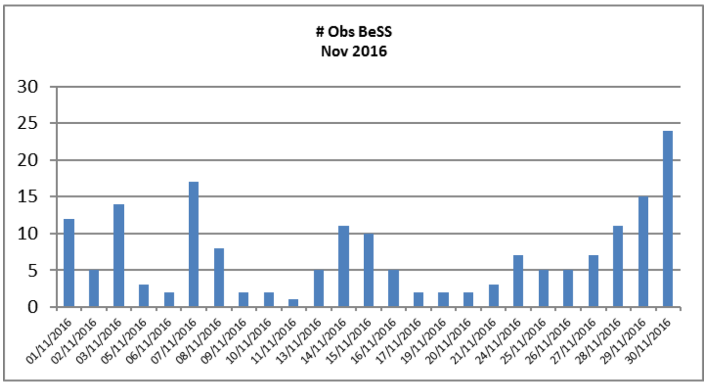
BeSS report – November 2016

Data compiled by Valérie Desnoux
Be projects section by Ernst Pollmann [here]()

Observateur	Nb spec
GARDE	27
Lester	23
Guarro Fló	21
de Bruin	17
Graham	17
Lemoult	16
Favaro	15
Sawicki	10
Daglen	7
GARREL	6
Wilson	4
Fosanelli	4
Pollmann	4
Lecocq	3
Desnoux	3
James	2
Heidemann	1

- 98 stars were observed
- 17 Observers contributed this month
- 180 Spectra H-alpha

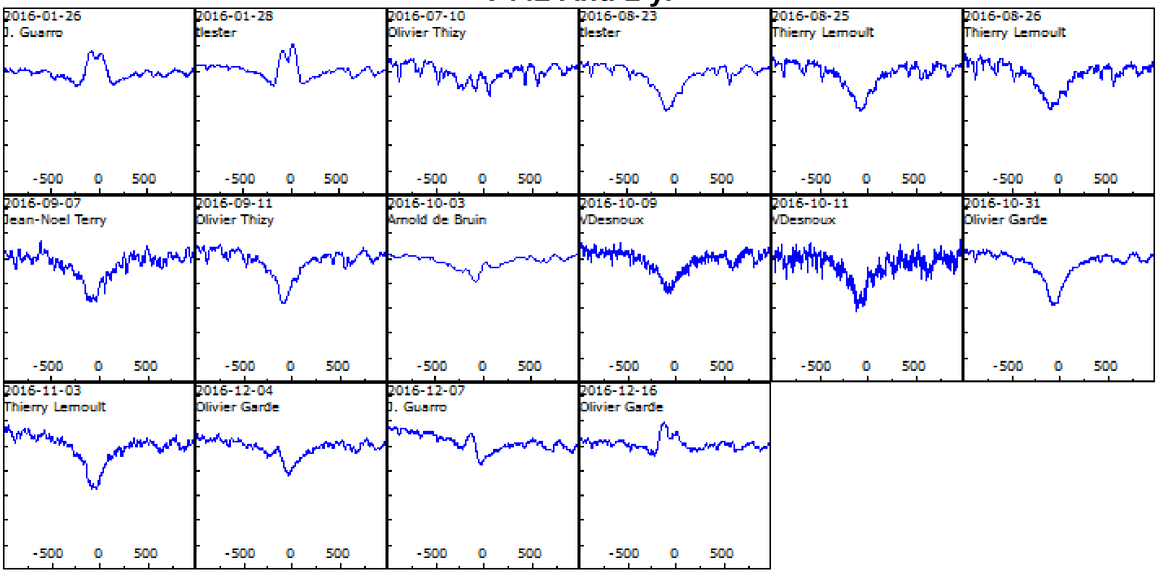


Objects observed

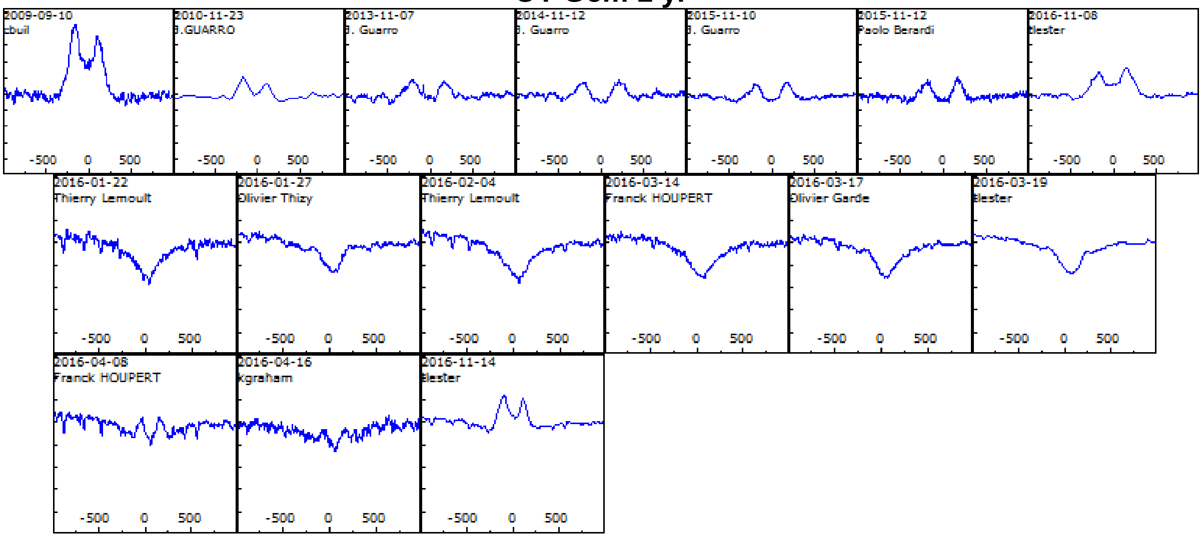
Classique							?	Herbig
gam Cas	phi And	ALFIRK	lam Eri	V2172 Cyg	V413 Aur	HD 195554		
zet Tau	V923 Aql	14 Lac	13 Tau	56 Eri	HD 21362	ELECTRA		
PLEIONE	25 Vul	V2136 Cyg	ALCYONE	V581 Per	HD 19993	KX And		
V442 And	28 Cyg	psi Per	eps Cap	HD 50209	HD 30677	KY And		
OT Gem	20 Vul	25 Peg	MEROPE	V728 Mon	HD 26398	25 Ori		
5 Cnc	iot Lyr	omi And	V782 Cas	HD 204185	V811 Cas	HD 208682		
bet CMi	NW Ser	eps Cas	HD 2789	HD 227611	HD 223044	bet Psc		
ome Ori	HD 224544	HD 193182	HD 192445	V409 Lac	V358 Per	31 Peg		
nu Gem	lam Cyg	V801 Cas	HD 13867	HD 228438	V447 Aur	omi Aqr		
IU Aur	18 And	phi Per	228 Eri	HD 35345	V1372 Ori	HD 196712		
QR Vul	EW Lac	10 Cas	eta Ori	HD 213088	69 Ori	2 Cet		
CX Dra	pi Aqr	16 Peg	V1369 Ori	AX Mon	HD 27846	V1150 Tau		
2 Ori	Menkhib	HD 212666	V2135 Cyg	HD 38856	V1374 Ori	V696 Mon		
HD 4931	HD 223387	V810 Cas	HD 217061	V351 Per	V404 Lac	LZ Del		

