Using Gemini poor-weather time to search for binary systems among faint Galactic WN stars

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Motivation

Wolf-Rayet (WR) stars are massive, hot and luminous objects.

They have intense, dense and hot stellar wind.

They are among the objects with the most extreme mass loss rates.

These dense stellar winds are responsible of their spectral characteristic; i.e. they are dominated by strong emission lines: Hydrogen, Carbon, Nitrogen and Oxygen.

WR stars are thought as O-type evolutive descendants.

Also, WR stars can be formed as a result of mass transfer in binary systems.

Motivation

Observational works dedicated to the study of multiplicity among massive stars, e.g. Barbá et al. (2010), Sana et al. (2013), and many references there in, provide evidence that the fraction of O+OB systems is high, greater than 50%. **This situation is not completely replicated by the available data for WR stars.**

There are about 50 binary systems detected among the galactic WR stars (less than the 10% of the known whole sample), and only 24 of them are known double-lined spectroscopic systems (SB2).

SB2 are key objects because they allow to determine some fundamental astrophysical parameters. Moreover, if they are eclipsing ones, the stellar mass and radius can be calculated in a direct and reliable way, and thus provide strong constraints on stellar physics and evolution models.

In this context, the discovery of such systems is highly relevant.

The project

In an attempt to search for new binary systems among faint WR stars, a spectroscopic monitoring of Southern Galactic WR stars is being carried out.

This survey started in 2007 and its main objectives are:

* Determine their degree of multiplicity

* In the discovered systems, to determine their orbital elements

* Refine their spectral classification

* Study of the available photometry

Sample selection

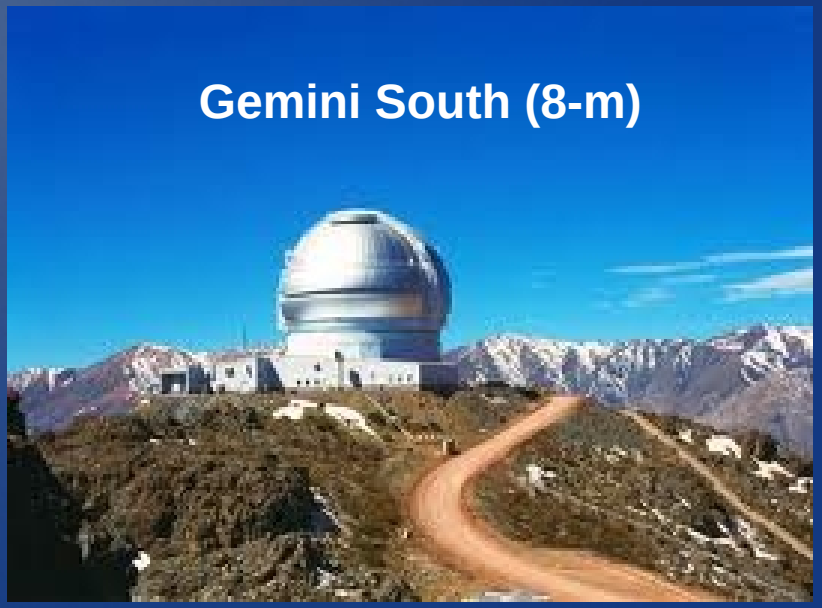
The objects were taken from the VIIth Catalog of Galactic WR stars, (van der Hucht 2001) and its update (2006). Such objects satisfy the conditions:

* observable from the Southern Hemisphere and fainter than magnitude V = 12

* spectral type WN

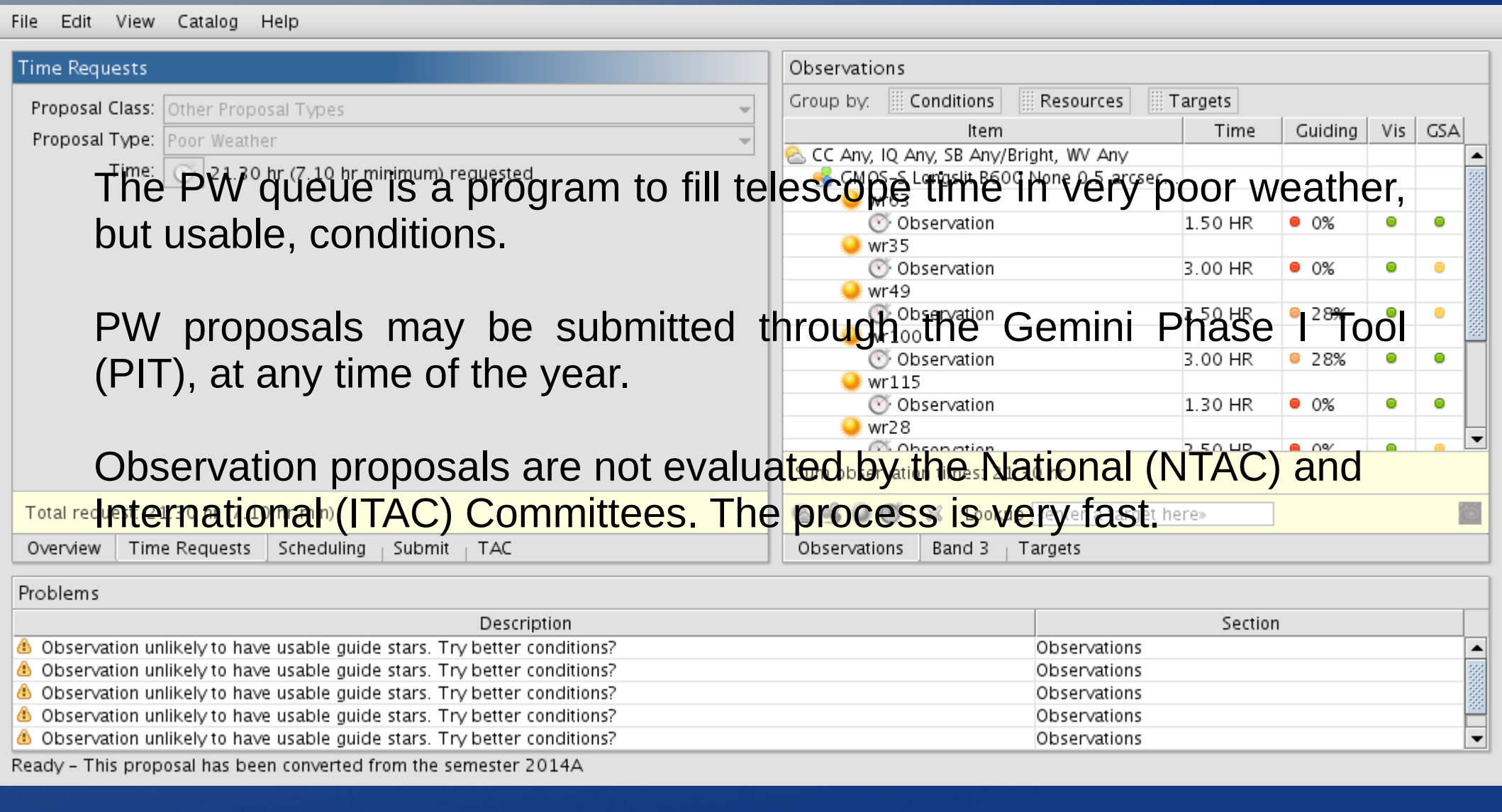
* to have not previous studies of radial velocity

Observations



Observations

In 2012, we decided to use the possibility of asking for poor-weather (PW) time at Gemini to observe some "candidates".



The PW queue is a program to fill telescope time in very poor weather, but usable, conditions.

PW proposals may be submitted through the Gemini Phase I Tool (PIT), at any time of the year.

Observation proposals are not evaluated by the National (NTAC) and International (ITAC) Committees. The process is very fast.

Time spent on these programs will not be charged to the partner countries.

It can be added notes, to the OT, about scheduling, or re-estimating the exposure times according to weather conditions (there is a wide range of observing conditions to be considered PW).

The observations are waiting for "bad weather" and they will be executed only when nothing in the regular queue is observable (even now, we have a PW proposal active since 2014A to observe 9 WRs. Once the observation is executed, it is "cloned", so it can be repeated at any time.)

A PW program is ideal for our project because it involves the "deliberate" observation of “bright for Gemini” stars.

We obtained the PW proposals GS-2012B-Q-94 (12.5h; 87%), GS-2013A-Q-97 (54.6h; 100%), GS-2014A-Q-94 (21.3h; 99%) !!!

