

# The status of the photometric and spectroscopic observations of Be stars

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## Bright Be stars in the fields of COROT

- ✓ 87 Be stars ( $V < 9.4$ ) in the cones of Corot including new Be stars discovered with the GAUDI database (Neiner, Hubert, Catala 2005)
- ✓ Among them, 18 secondary target candidates

# Spectroscopic data

- ✓  $V < 8$ : Spectra in the GAUDI database
- ✓  $8 < V < 9.4$ : Spectra from ESO (FEROS)  
Brazilian time; LNA , 1.6 m tel.+OPD  
CASS; OHP, 1.52 m-tel.+Aurelie
- ✓ Missing spectra for 23 stars

# Spectroscopic analysis

- ✓ Determination of **fundamental parameters** taking into account **fast rotation** and **veiling** for 64 Be stars (among the 87 ones in the cones of COROT) (*Frémat, Neiner, Hubert et al. 2005, A&A in press*)
- ✓ Search for **spectroscopic** variability (LNA + OHP+ multisite) for the most interesting brighter objects
- ✓ Search for **magnetic fields** (EsPaDoNS + NARVAL), to be done

✓ From modeling of different spectral domains ☹  $T_{\text{eff}}$ ,  $\log g$ ,  $V \sin i$  and  $i$  for a given  $\Omega/\Omega_c$

**Without** correction for rotational effects:

$$T_{\text{eff}} = 25450^\circ \pm 1000^\circ\text{K},$$

$$\log g = 3.87 \pm 0.10$$

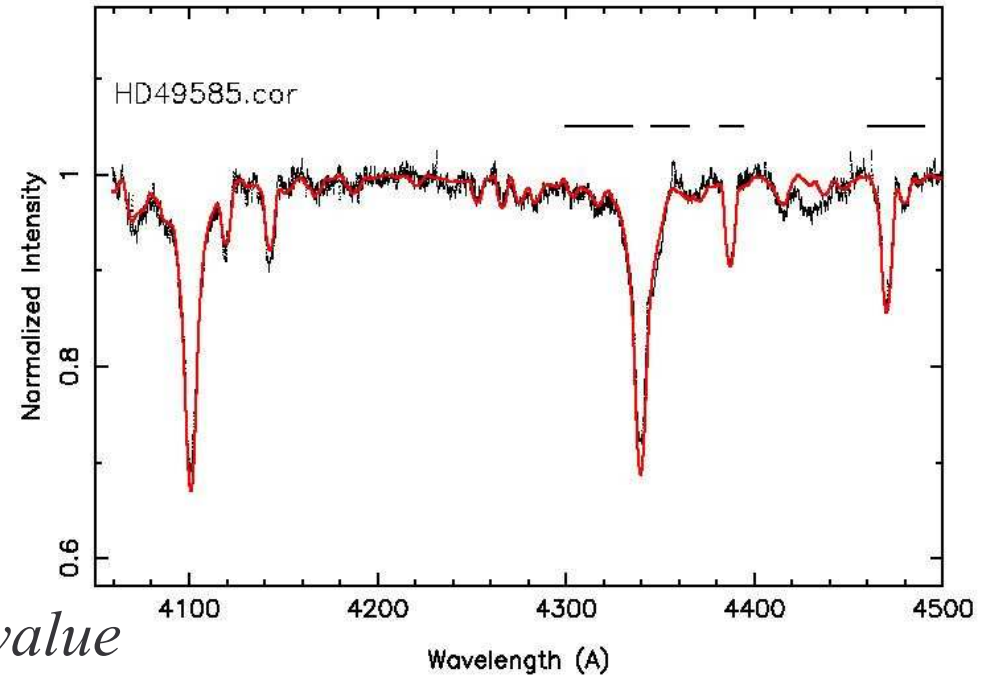
$$V \sin i = 310 \pm 30 \text{ km/s}$$

**With** corrections for  $\Omega/\Omega_c = 0.9$  (value adopted from Frémat, Zorec et al., 2005, *A&A in press*):

$$T_{\text{eff}} = 26000^\circ \pm 1000^\circ\text{K},$$

$$\log g = 4.10 \pm 0.10$$

$$V \sin i = 325 \pm 30 \text{ km/s}, i \sim 60^\circ$$



## Apparent fundamental parameters and revised spectral types of Be stars

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ID	SIMBAD		(Frémat et al. 2005)			
HD	V	Sp. Type	$T_{\text{eff}}$	log g	$V \sin i$	Sp. Type
42406	8.01	B9	15000±1000	3.72±0.10	300±25	B4IVe
43264	7.51	B9	10500±1000	2.76±0.10	288±10	B9IIIe
43285	6.05	B6Ve	14000±1000	3.78±0.10	260±20	B5IVe
44783	6.23	B8Ve	11000±1000	3.05±0.15	226±50	B9IIIe
45901	8.87	B2Ve	26500±2000	3.73±0.15	164±15	B0.5IVe