Emission increase since last observations

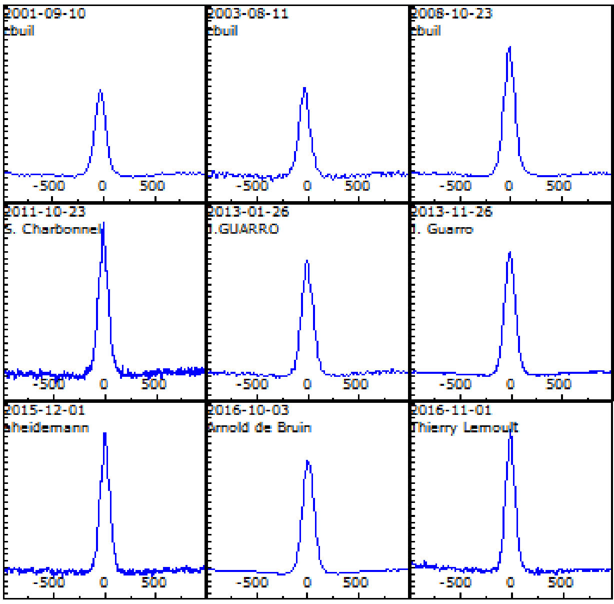
V442 And 1 yr



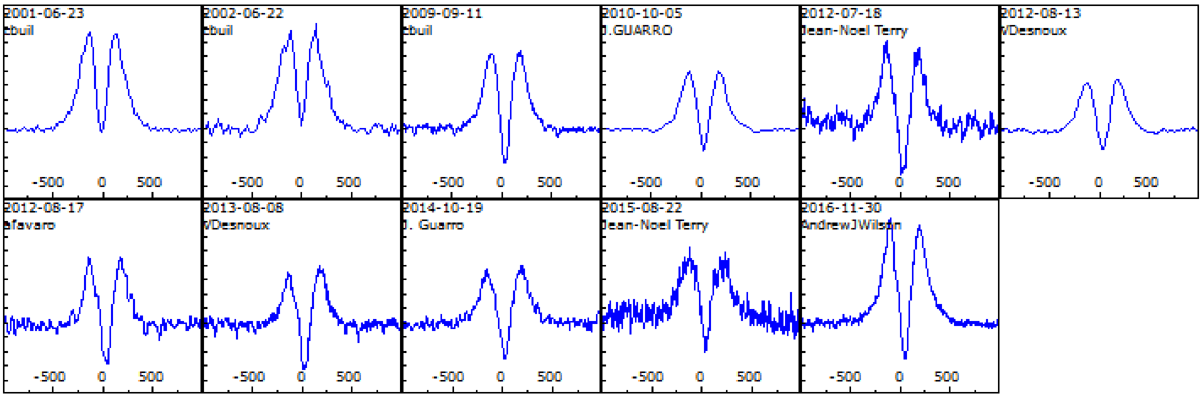
OT Gem 1 yr



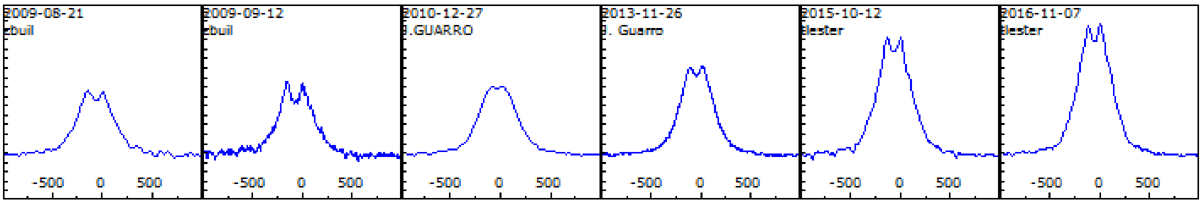
HD 13867



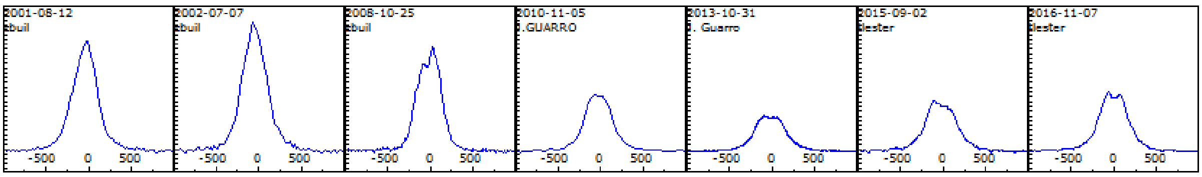
LZ Del



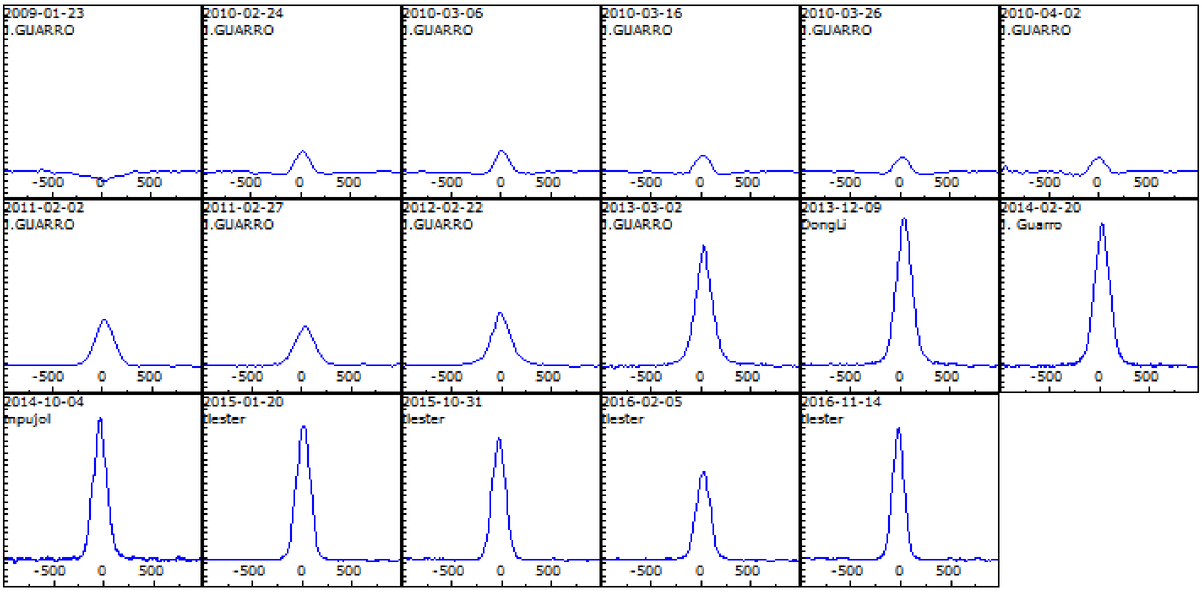
V358 Per



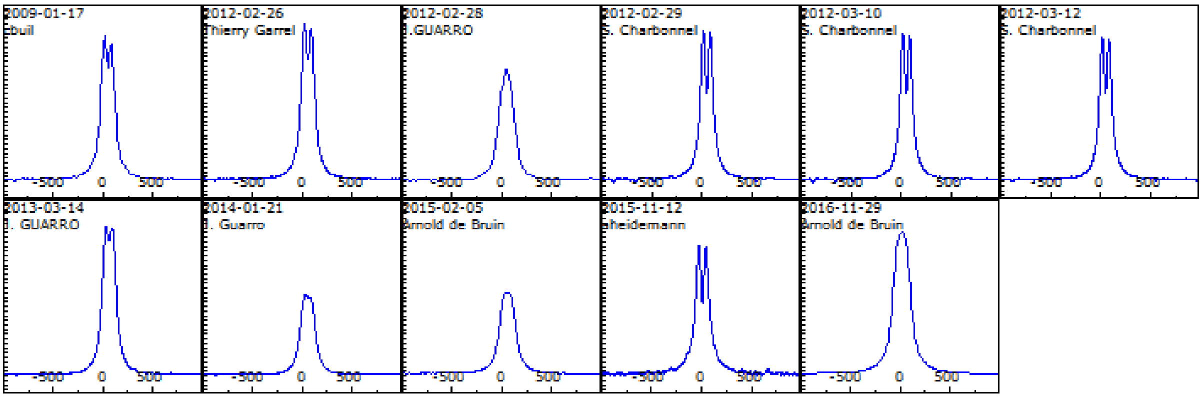
V404 Lac



V811 Cas



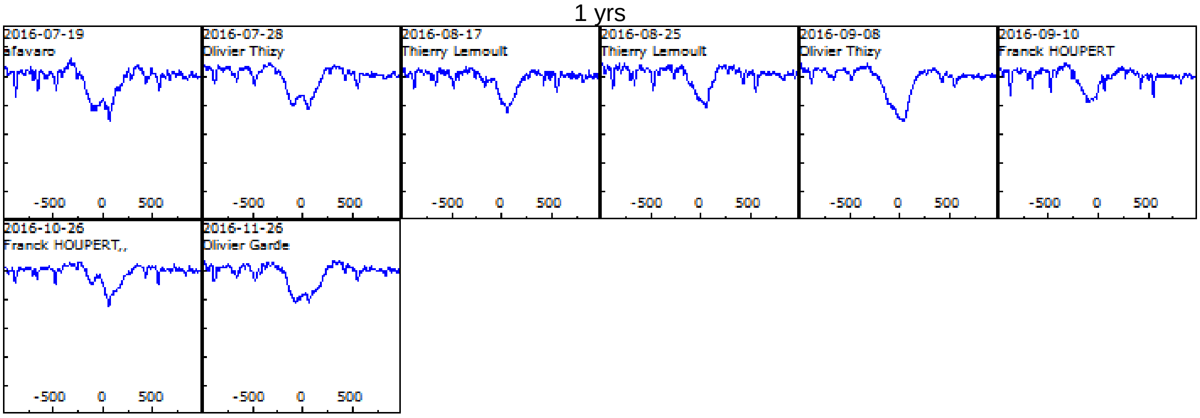
V1374 Ori



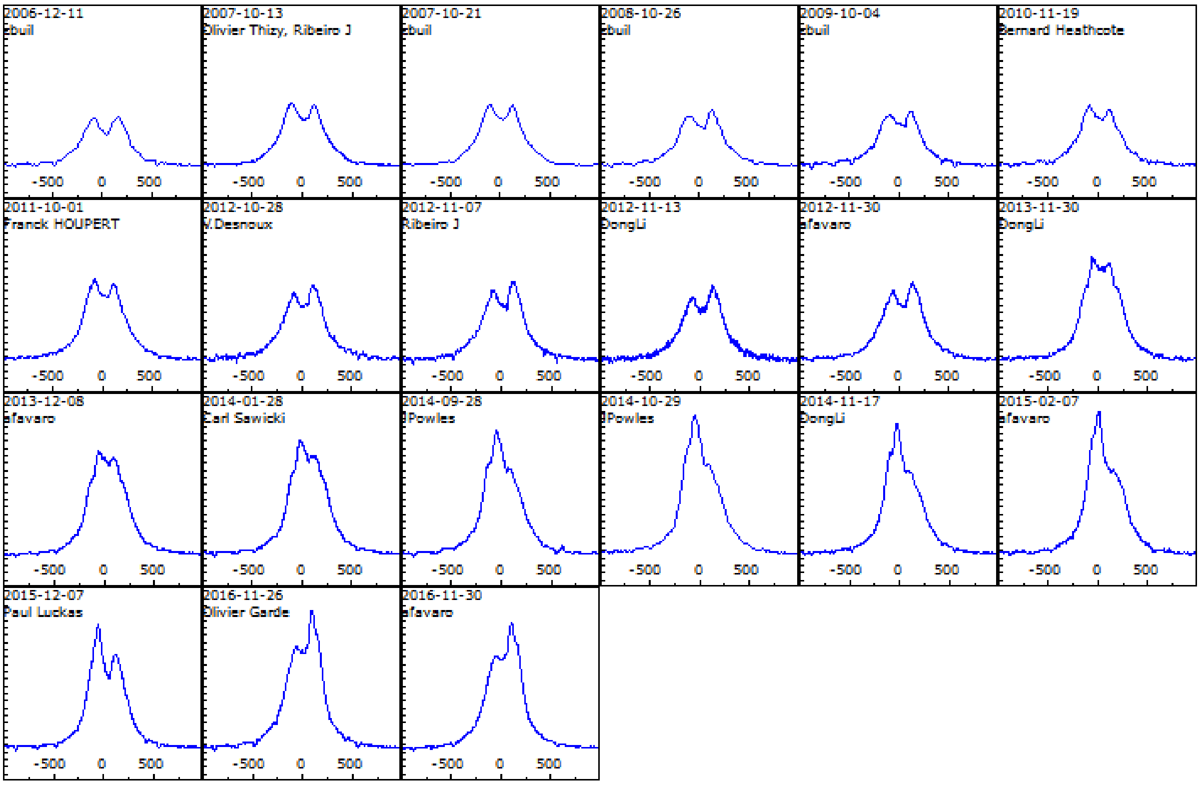
