BeSS report – May 2017

Data compiled by Valérie Desnoux – H-alpha monitoring
Be projects section by Ernst Pollmann here

Observateur	Nb spec
Heathcote	30
Sawicki	14
GARDE	13
Bohlsen	9
Dejean Pastor	6
Fosanelli	4
Pollmann	4
de Bruin	3
DUBREUIL	2
Buil	2
Sollecchia	1
Graham	1
Dejean	1
Total général	**90**

- 63 stars were observed
- 13 Observers contributed this month
- 90 Spectra

Events of the month…

EE: Emission Event, ME: Moderate Events, DE: Decreasing Event

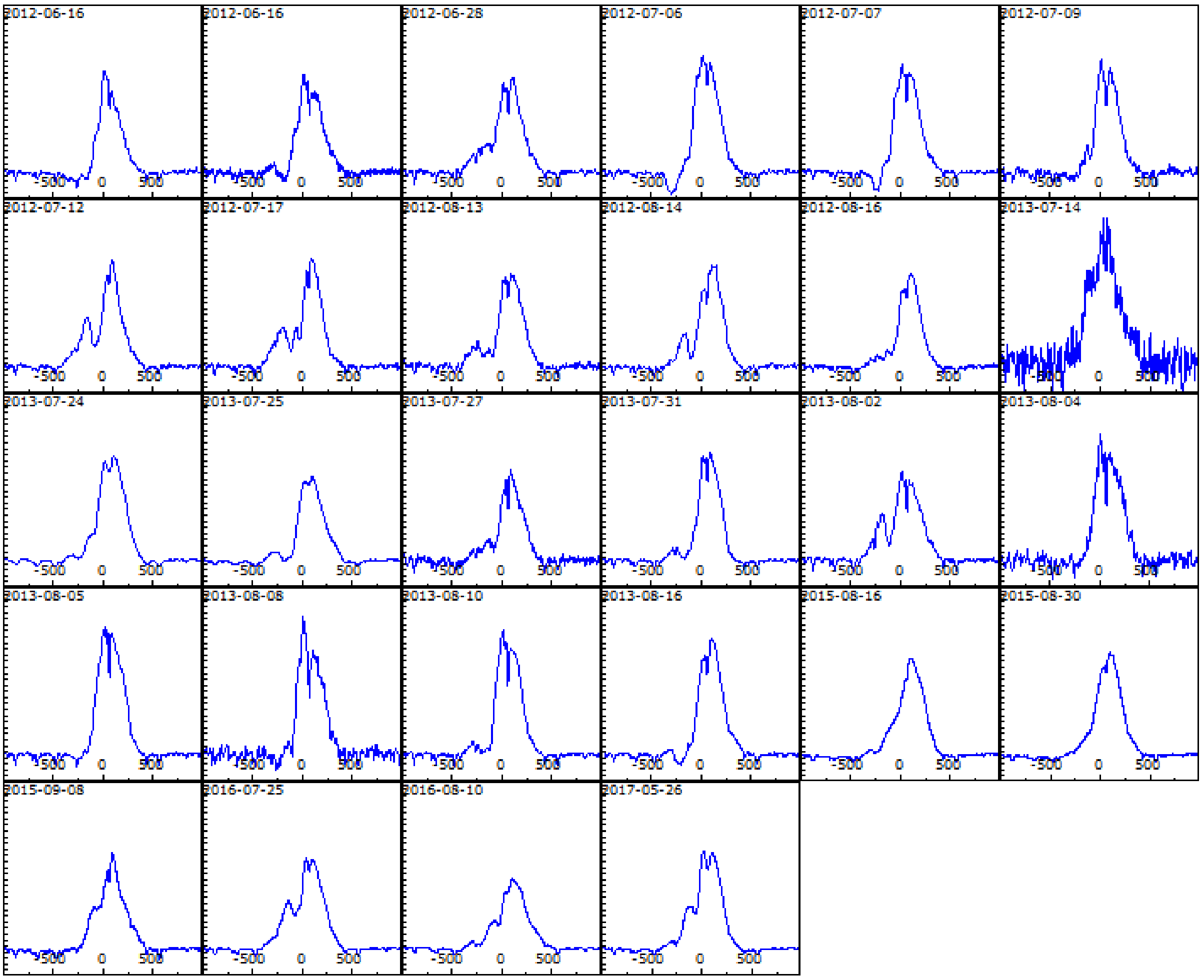
EE	ME	DE
V4379 Sgr	kap Dra	V518 Car
HD 163296	HL Lib	
del Cen	66 Oph	
	CX Dra	
	V1026 Sco	
	OY Hya	
	V658 Car	

