, we may wonder whether VFTS682 formed 'in situ" or was dynamically ejected from the core of R136. The discovery of this massive isolated star represents a unique oportunity to study the dynamical ejection scenario and/or massive star formation theory and to adress the existence upper stellar mass cutoff.

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