Moderate evolutions of H-alpha line

14 Lac

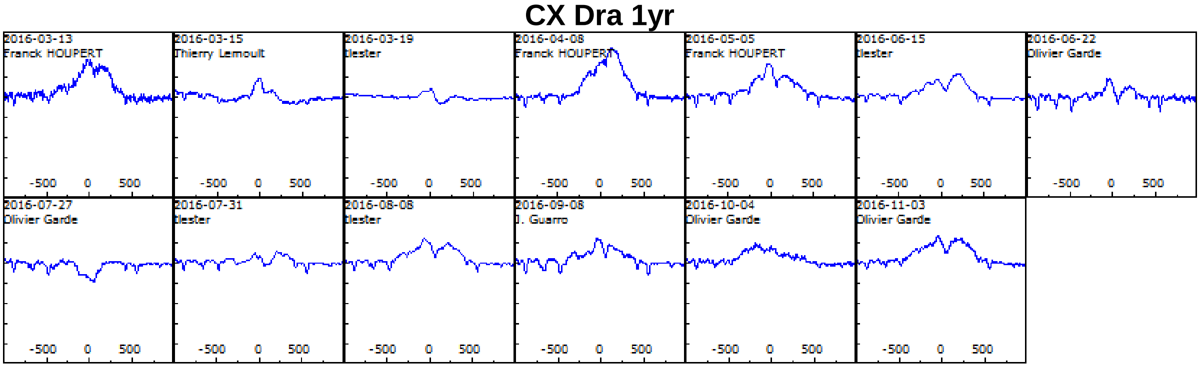
1 yrs



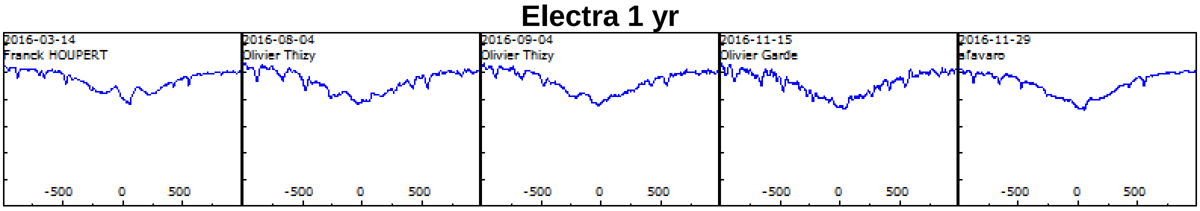
228 Eri



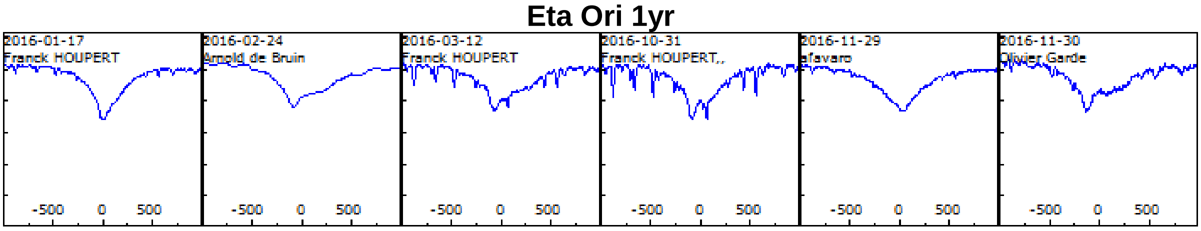
CX Dra 1yr



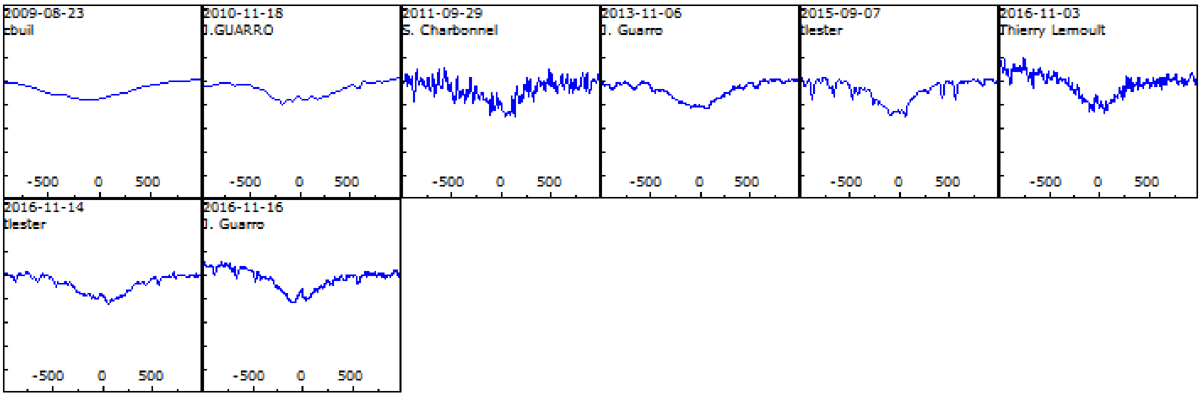
Electra 1 yr



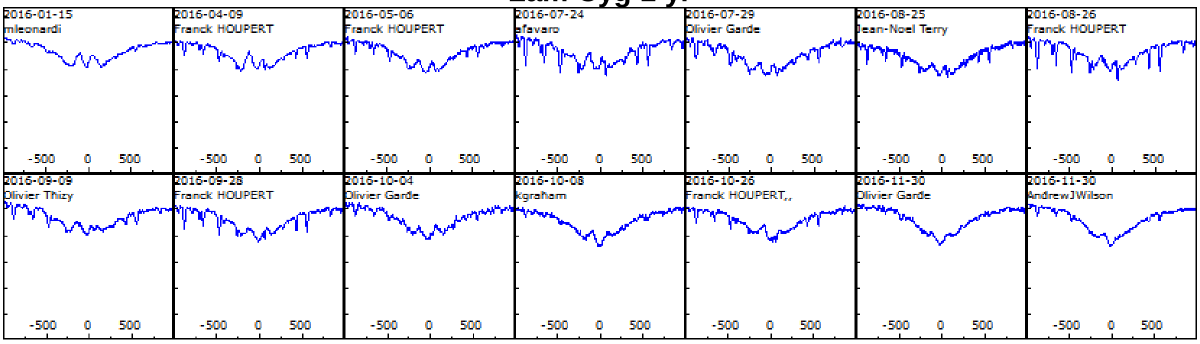
Eta Ori 1yr



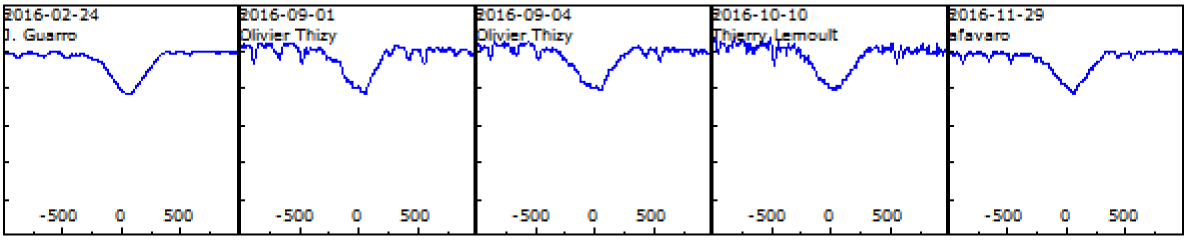
HD 217061



Lam Cyg 1 yr



Menkhib



Emission decrease of H-alpha line

None this month

Be monitoring projects

By Ernst Pollmann

COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 6169

Konkoly Observatory
Budapest
26 May 2016

HU ISSN 0374 – 0676

MONITORING THE RADIAL VELOCITY OF HeI 6678 OF γ Cas

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Introduction

The Be star γ Cas (27 Cas, HD 5394, HR 264) is a primary component of a spectroscopic binary and is the very first Be star known, discovered by Secchi (1887). Spectroscopically γ Cas has been investigated mostly in the Balmer lines, mainly in Hα. Recent studies considered He and Fe II lines as well as the kinematics of the circumstellar shell (Hanuschik, 1994, Smith, 1995). The HeI 6678 line has an important diagnostic value of activity close to the star's surface. Investigations of Smith (1995), Harmanec et al. (2000), Harmanec (2002), Pollmann & Stober (2007) and Pollmann (2009) give detailed information about the long-term behaviour of the equivalent widths of the HeI 6678 emission line.