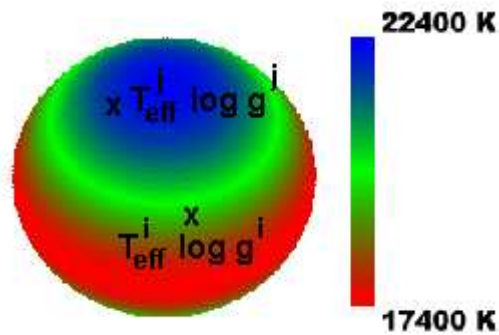
*A complete version of the table is available at the CDS*

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Fundamental parameters of Be stars after correction for different values of  $\Omega/\Omega_c$

HD	$\Omega/\Omega_c=0.80$			$\Omega/\Omega_c=0.90$			$\Omega/\Omega_c=0.95$		
	$T_{\text{eff}}$	$\log g$	$V \sin i$	$T_{\text{eff}}$	$\log g$	$V \sin i$	$T_{\text{eff}}$	$\log g$	$V \sin i$
43285	15000	4.03	266	15000	3.99	274	15000	3.93	292
44783	12000	3.37	226	12000	3.40	227	11500	3.13	231
45901	27000	3.78	171	27000	3.79	173	27500	3.84	175
46380	23500	3.91	306	23500	3.92	310	23500	3.94	315
46484	27500	3.69	127	26500	3.61	130	29000	3.81	128

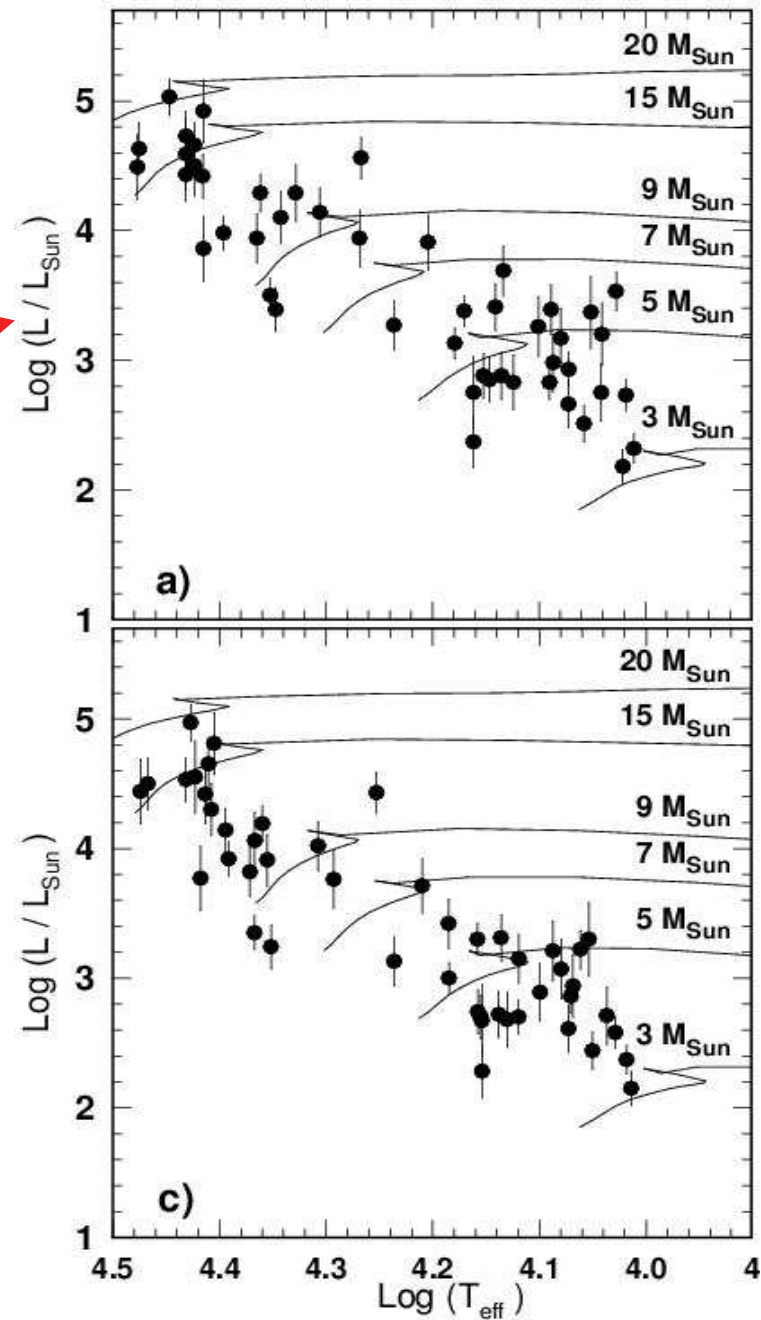
*A complete version of the table is available at the CDS*