Objects observed

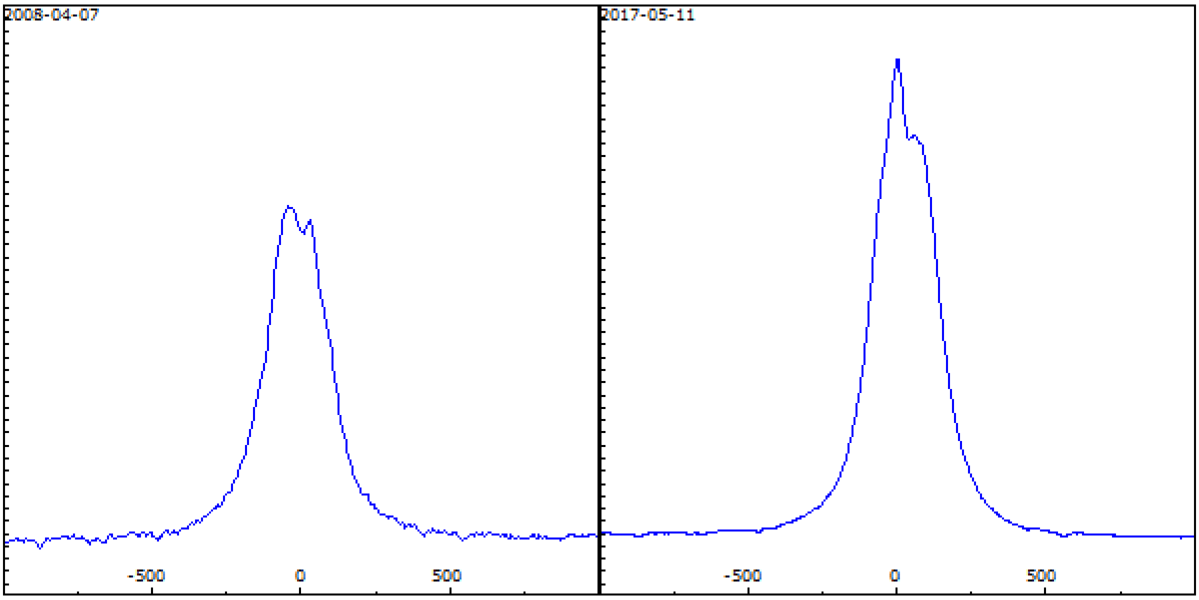
Classique							?	Herbig
zet Tau	HD 65930	V2315 Oph	HD 166917	HD 84567	mu Cen	HD 172122		V1026 Sco
5 Cnc	del Sco	z Her	HD 116875	HD 72014	V767 Cen	HD 163848		HD 163296
FF Cam	QR Vul	HD 87543	HD 230579	V4379 Sgr	HD 85495	V771 Sgr		V718 Sco
tet CrB	HL Lib	ALFIRK	V716 Cen	HD 79206	HD 83032	V518 Car		
bet CMi	66 Oph	OY Hya	V1008 Cen	HD 135160	V480 Car	HD 127756		
zet Crv	48 Lib	FY Vel	V658 Car	HD 125015	del Cen	HD 119682		
kap Dra	V986 Oph	HD 71510	J Vel	tet Cir	V795 Cen	LV Mus		
l Hya	CX Dra	V946 Cen	d Lup	eta Cen	HD 120330	HD 118094		
phi Leo	eps Aps	HD 147196	HD 85860					