In the context of the investigations concerning the periodic behaviour of the ratio V/R of the relative intensities of the violet component I_v to the red component I_r of the HeI 6678 emission line in γ Cas (Fig. 1), as it was described by Pollmann & Guarro (2015), a clearly detectable and clear variation of its radial velocity with a spectral resolving power of 10000 to 20000 were noticed. The HeI 6678 emission is formed close to stars photosphere and, therefore, it should be possible to measure RV without restructuring or turbulence effects, as in the outer region of the disk at Hα. Harmanec et al. (2000) (H2000 hereafter) argued that there are at different times "migrating sub-features" moving across the Hα line profile which affect the blue and red wings.

Against this background, the RV monitoring of the HeI 6678 absorption core of γ Cas will offer an opportunity to observe an "undisturbed" process. The BeSS data base[1] provides the use of corresponding γ Cas HeI 6678 spectra of observers of the ARAS group[2] from the years 2000 to 2016. Altogether 112 spectra of that time period were usedfor the investigation presented here, 52 BeSS spectra (observers are mentioned the caption to Fig. 2) from Sept. 2000 (JD 2451810) to Feb. 2016 (JD 2457442), 15 spectra of the Pollmann & Guarro (2015) paper, and 45 further spectra of the author (not all in BeSS). All RV data used in the analysis present here are available at: `http://astrospectroscopy.de/media/files/RV_data_gamcas.txtt`.

[1] http://basebe.obspm.fr/basebe/
[2] http://www.astrosurf.com/aras

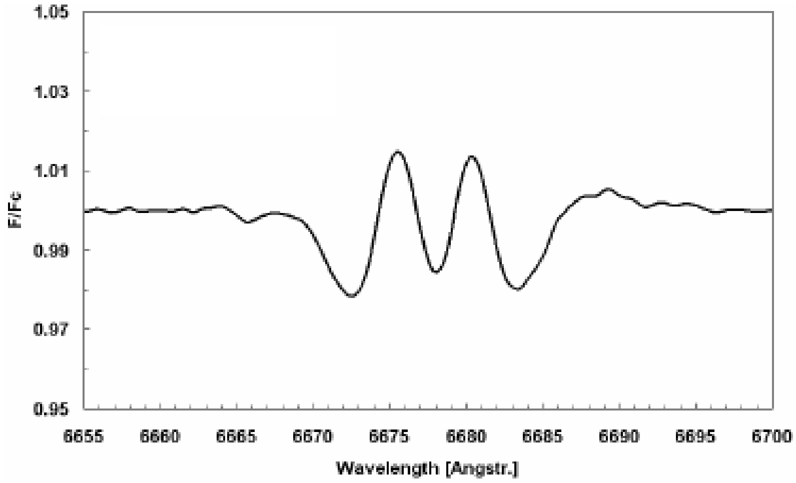

Figure 1. Example spectrum of the HeI 6678 emission of γ Cas, taken by the author November 01, 2015 with a LHIRES III spectrograph (R ca. 17000)

Observations

The spectra for the RV measurements of the HeI 6678 line presented here, were taken at different locations with 20 cm Newtonian and 40 cm Schmidt-Cassegrain telescopes. Spectrographs with spectral resolving powers of 10000 to 20000 were used. The signal to noise ratio of these spectra were of the order of magnitude S/N ca. 200-300. The spectra have been reduced with standard procedures (instr. response, normalisation, wavelength calibration) using the program VSPEC[3].

The evaluation of the heliocentric RV was performed by the profile mirror method. This method measures the Doppler shift of spectra by correlation of the spectral lines with their mirroring around the laboratory wavelength, and is particularly suitable for the evaluation of asymmetrical lines within exactly specified profile ranges.

Results

With the HeI 6678 RV of these spectra, along with Fig. 2 of the H2000 paper, it was possible to design a total overview of the RV time behaviour since 1993 (Fig. 2). The time base of 22 years in that long-term overview with the BeSS data starting from September 2000 demonstrates the continuation of the RV process from where the H2000 measurements ended.

