Searching for hidden Wolf-Rayet stars in the Galactic Plane

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Introduction & Motivation

- Wolf-Rayet (WR) stars are bare He cores of the most massive O stars and so their spectra are dominated by broad emission features of Nitrogen and Helium (WN) and Carbon (WC)

Why study WR stars?

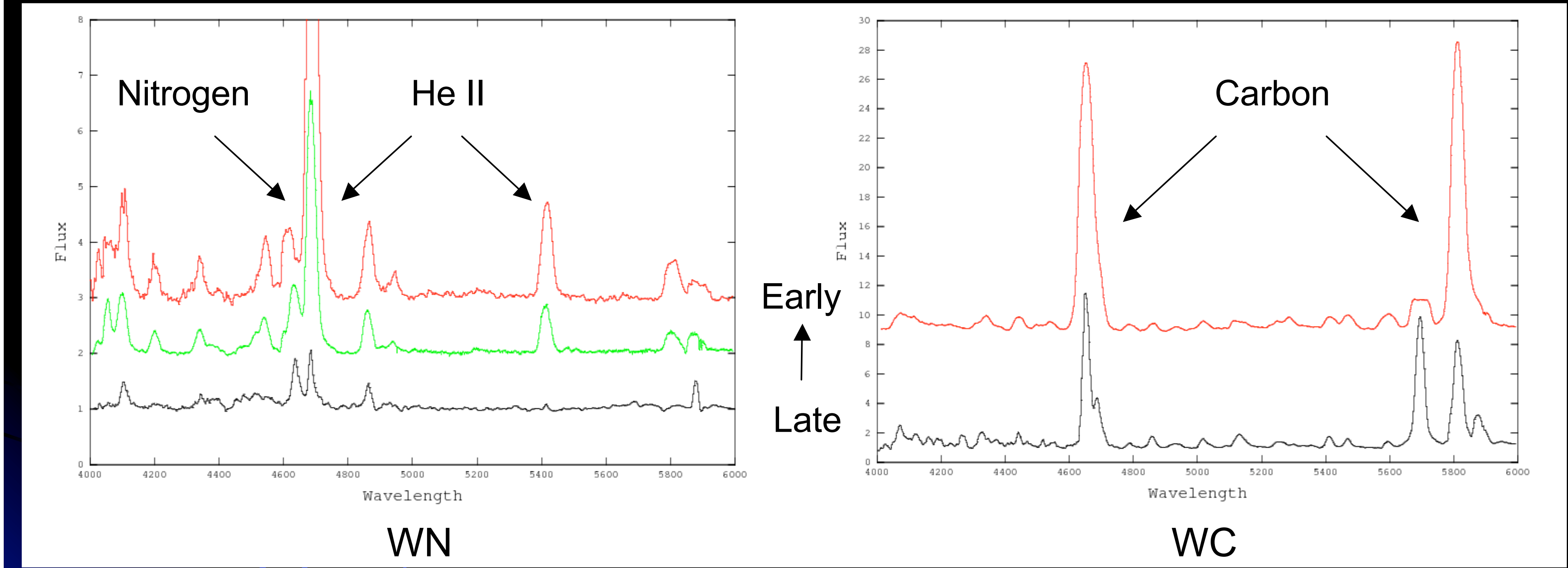
- WR populations [i.e. N(WC)/N(WN)] provide a vital test of evolution models
- If we are to understand populations in unresolved galaxies we must understand the population in the Milky-Way

Previous surveys

- Large scale surveys for Galactic WR stars generally use optical narrow-band filters tuned to WR emission
- The majority of WR stars reside within 1° of the Galactic Plane where dust extinction is high,

  => need IR wavelengths to find all the WR stars in the Galaxy
- N(WR)~300, but studies suggest a population of 1000-2500