Location of Be stars in the HR diagram

Without correction for rotational effects

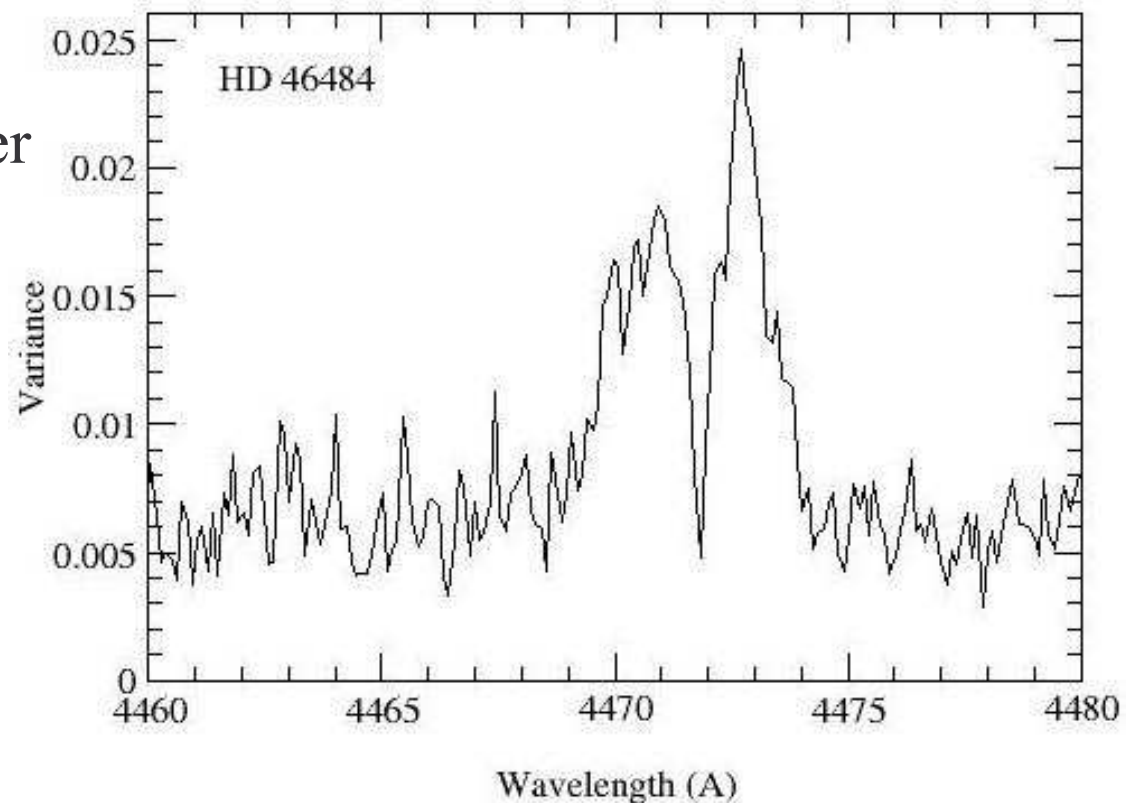
With corrections for  $\Omega/\Omega_c=0.9$



## Search for spectroscopic variability

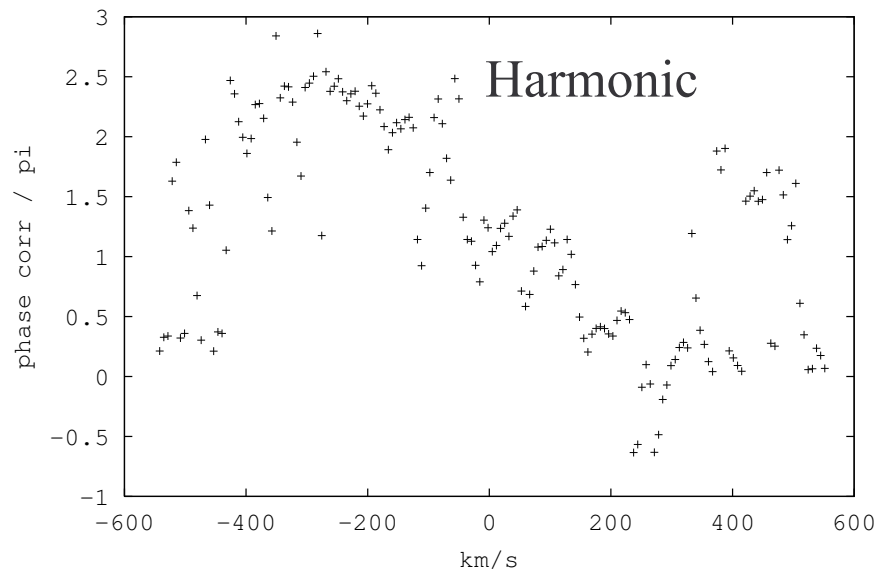
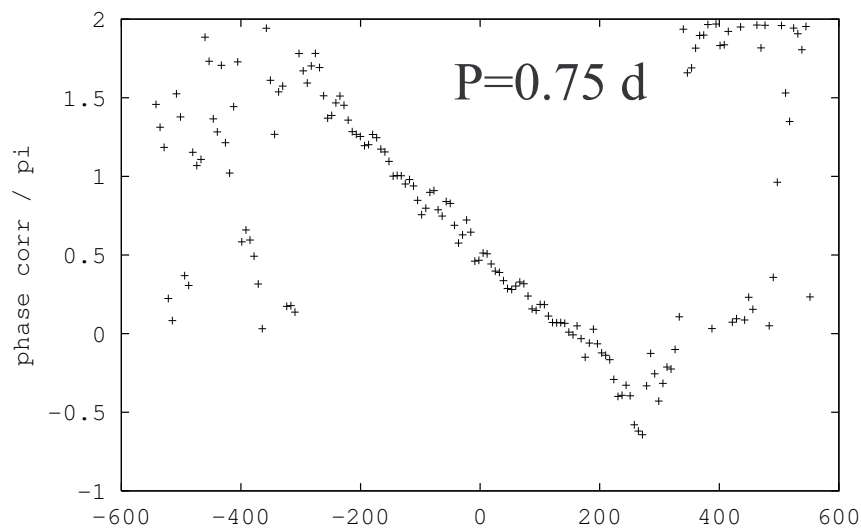
OHP, T\_1.52m+Aurelie: Study of the variance in some strong photospheric lines