[3]http://www.astrosurf.com/vdesnoux

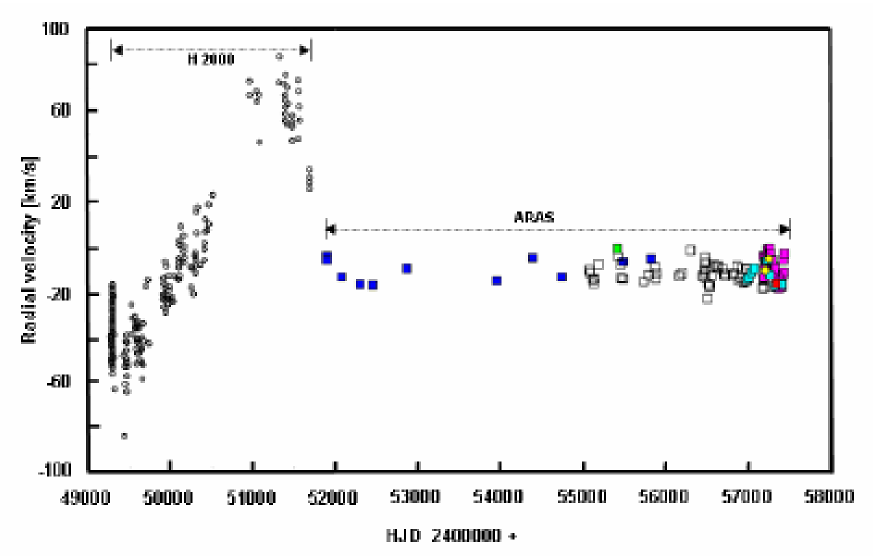

Figure 2: The compound long-term monitoring of RV measurements of H2000 (open circles), and the monitoring of observers of the ARAS group: Pollmann (open squares), Guarro (magenta squares), Lester (turquoise squares), Montier (yellow squares), Houpert (red squares), Buil (blue squares), Thizy (green squares), Berardi (open triangle)

	Period	Semi-Amplitude	Epoch T0 (JD)	RMS
H 2000	203.59 d (± ?)	7.0 km/s (± 1.5)	2450578.7 (± ?)	8.95 km/s
ARAS	202.2 d (± 0.6)	4.44 km/s (± 0.51)	2451740.89 (± 14.3)	3.6 km/s

Table 1: Result comparison of the analysis of H2000 and ARAS.

Table 1 shows the comparison of the period, semi-amplitude, epoch T0 and RMS, measured as result of the ARAS analysis and the results of H2000.

The first surprise is that after the RV (H2000) maximum with + 90 km/s (approx. JD 2451300, May 1999), our campaign clearly shows the RV at a more or less constant level between 0.5 and -20 km/s. This overall RV behavior leads to the question of the physical causes within this ring-like Helium zone, the answers to which cannot be given here. But at least it was interesting to see, whether the periodic behavior of the HeI 6678 RV between Sept.1993 and Sept. 2000, found by H2000, has changed. In order to find this out, a PDM (Phase Dispersed Minimization) analysis (Stellingwerf, 1978) of our data from Sept. 2000 to Dec. 2015 has been performed. The result with a clearly detectable period of 202 d is shown in Fig. 3. The corresponding phase diagram with the parameter summary is shown in Fig. 4.

Discussion

With our instruments nowadays we were able to achieve primarily a much better signal to noise ratio (S/N) than H2000. In addition the application of the spline filtering interpolation of the program VSPEC enables in small limits by adjustment of very carefully adapted spline coefficients, to smooth the line profile (ca. factor 1.1 to 1.2 of the normalized continuum), without any modification of the spectral information itself.

The use of that tool leads to an improvement of the accuracy of the RV determination. With the results in Fig. 3 & 4, this campaign confirms a clearly detectable phase behavior with a period very close to the period of H2000, in spite of very different RV time behavior, shown in Fig. 2.

It is difficult to judge, whether the small difference between the period established by H2000 and the period found in this analysis, is really significant. Maybe the small difference of 1.39 km/s is caused by the very strong change of the RV amplitude (Fig. 2) during the observation period of H2000.

I want to emphasize that with our spectra we achieved a much better RMS (3.6 km/s) than H2000 (8.95 km/s).

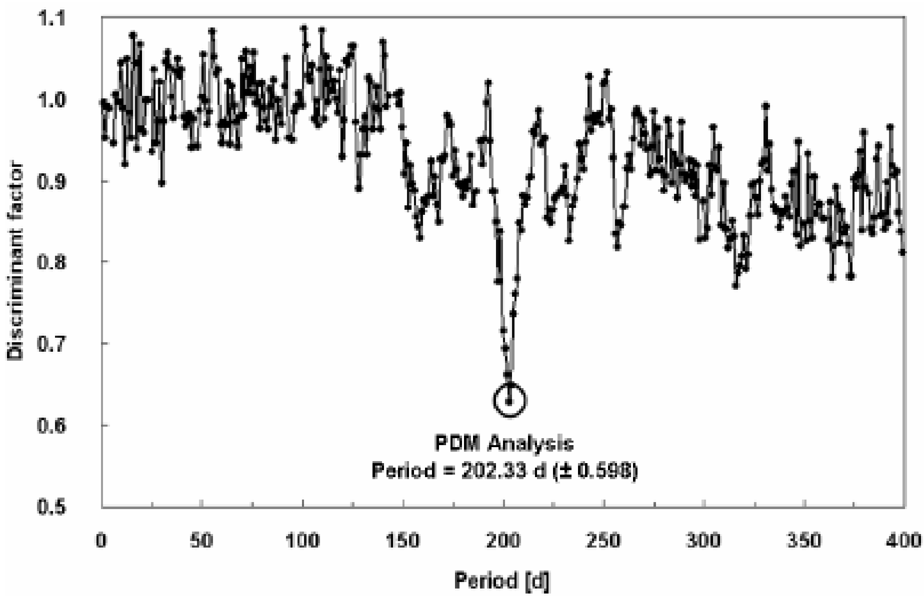

Figure 3: The PDM analysis of the ARAS RV data from Sept. 2000 to Dec. 2015 with a clearly detectable period of 202.33 days.