WR Spectra


Nitrogen
He II
Flux
Wavelength
WN
Early
Late
Carbon
Flux
Wavelength
WC

A broad-band survey

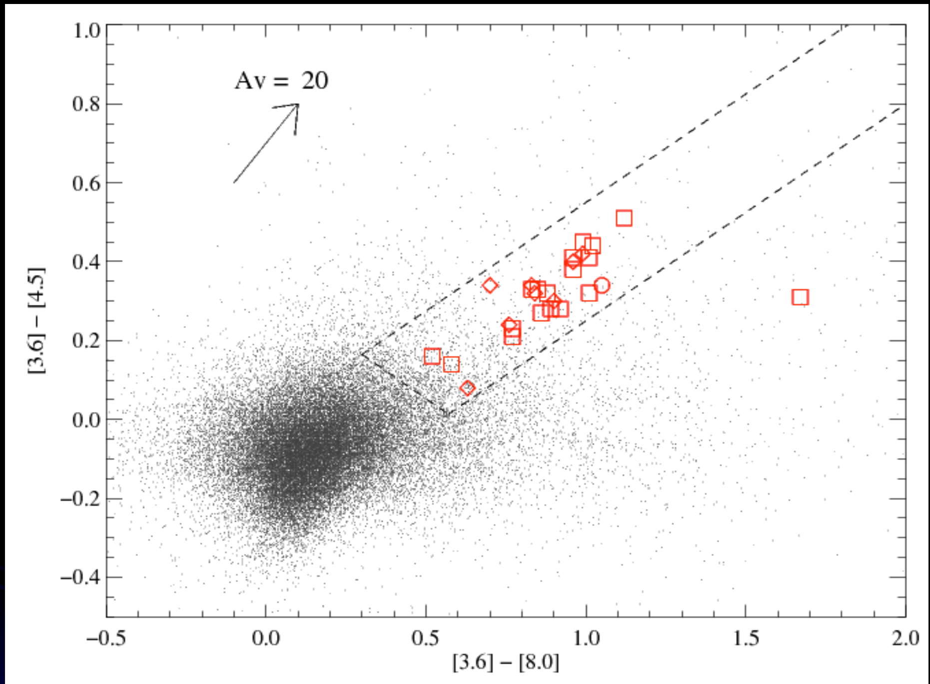
- WR stars exhibit free-free emission characteristic of a stellar wind

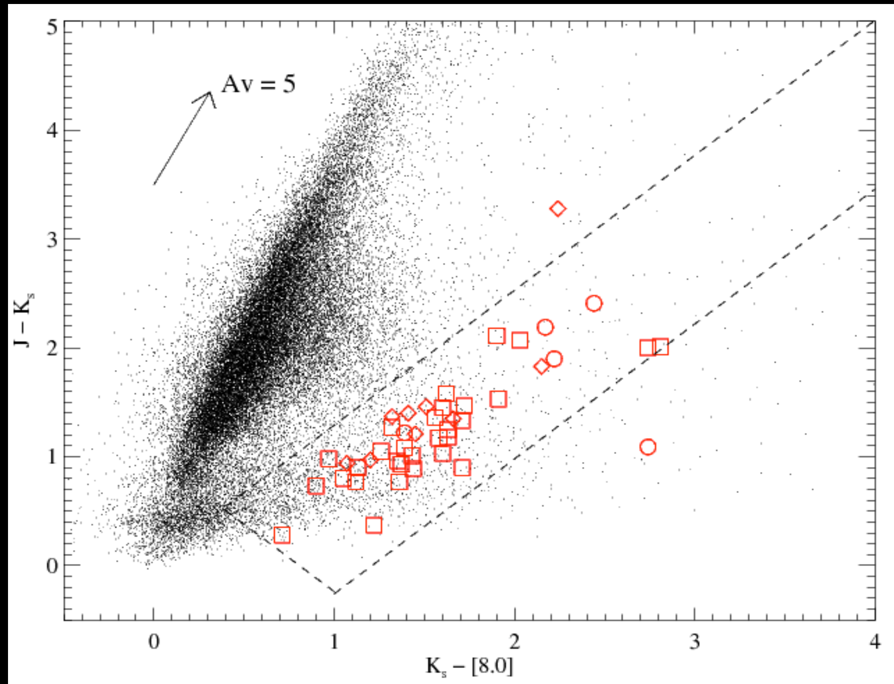
  => WR stars display an IR excess relative to 'normal' stars

Can we detect this IR excess using broad-band colours?

- Williams & Antonopoulou (1981) showed that it is possible to distinguish WR stars via their broad-band near-IR colours <u>but</u> there is a significant overlap with may other stellar types (i.e. YSOs)
- Van Dyk et al (2006) took this one step further and used a combination of near- (2MASS) and mid-IR (*MSX)* colours to identify candidate WR stars, this led to the discovery of a new WR star
- Here, we have combined the results of 2MASS and *Spitzer* GLIMPSE surveys to identify WR candidates within the Galactic plane.

A broad-band survey





- IR colour-colour diagrams for a 1°x 1° degree slice of the galactic plane centred on l=312°. Previously reported WR stars (open symbols) clearly separate from the general stellar locus (points). WN stars are denoted by squares and WC and WC9d stars correspond to diamonds and circles, respectively. The dashed line indicates the colour-space used to select targets for spectroscopic follow-up.

