*A Massive Star Odyssey, from Main Sequence to Supernova*
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# Spectral analysis of WC stars in M 33 using CFHT-MOS

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**Abstract.** We have analyzed eight single WC4-7 stars in M 33, spanning a variety of galactocentric distances, using optical CFHT-MOS spectroscopy. Provisional stellar parameters are determined using the code of Hillier & Miller (1998), which are compared here to Galactic and LMC counterparts.

## 1. Introduction and observations

Studies of young, massive stars in M 33 provide a useful test of evolutionary models. This is because its metallicity spans $1.0\,Z_\odot$ (inner regions) to $0.2\,Z_\odot$ (outer spiral arms), it is nearby, with a well determined distance, a low extinction, and is viewed with a low inclination. Observations used in this present study were obtained using the Multi-Object Spectrograph (MOS) on the 3.6m Canada France Hawaii Telescope (CFHT) between October 2000 and October 2001. 50 Wolf-Rayet stars were observed, representing approximately one third of the known WR content of M 33. From this sample, eight apparently single WC stars were selected and the photometry for each star was calculated from a $V$-band CFHT 12K image of M 33, using nearby secondary standards taken from Macri *et al.* (2001), whilst archival *HST*-WFPC2 images were used for two stars.

## 2. Results

There have already been a number of detailed studies analyzing Galactic and LMC WC-type stars (*e.g.*, Crowther *et al.* 2002) using CMFGEN (Hillier & Miller 1998) to calculate stellar properties ($v_\infty$, $\dot{M}$, $T$, log $L$, abundances). For our sample we used identical analysis techniques. C/He ratios were determined from the diagnostic lines of He II 5412 and C IV 5471. For the oxygen abundance the main optical diagnostic line of O III/V 5592 was used. The range of (C+O)/He ratios derived for this study are comparable to those previously found for Galactic and LMC WC stars, as illustrated in Figure 1 (right panel). AM 16 (WC5) and AM 17 (WC5) appear to be rich in oxygen, having C/O $\simeq 1$ (by number).

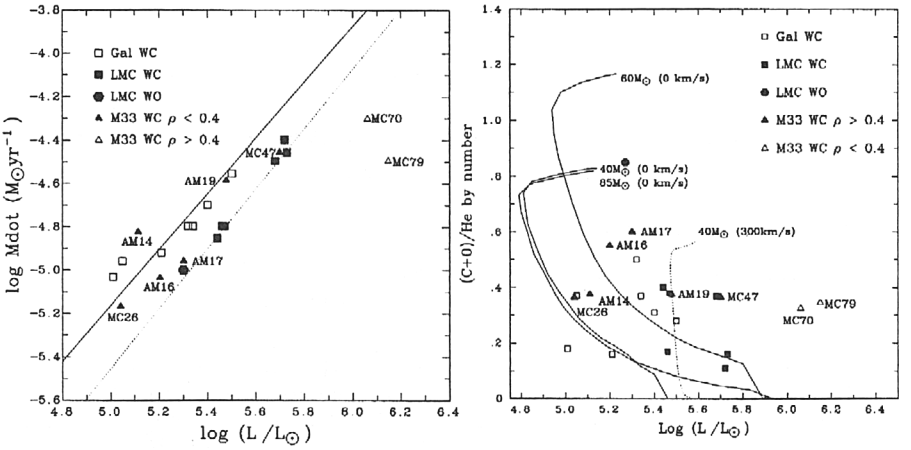


Figure 1. *Left:* Comparison between mass-loss rates and luminosities of Galactic, LMC and M 33 WC stars. The lines correspond to the calibrations of Nugis & Lamers (2000) for Galactic WR stars (solid), plus a linear fit to the LMC data (dotted, Crowther *et al.* 2002). *Right:* Comparison between (C+O)/He values for WC stars in the Galaxy, LMC and M 33 *vs.* luminosities. The evolutionary predictions shown are for non-rotating stars (solid, Meynet *et al.* 1994), and for an initially rapidly rotating 40 $M_\odot$ model (dotted, Meynet & Maeder 2000), all at solar metallicity.

Luminosities of M 33 WC stars span a much greater range than LMC or Galactic counterparts, *i.e.*, $5.0 \leq \log L/L_\odot \leq 6.2$. Figure 1 (left panel) compares mass-loss rates of M 33 WC stars with previously studied LMC and Galactic WC stars. We find that M 33 stars lying closer than 40% of the Holmberg radius, with metallicities $\geq 0.6\,Z_\odot$, possess stellar winds which are comparable in strength to LMC and Galactic stars. Much weaker winds are found for MC70 (WC5) and particularly MC79 (WC4), with SMC-like metallicities. This fits in with the recent suggestion by Crowther *et al.* (2002) of a metallicity dependence for WC winds, with $\dot{M} \propto Z^{0.5}$.

This work is part of an on-going project to study WR stars at a number of different metallicities, ranging from metal-poor galaxies, such as IC 10, to metal-rich galaxies like, M 83 (see Crowther *et al.* , these Proceedings).

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