

Analyses of Wolf-Rayet Stars in Local Group Galaxies

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Abstract. We have started a project to observe and analyze Wolf-Rayet stars in the galaxies of the Local Group. The first observing run was marred with disastrous weather and therefore, we do not yet have any results to report. Instead, we briefly summarize the motivation of our project.

1. Introduction

Wolf-Rayet (WR) stars are the (mostly) helium burning descendants of the most massive stars, identified by their broad emission line features. There is currently no theory that adequately predicts the structure and properties of their very strong winds and high mass loss; the dependence of the WR wind properties on metallicity is not well understood either. Observationally, it is known that the equivalent widths and FWHMs of emission lines in the spectra of WR stars exhibit a clear metallicity dependence (Massey 1996). However, further progress in understanding the role metallicity plays in stellar winds has been hampered by the fact that there have so far been only a few WR stars located in non-solar environments for which the stellar parameters have been determined. To date, only a handful of WR stars in the LMC have been analyzed in detail for their stellar parameters (Koesterke et al. 1991; Crowther & Smith 1997; de Koter et al. 1997); even fewer stars have been analyzed beyond the Magellanic Clouds (Smith et al. 1995).

2. Spectroscopic Analyses

Five observational quantities are needed for the spectroscopic analysis of a WR star: a He I line strength, a He II line strength, the line strength of a He II/H I line blend, the continuum flux, and the wind terminal velocity, i.e. the line widths. These yield the stellar parameters and the H to He abundance ratio. In addition, for each abundance to be determined – carbon, nitrogen – a line of the main ionization stage of that element needs to be analyzed.

Usually, the most difficult aspect of the observation is to obtain an unblended He I line. The He I 10830 Å line is particularly useful because this is

the strongest He I line in a WR spectrum and it is relatively isolated, i.e. it is essentially free from blends with other emission lines.

3. Observations

The first step in our project is to obtain equivalent widths of the important He I $\lambda 10830$ using narrow band filter measurements. We had observing time allocated from 2nd to 6th of September 1998 at ESO's NTT with SOFI. Unfortunately, during this period there was extremely bad weather so that we had in total only three hours of observing time and during this time the seeing was worse than 1". We hope that we will have more luck with our next observing run but obviously, for these proceedings we do not have any results to present.

4. Motivation

- Why observe extragalactic WR stars? – It is known that the spectral characteristics of WR stars vary with metallicity. We need to understand these variations by investigating how the physical properties and stellar parameters of these stars (i.e. luminosity, temperature, and mass-loss rate) vary with metallicity. The results will provide insight into the theory of mass-loss in WR winds.
- Why analyze WR stars in young clusters? – We are of the opinion that the most luminous young clusters in the Local Group galaxies are mini-versions of more distant starburst regions. We put forward the hypothesis that the WR stars in starbursts are responsible for delivering nitrogen to the local ISM. The determination of the stellar properties, and in particular of the nitrogen mass loss fraction, will allow us to test this hypothesis.

References

- Crowther, P.A., Smith, L.J. 1997, A&A, 320, 500
 de Koter, A., Heap, S.R., Hubeny, I. 1997, ApJ, 477, 792
 Koesterke, L., Hamann, W.-R., Schmutz, W., Wessolowski, U. 1991, A&A, 248, 166
 Massey, P. 1996, in: 33rd Liège Intern. Astrophys. Col., p. 361
 Smith, L.J., Crowther, P.A., Willis, A.J. 1995, A&A, 302, 830

Discussion

Armandroff: Have you considered extending your interesting study to lower metallicity galaxies like IC 1613 or IC 10?

Schmutz: Yes, we did. Both galaxies are interesting because of their low metallicity. However, there are no large compact clusters in these galaxies that contain

WR stars.

Maeder: When you say you want to determine the amount of nitrogen injected by WR stars, do you have in mind the search for a source of primary nitrogen?

Schmutz: So far we have not thought there could be primary nitrogen so we are considering secondary nitrogen, i.e. CNO processed Carbon and Oxygen.