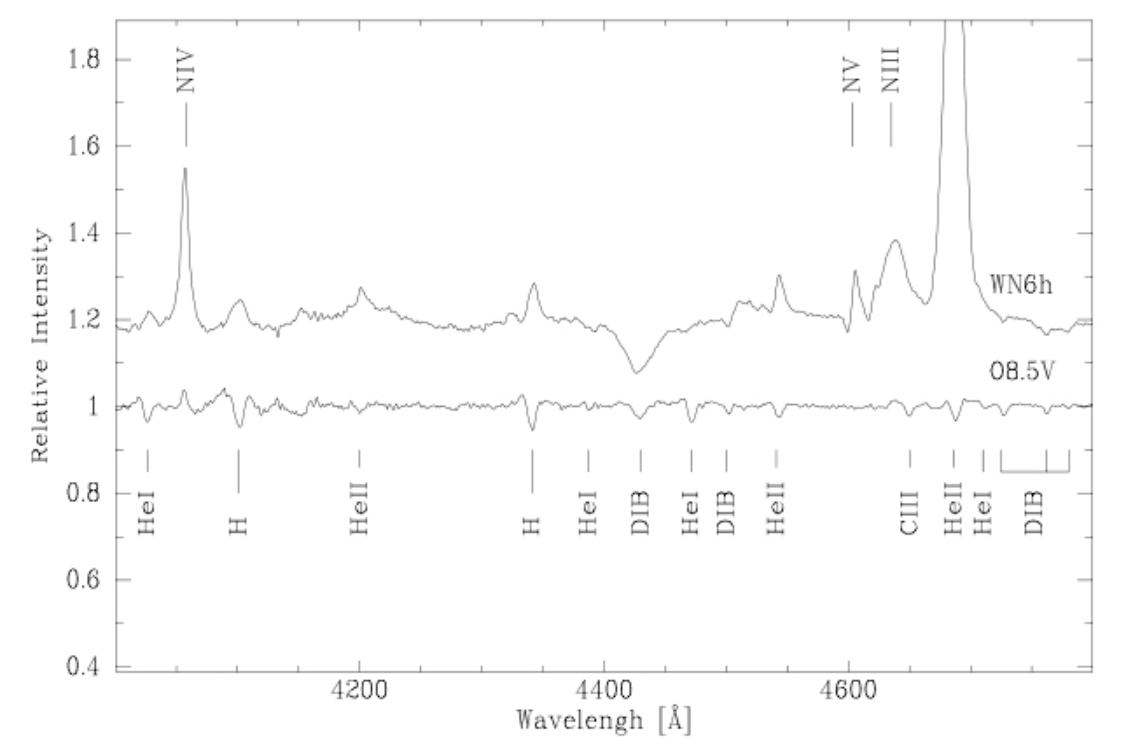
A total of ~150 spectra.

The new spectra allowed us to confirm preliminary periodicities; to improve some orbital parameters; and to measure absorption lines belonging to the O-type companion in a binary (very noisy in previous spectra).

Results: The double-lined system WR 35a

Discovered by Shara et al. (1991). V ~ 14

Spectral type: WN6h, Smith et al. (1999)