But insufficient number of spectra for  $l$  and  $m$  determination by modelisation of line profiles

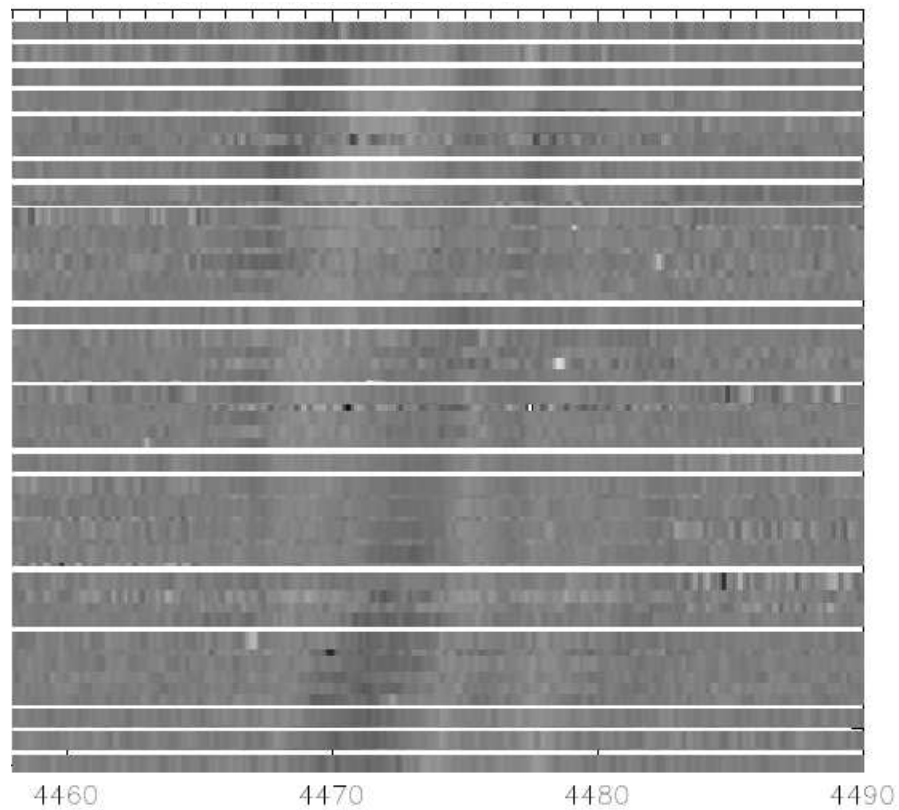


# NW Ser: a candidate for **short runs**

DDO, Toronto, 1.88m



$l=2$   
 $|m|=1$  !!!



# Current status and strategy for spectroscopy

- ✓ Spectra for determination of fundamental parameters are still missing for 23 stars but observations in progress on Brazilian time (J. Renan de Medeiros)
- ✓ temporal series for spectroscopic variability analysis of secondary targets candidates ( $l$  and  $m$  determination of pulsation mode) are missing.
- ✓ Large programme including selected Be stars is needed!

# Photometric data

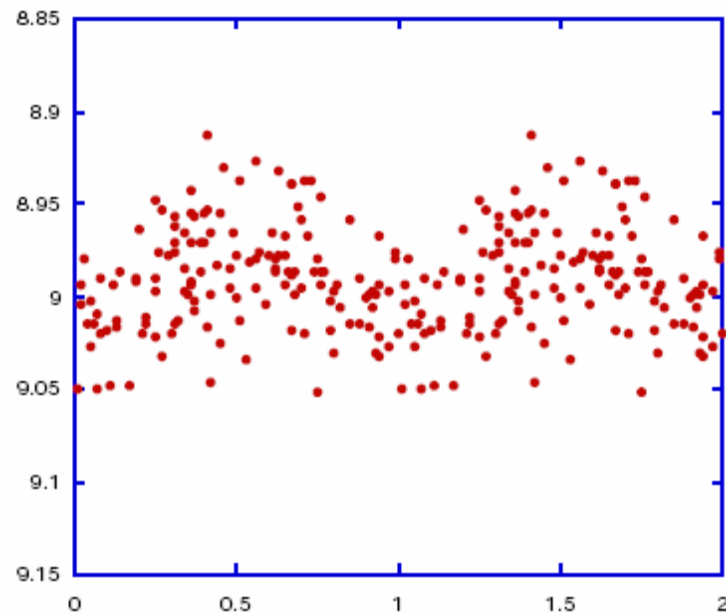
- ✓ Search for photometric variability for all the sample
- ✓ HIPPARCOS
- ✓ ASAS
- ✓ Search for photometric variability for secondary candidates:
- ✓ OSN-GRANADA