Emission increase since last observations

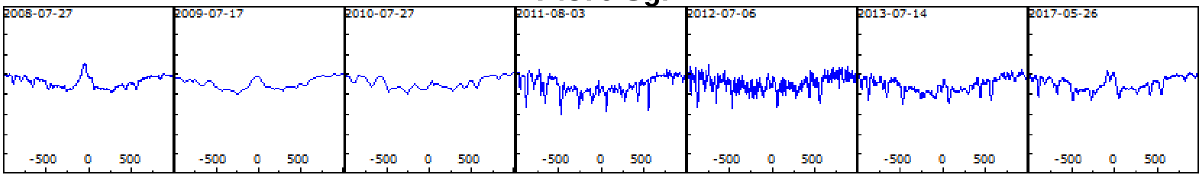
HD 163296



Del Cen

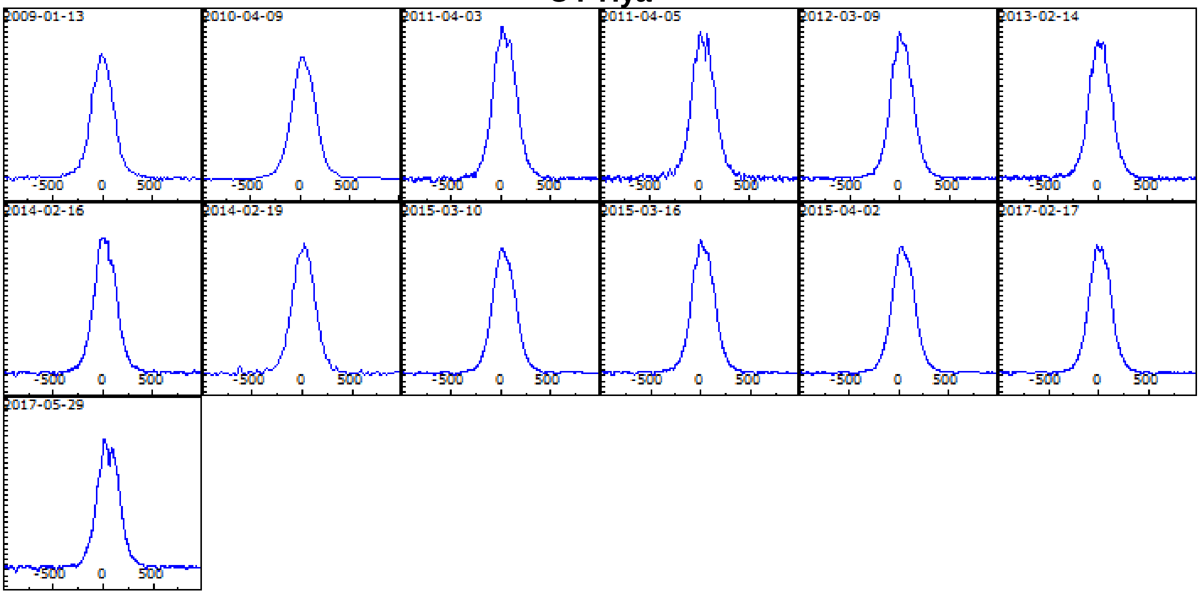


V4379 Sgr

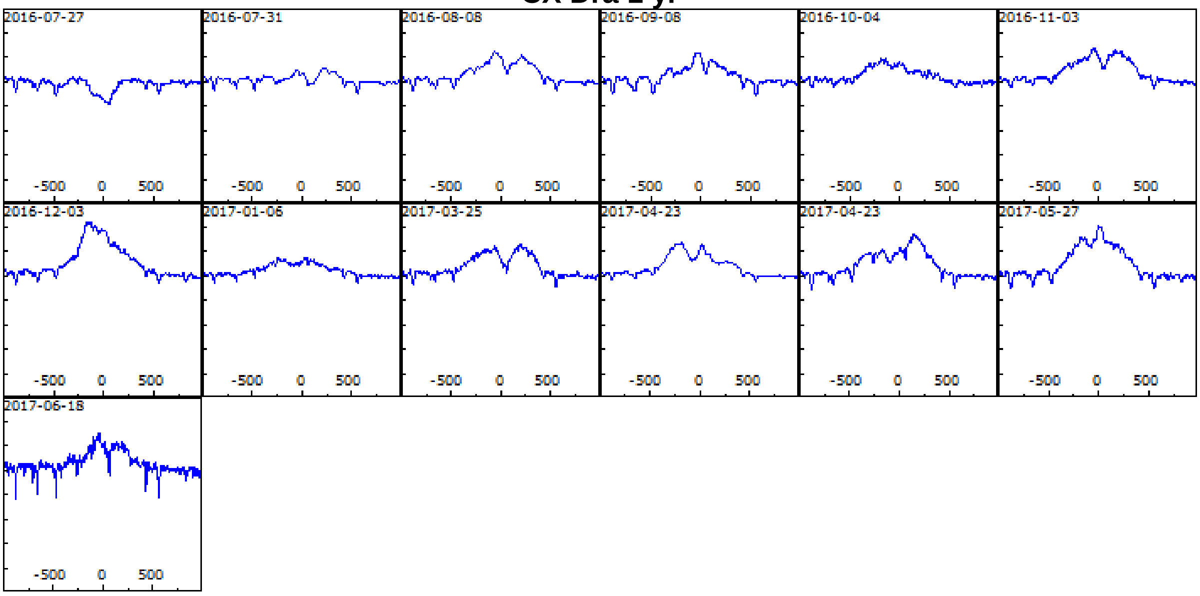


Moderate evolutions of H-alpha line

