**Wolf-Rayet Stars**
*W.-R. Hamann, A. Sander, H. Todt, eds.*
*Potsdam: Univ.-Verlag, 2015*
*URL: http://nbn-resolving.de/urn:nbn:de:kobv:517-opus4-84268*

# The Distribution of Massive Stars in M101

**J. Bibby[1], M. Shara[2], D. Zurek[2], P. A. Crowther[3], A. F. J. Moffat[4], L. Drissen[5] & M. Wilde[2]**

[1] *Jeremiah Horrocks Insitute, University of Central Lancashire* [2] *American Museum of Natural History*
[3] *University of Sheffield* [4] *Université de Montréal* [5] *Université Laval*

75 WR stars and 164 RSGs are identified in a single WFC3 pointing of our M101 survey. We find that within it's large star-forming complex NGC 5462 WR stars are preferentially located in the core whilst RSGs are found in the halo, suggesting two bursts of star-formation. A review of our WR candidates reveals that only ~30% are detected in the archival broad-band ACS imaging whilst only ~50% are associated with HII regions.

## 1 Motivation & Data

The location and relative numbers of Wolf-Rayet (WR) and Red Supergiant (RSG) stars can be used to investigate star-formation history and test theoretical predictions from stellar evolutionary models.

HST/WFC3 imaging of M101 using the F469N filter was used with archival ACS imaging to identify WR and RSG stars. Follow-up Gemini/GMOS spectroscopy was obtained to confirm the WR nature of the candidates. The top spectrum in Fig. 1 indicates at least one early-type WN star whilst the lower spectrum suggests an unresolved cluster hosting both WN and WC subtypes based on the presence and relative strengths of the He II$\lambda$4686, C III$\lambda$4650 and C IV$\lambda$5808 lines. Flux calibration will quantify the total WR population of each source.

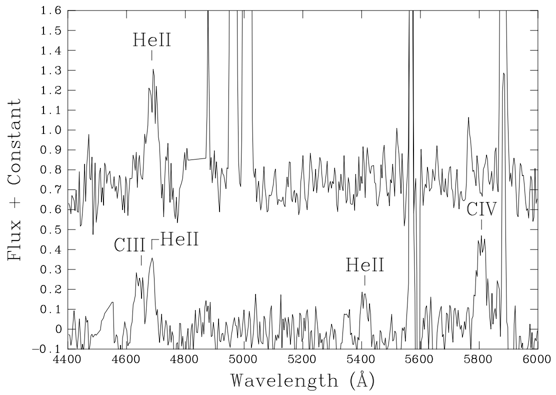


**Fig. 1:** GMOS spectra of a WNE star (upper) and unresolved WN+WC cluster (lower) in M101.

## 2 Spatial Distribution of WR Stars

WR stars and RSGs are useful tools in constraining both the age of a star-forming region and the mode of star-formation. Less massive RSGs are indicative of an older population if a single burst of star-formation is assumed. Analysis of the large star-forming complex NGC 5462 in M101 shows that both WR and RSG stars are present.

WR stars are preferentially located in the core of the star-forming cluster which hosts the brightest H II regions. We find the RSG/WR ratio increases from ~0.4 in the core to ~5 in the more isolated regions. This supports a conclusion of multiple epochs of star-formation, in agreement with previous work by Drissen et al. (1999).

Previous work finds that ~70% of ccSNe and ~75% of WR stars are associated with H II regions (Crowther 2013; Bibby & Crowther 2012). Inspection of ground-based H$\alpha$ imaging reveals that only ~50% of these WR candidates are associated with H II regions. Fig. 2 shows that the WR candidates detected in only the F469N filter are evenly distributed across the field, which is unexpected.

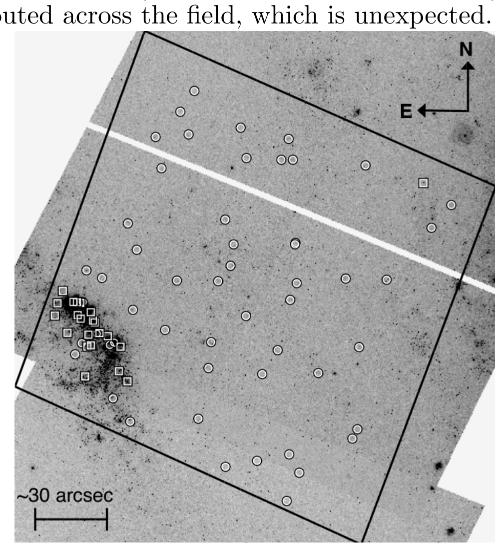


**Fig. 2:** One WFC3 field of M101. WR candidates detected with a 3$\sigma$ excess (squares) and F469N detection only (circles) are shown.

This could suggest a low-mass origin for some WR stars, or there could be some contamination in the field. Possible contaminants could include symbiotic stars or planetary nebula, although the magnitudes of the WR candidates appear fainter than one would expect for PN. Inspection of deeper H$\alpha$ imaging and narrow-band O III imaging will allow us to identify the most likely explanation.

## References

Bibby, J. & Crowther, P. 2012, MNRAS, 420, 3483
Crowther, P. 2013, MNRAS, 428, 1927
Drissen, L., Roy, J., Moffat, A., & Shara, M. 1999, AJ, 117, 1249
Shara, M., Bibby, J., Zurek, D., Crowther, P., Moffat, A., & Drissen, L. 2013, AJ, 146, 162
Smith, L., Shara, M., & Moffat, A. 1996, MNRAS, 281, 163