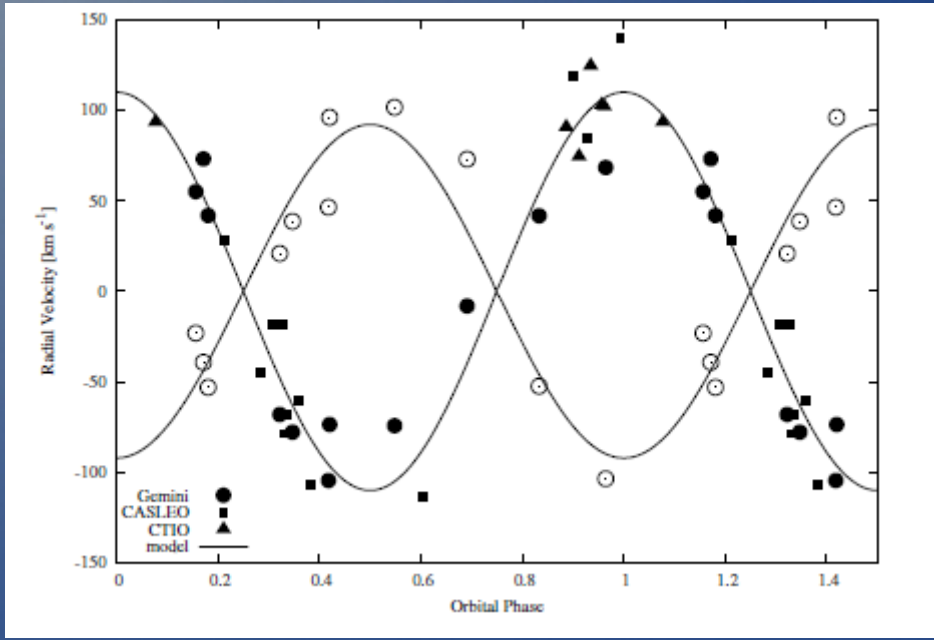
Spectral Type: WN6h + O8.5V

R. Gamen, A. Collado, R. Barbá, A.-N. Chené , and N. St-Louis 2014, A&A 562, A13

- 29 spectra, between 1998 and 2013 (CASLEO, CTIO, Gemini)

- P = 41.989 ± 0.009d

- Minimum masses, WN = 15 M_{Θ} , O = 16M_{Θ}



HeII λ4686 representing the WN motion and absorption lines, the O 8.5 V

R. Gamen, A. Collado, R. Barbá, A.-N. Chené , and N. St-Louis 2014, A&A 562, A13

Results: The Single-lined binary system WR44

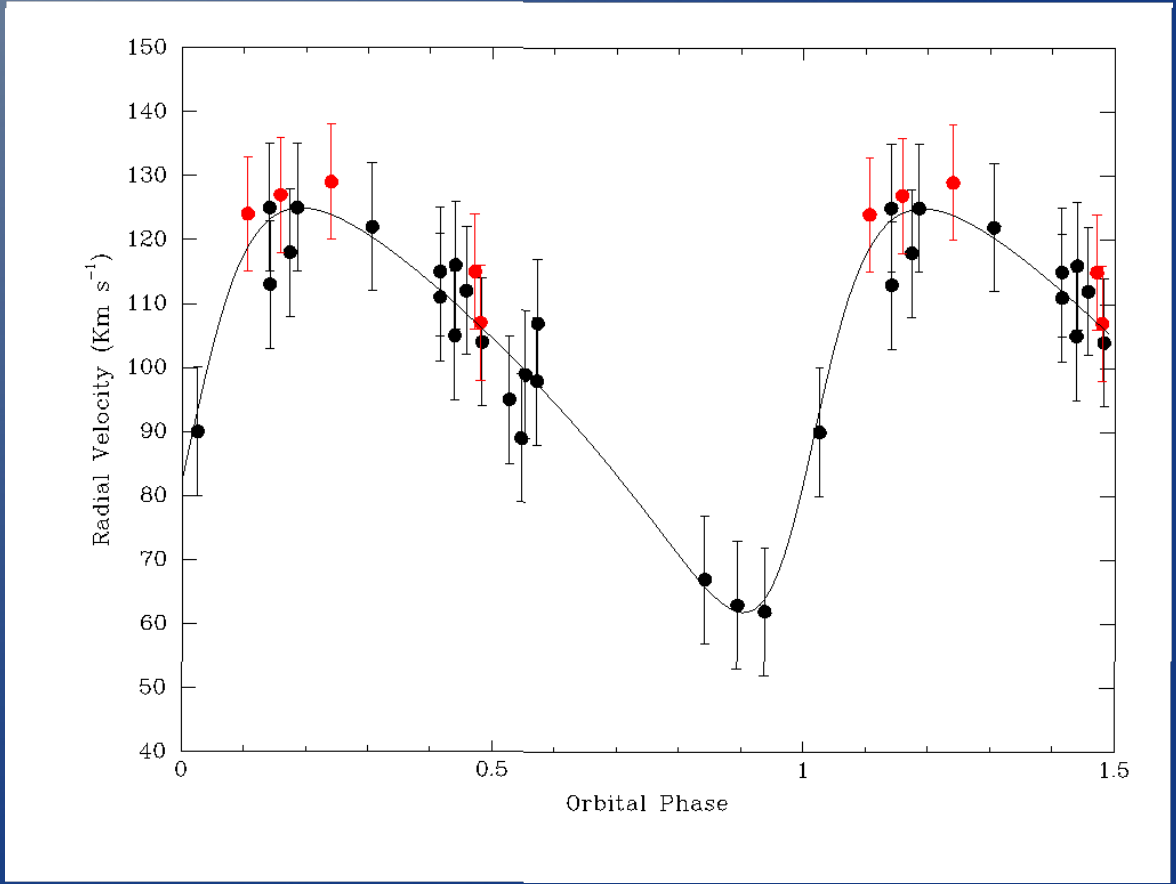
- Included as “WN4 + OB?” in VIIth Catalog of Galactic WR stars, based on dilution of the emission lines.