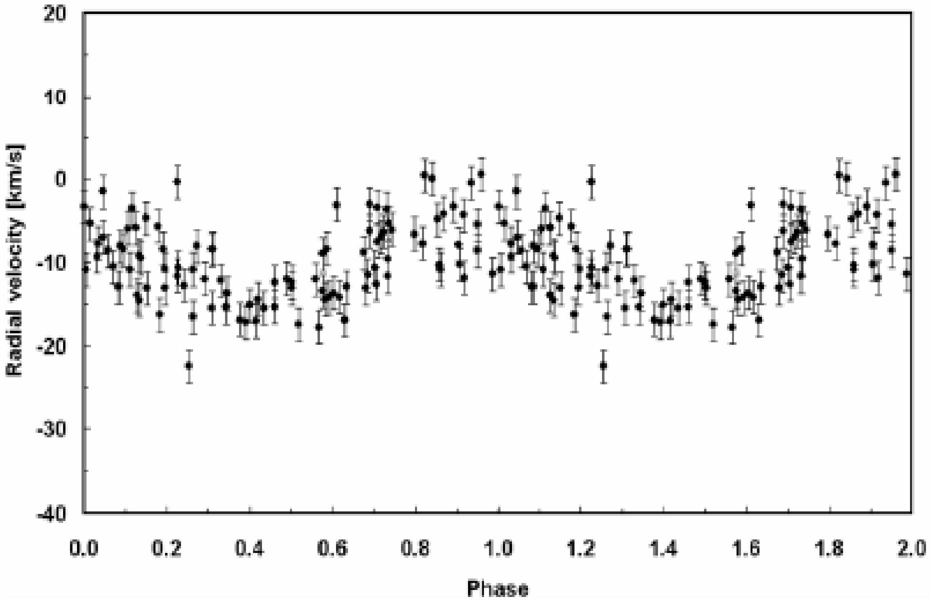

Figure 4: Phase diagram of the found period of the PDM analysis in Fig. 3

Acknowledgements

I am grateful to Sara and Carl Sawicki (Alpine, Texas, USA) for their helpful improvements and suggestions in language.

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Addendum to the IBVS No. 6169 original paper

Due to the enormous change of the radial velocity (RV) in the line He I (6678) of γ Cas in the timeframe H2000 (Fig. 1) inevitably leads to the question about its root cause. It is, therefore, very interesting to compare the RV with the evolution of equivalent width (EW) of the Hα line during the observation period (Fig. 2).

During change of the RV, there is also a drop of EW found by about 45 percent (%), which decreases from 45 Å to about 25 Å. The EW of Hα can be seen as indicator for the total mass of the disk of the primary star, which rotates together with the inner Helium disk counterclockwise around the star.

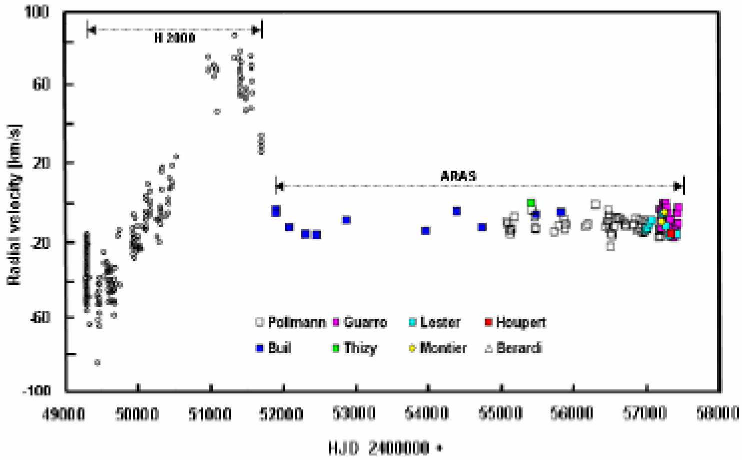

Figure 1: RV-Monitoring of the Helium I 6678 Emission

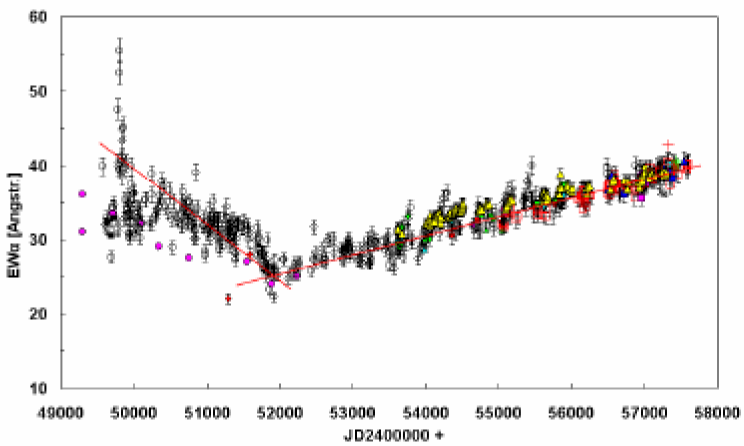

Figure 2: Monitoring of the Hα equivalent width

The change in the EW shall be taken as a mass loss of the disk to about half of its original mass. The γ Cas binary system consists of both masses: m1 for the companion and m2 for the primary plus the mass of the disk. According to Kepler´s third law (m1 * a1 = m2 * a2) the mass loss of the disk would mean that also the distance a2 of the primary plus disk will change relative to the common center of gravity of the system.

This again will explain well the change of radial velocity up to the H2000 maximum at JD 2451500. Starting at approx. JD 2451800 (see both figures) another interrelation will occur: Fig. 2 demonstrates a constant increase of EW. This would correspond to an increase of mass of the disk fed by mass of the primary.

But the total mass m2 (primary plus disk) nevertheless remains almost constant. Consequently no increase of RV will occur. This is consistent with both observations of the radial velocity of HeI 6678 and the equivalent width of the Hα line.

Acknowledgements

I am grateful to Thilo Bauer (Astroinformatics, Bornheim, Germany) for his helpful improvements and suggestions in language.

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ArasBeAM portal at http://arasbeam.free.fr/

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