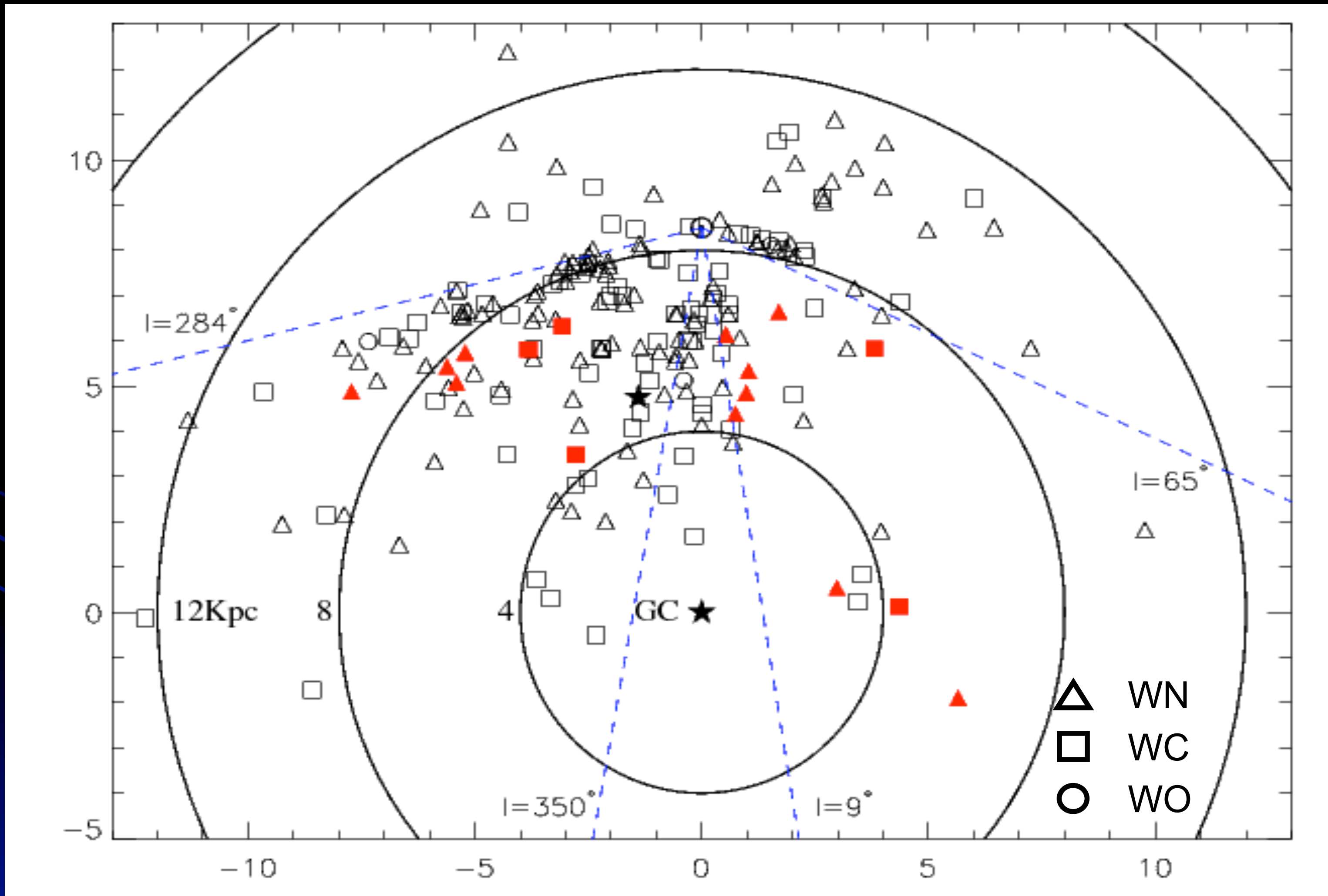
Results: 15 New WR Stars

- Final WR candidate list contained ~5000 stars, 184 of which have been spectroscopically observed
- 15 stars were confirmed as bona-fide WR stars
- 11 WN + 4 WC Stars

  => not biased towards a specific WR subtype
- Some WC stars have unresolved circumstellar dust shells, these stars have large IR excess

  => none of the WC stars identified are dusty
- 75% of the non-WR detections showed leading H transitions (Hα, Hβ, Pβ, Brγ) consistent with OB hypergiants and supergiants
- 40 objects displayed rich emission line spectra (H, HeI, [FeII]) consistent with Be/B[e] stars

Galactic WR Distribution



Summary

- WR stars exhibit unique emission line spectra which allows them to be easily detected via narrow-band imaging surveys
- Our recent study has demonstrated that it is possible to distinguish WR stars via a combination of near- (2MASS) and mid-IR (GLIMPSE) colours
- Using the observed colours of the known Galactic WR stars as a 'training set' we have identified ~5000 candidate WR stars in the Galaxy
- Spectroscopic follow-up of 184 candidates has led to the identification of 15 new WR stars (11WN and 4WC stars)
- The majority of the new WR stars have $R_G < R_{sun}$, suggesting that our survey is sensitive to nearby, heavily obscured regions of the Galaxy rather than more distant WR stars