- Spectral type: WN6

- 25 spectra, between 2007 and 2014 (CASLEO, CTIO, Gemini)

- RV > 100 km/s (HeII λ4686)

- P = 22.704 ± 0.03 d



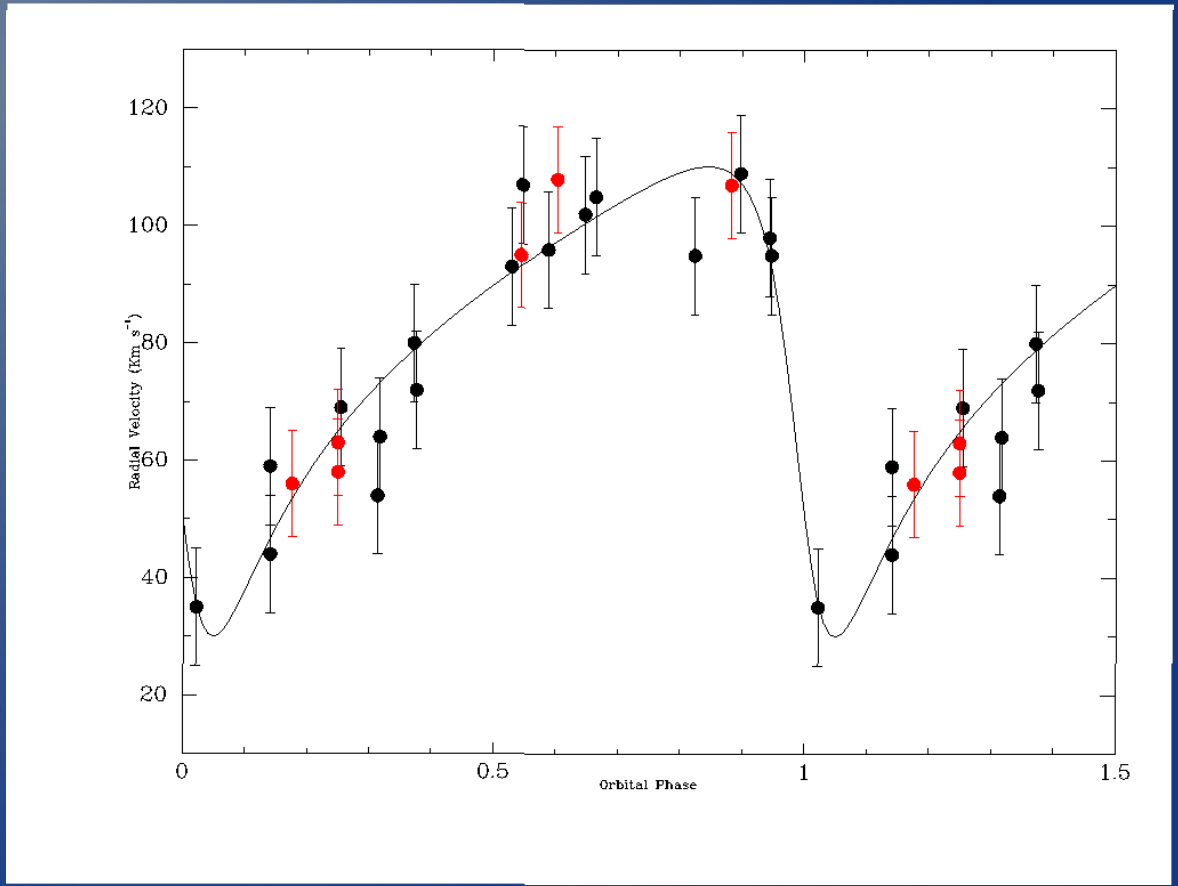
WR 49

- Spectral type: WN5(h) Smith et al. (1996) → WN5(h)