# Photometric data

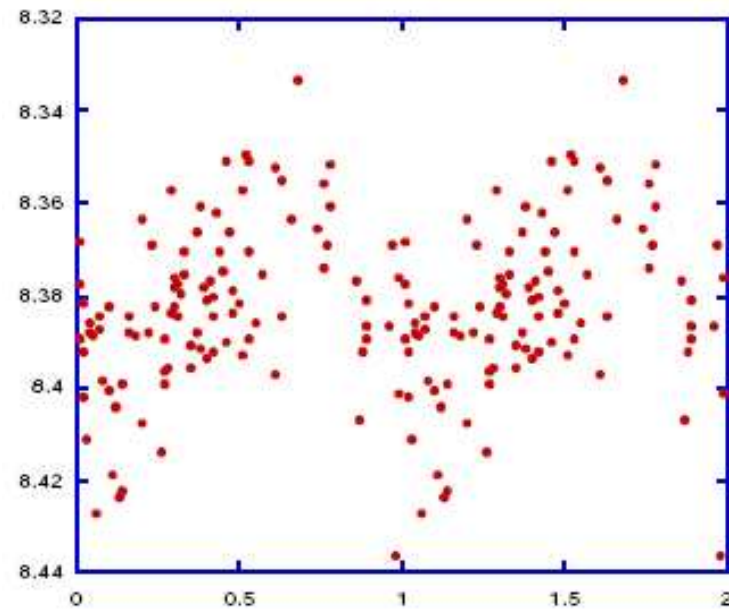
Search for variability and periods:

- ✓ **HIPPARCOS** : 10 Be stars with short periods  
19 others with evidence of variability

HD 49330



HD 50209



# Photometric data

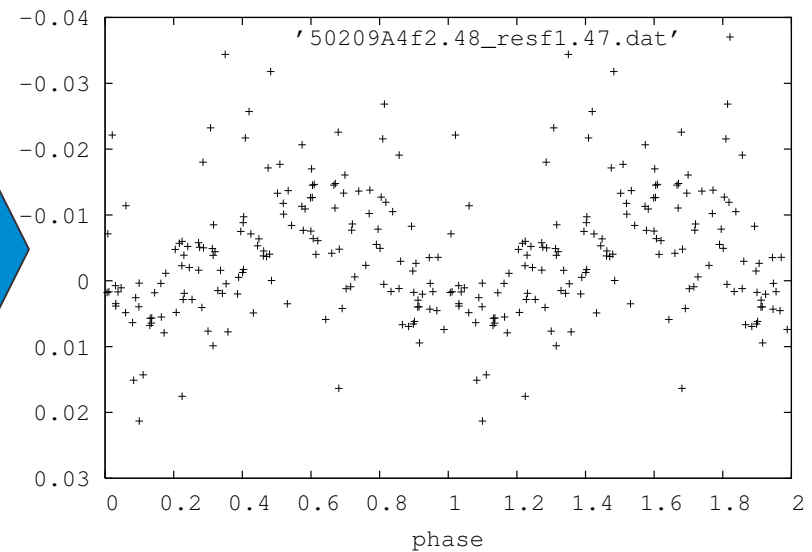
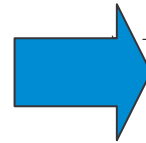
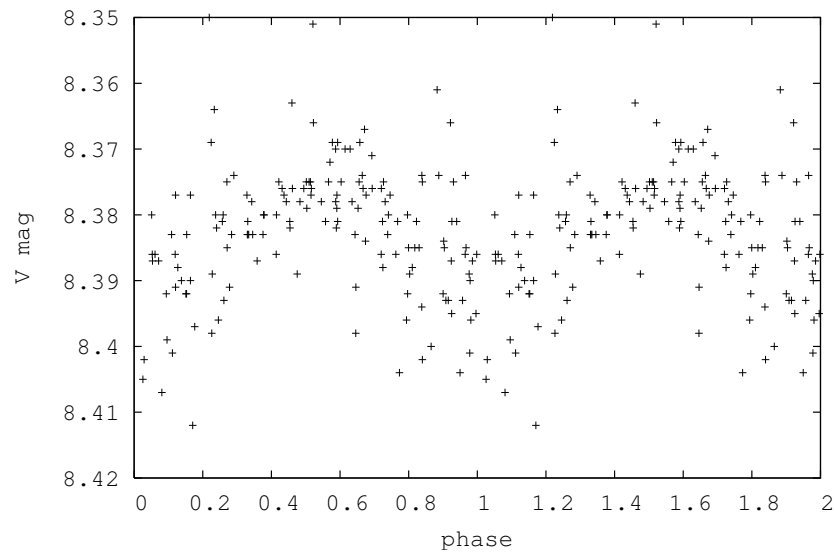
Search for variability and periods:

- ✓ **ASAS:** (Pojmanski, G. 2002, Acta Astron, 52, 397)  
7 periodic & 2 **Multiperiodic**

**Secondary Candidate**

**HD 50209** P=0.40d

P=0.68d



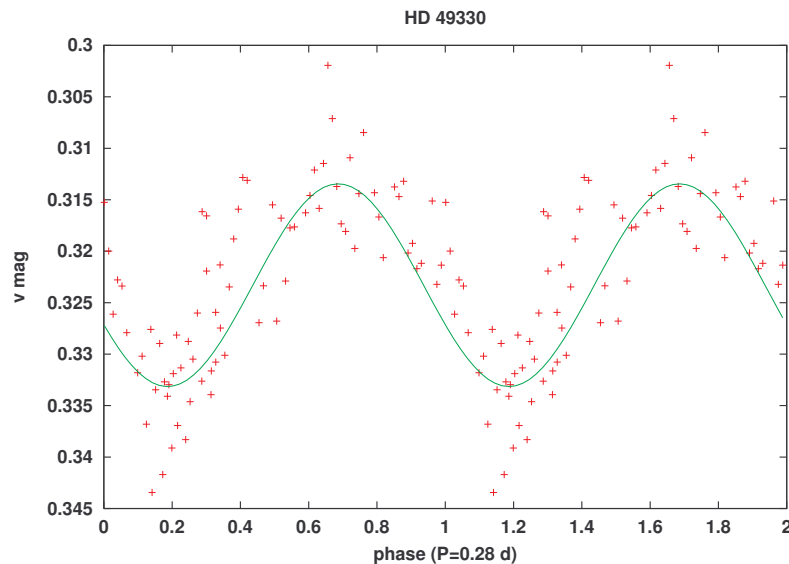
# Photometric data

Search for variability and periods:

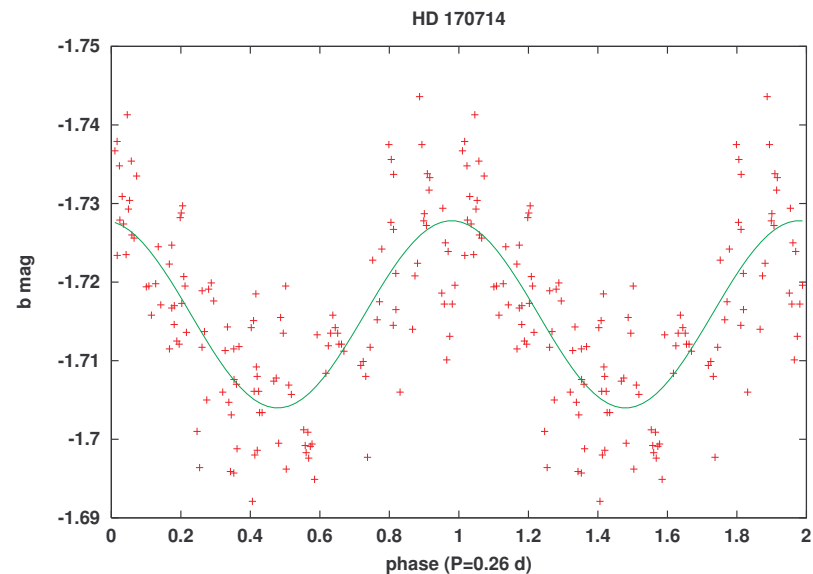
✓ **OSN-GRANADA:**

13 Be stars with short periods; among them 7 **secondary candidates** (*Gutiérrez-Soto et al. 2003*)

HD 49330



HD 170714



# Photometric data

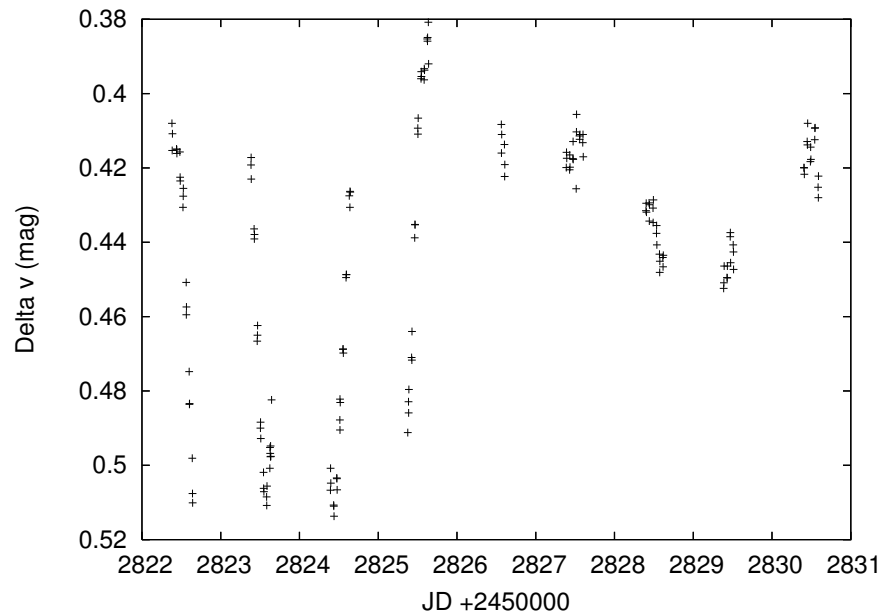
Search for variability and periods:

✓ **OSN-GRANADA**

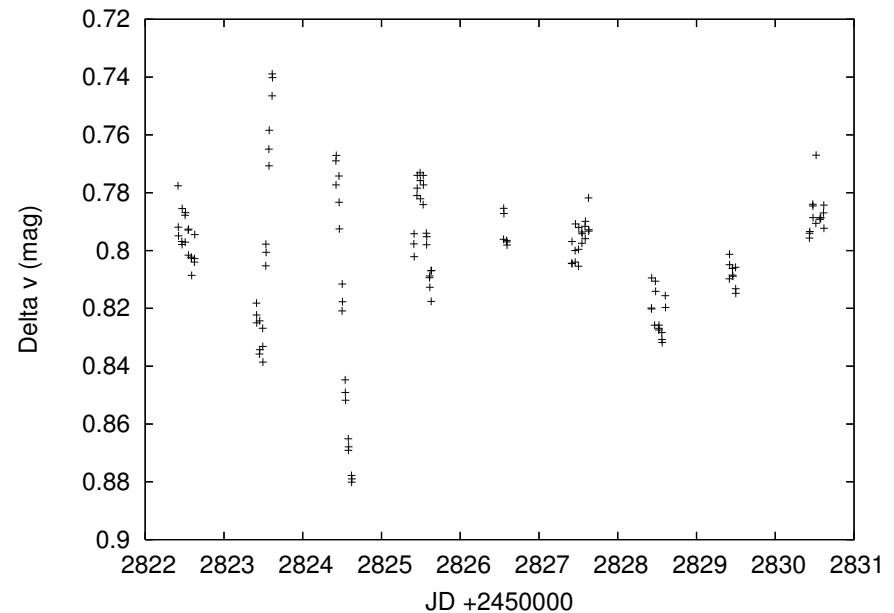
**Multiperiodicity** of NW Ser and V1446 Aql