- 23 spectra, between 2007 and 2014 (CASLEO, CTIO, Gemini)

- RV > 70 km/s (HeII λ4686)

- P = 17.001 ± 0.003 d



WR 35

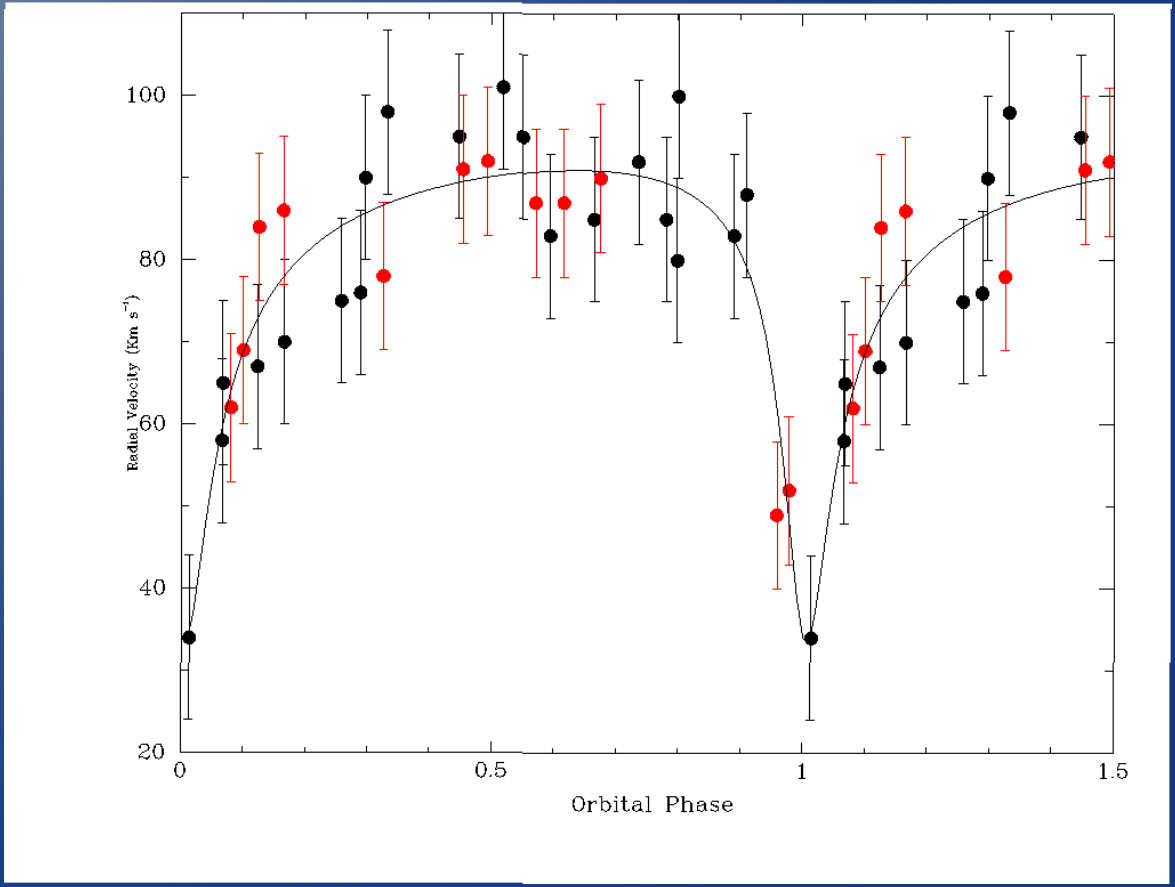
- Included as “WN6h + OB?” in VIIth Catalog of Galactic WR stars, based on dilution of the emission lines.

- Spectral type: WN6(h)

- 32 spectra, between 2002 and 2014 (CASLEO, CTIO, Gemini)

- RV = 85 km/s (HeII λ4686)

- P = 8.1610 ± 0.0004 d



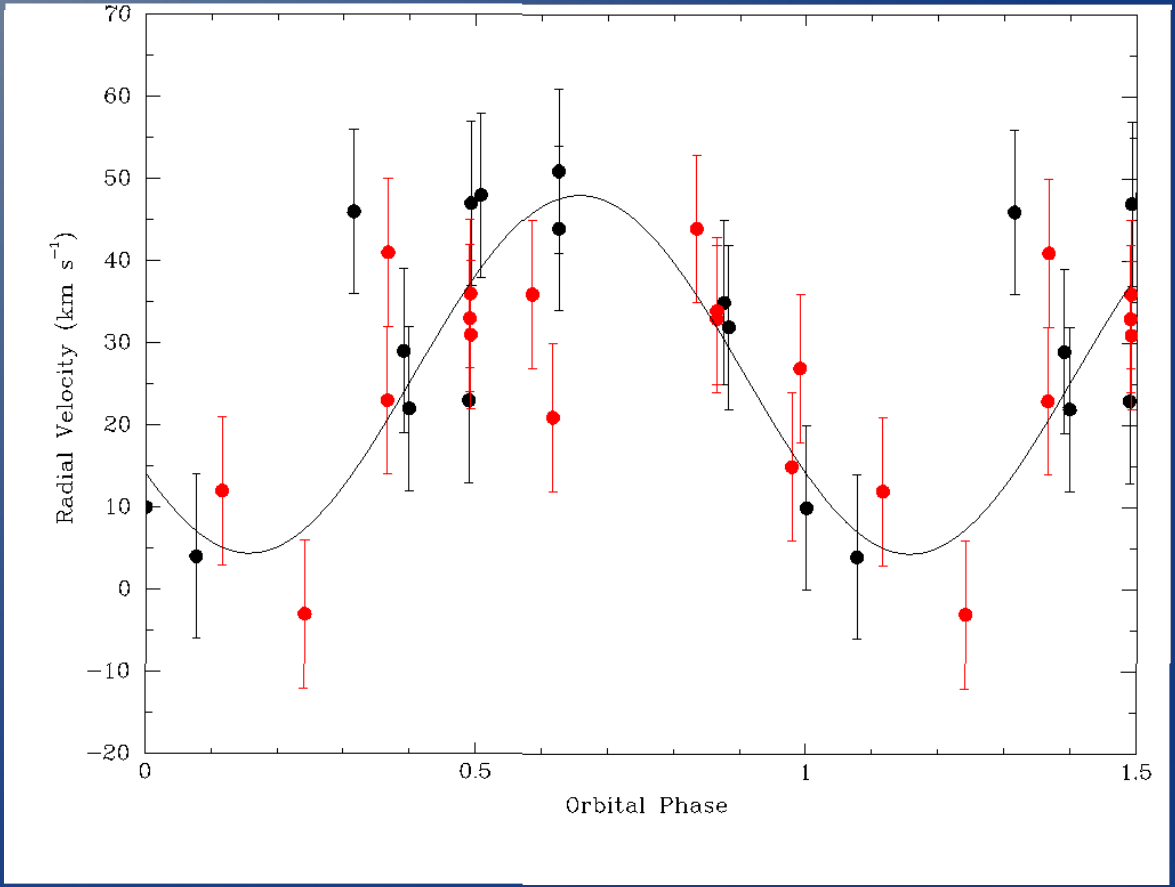
WR 83

- Spectral type: WN5, Smith et al. 1996 → WN6

- 27 spectra, between 2004 and 2014 (CASLEO, CTIO, Gemini)

- RV > 50 km/s (HeII λ4686)

- P = 8.0029 ± 0.0008 d



Summary

We are carrying out a spectroscopic monitoring of Galactic Wolf-Rayet stars using CASLEO, CTIO, and LCO, **but also taking advantage of Gemini poor weather.**

We obtained about 80 hours of observations since 2012B (~150 spectra).

Gemini PW allows us to improve the sampling of data. Classical runs, e.g. on CASLEO, imply only one epoch by semester.

We discovered 9 new binary systems: 3 SB2 and 6 SB1. Also, 15 radial-velocity variables whose periodicity was not found yet.

I would like to thank the Gemini Office in Argentina and Gemini Observatory for providing a way for me to be here.

Also, I would like to thank the scientific committee for allowing me to present this work.