(*Gutiérrez-Soto et al. 2005*), candidates for **short runs**

NW Ser



V1446 Aql



# Results for secondary candidates

## Centre

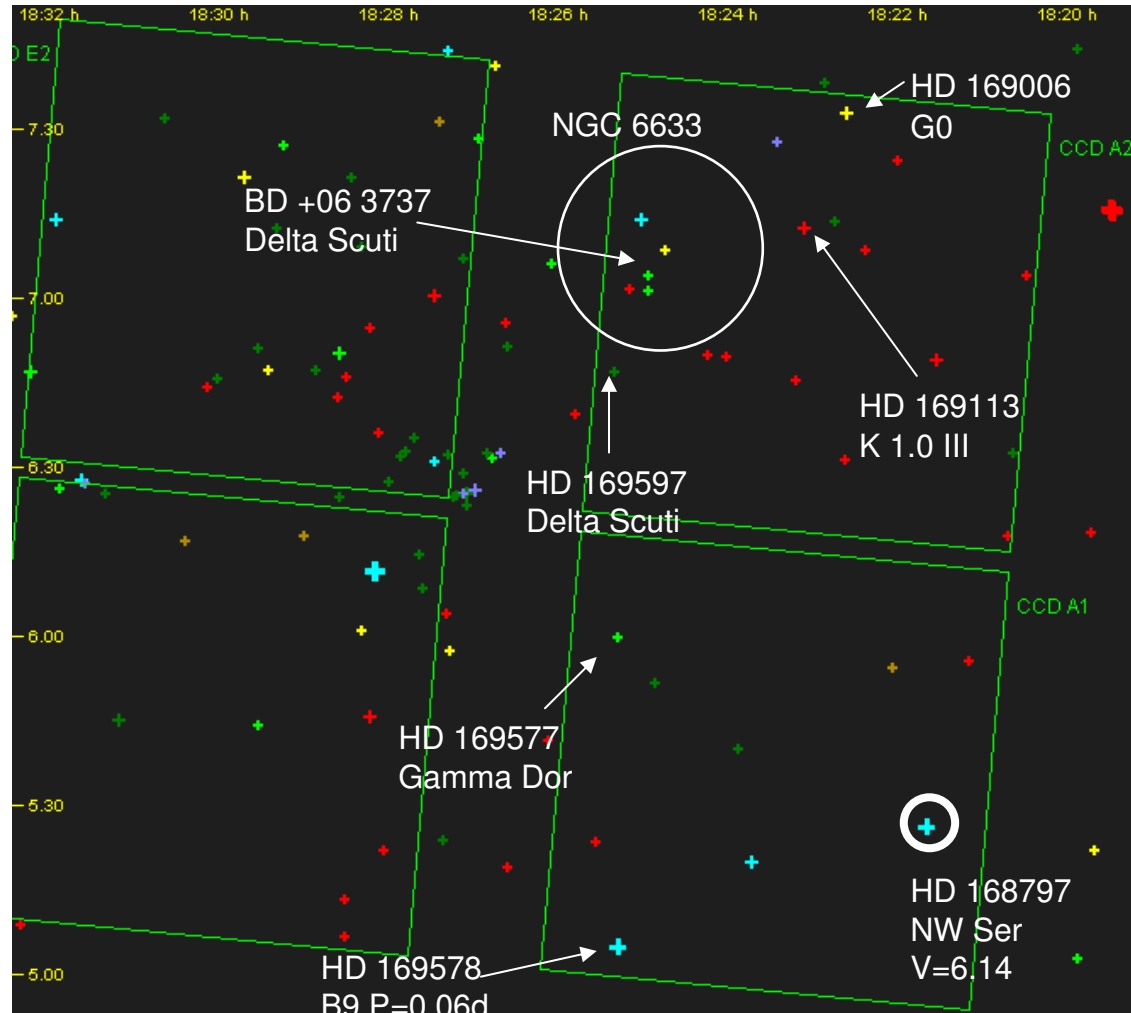
<b>Be target</b>	<b>Type</b>	<b>V</b>	<b>vsini</b>	<b>Var</b>	<b>Main target</b>
<b>HD 171219</b>	B5IIIe	7.65	300	no var	<b>HD 171234+170580</b>
<b>HD 171219</b>	B5IIIe	7.65	300	no var	<b>HD 171834</b>
HD 175869	B8IIIe	5.56	164		<b>HD 175726</b>
<b>HD 181231</b>	B5IVe	8.58	250	0.42 d	<b>HD 181555+180642</b>
<b>HD 181367</b>	B6IVe	9.36	279	no var	<b>HD 181555+180642</b>

# Anticentre


<b>Be target</b>	<b>Type</b>	<b>V</b>	<b>vsini</b>	<b>Variability</b>	<b>Main target</b>
HD 43285	B5IVe	6.07	260	0.46 d	<b>HD 43587</b>
HD 43913	A0e	7.88			<b>HD 43587</b>
HD 45901	B0.5IVe	8.8	164	1.82 / 0.14d	<b>HD 46558</b>
HD 46484	B1Ve	7.74	120	Spec	<b>HD 46558</b>
HD 47359	B0IVe	8.87	443		<b>HD 46558</b>
HD 49330	B0.5IVe	8.92	270	0.28 / 0.24 d	<b>49933+49434</b>
HD 49567	B3III	6.15	85	2.56 d	<b>49933+49434</b>
HD 49585	B0.5IVe	9.13	310	0.61 d	<b>49933+49434</b>
HD 50087	B8III	9.08		2.04 d	<b>49933+49434</b>
<b>HD 50209</b>	B8IVe	8.33	200	0.40 + 0.68 d	<b>49933+49434</b>
HD 50891	B0.5Ve	8.88	220	0.54 d	<b>HD 52265</b>
HD 51193	B1.5IVe	8.06	215	0.61 + 5.5 d	<b>HD 52265</b>
HD 51404	B1.5IVe	9.3	335	0.37 d	<b>HD 52265</b>
HD 51452	B0IVe	8.08	298	Spec	<b>HD 52265</b>

# NW Ser: a candidate for **short runs**

- ✓ Phot: 4 short periods
- ✓ Beta Cephei and SPB hybrid star candidate
- ✓ Spec: 1 confirmed period with  $l=2$  and  $|m|=1$



# Current status and strategy for photometry

- ✓ 21 periodic stars
- ✓ 4 multiperiodic stars  **Short runs**
- ✓ 15 from 18 **secondary candidates** well studied and 11 periodic.
- ✓ More observations are planned.
- ✓ Photometric observations in Granada in order to study the variability of Be stars in the short-run fields.

# Conclusions

- ✓ Spectral type and fundamental parameters of the majority of Be stars have been determined.
  - ✓ We have found **variability, periodicity and even multiperiodicity** in most of the Be stars, **in spectroscopy and in photometry**.
  - ✓ We need to prepare simultaneous spectroscopy of the Be stars which will be observed by COROT.
  - ✓ We need a large programme including selected Be stars!!
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- ✓ Title of next talk at 16:00 could be “The ESO Large programme on Beta Cep, Gamma Dor, Delta Sct **and Be stars**”