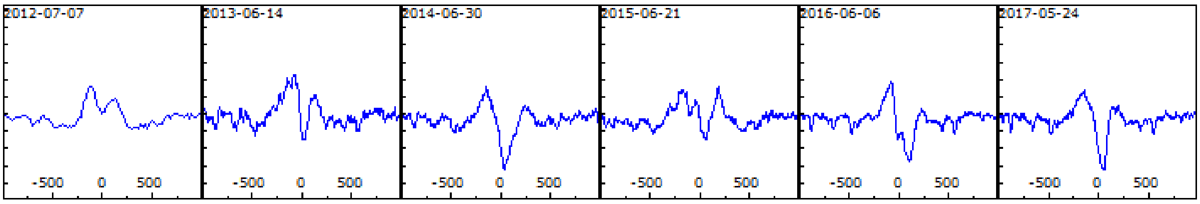
OY Hya



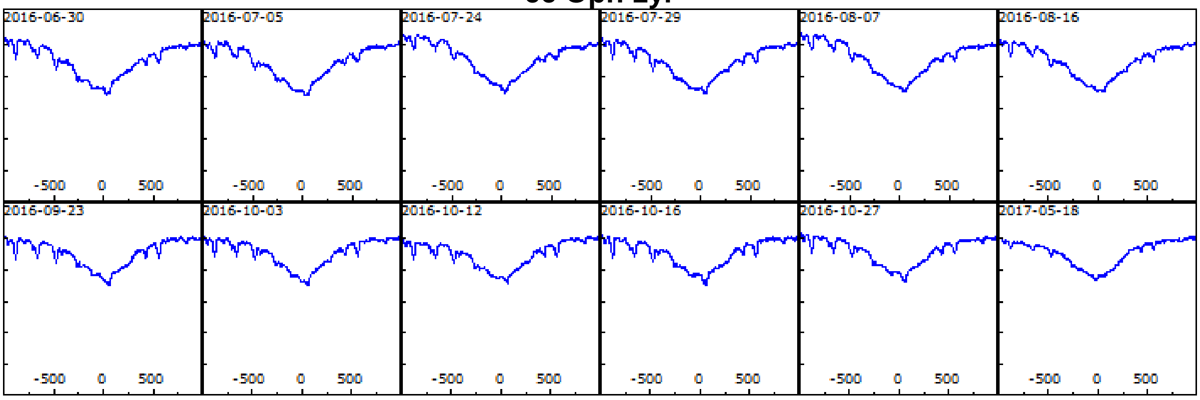
CX Dra 1 yr



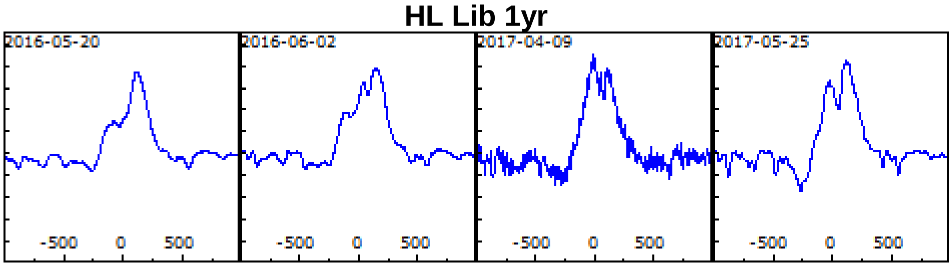
V1026 Sco



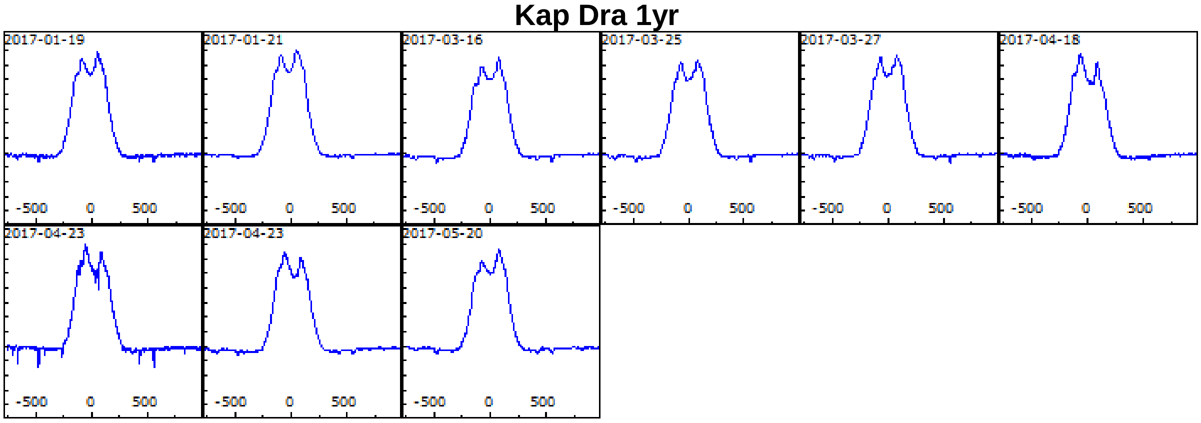
66 Oph 1yr

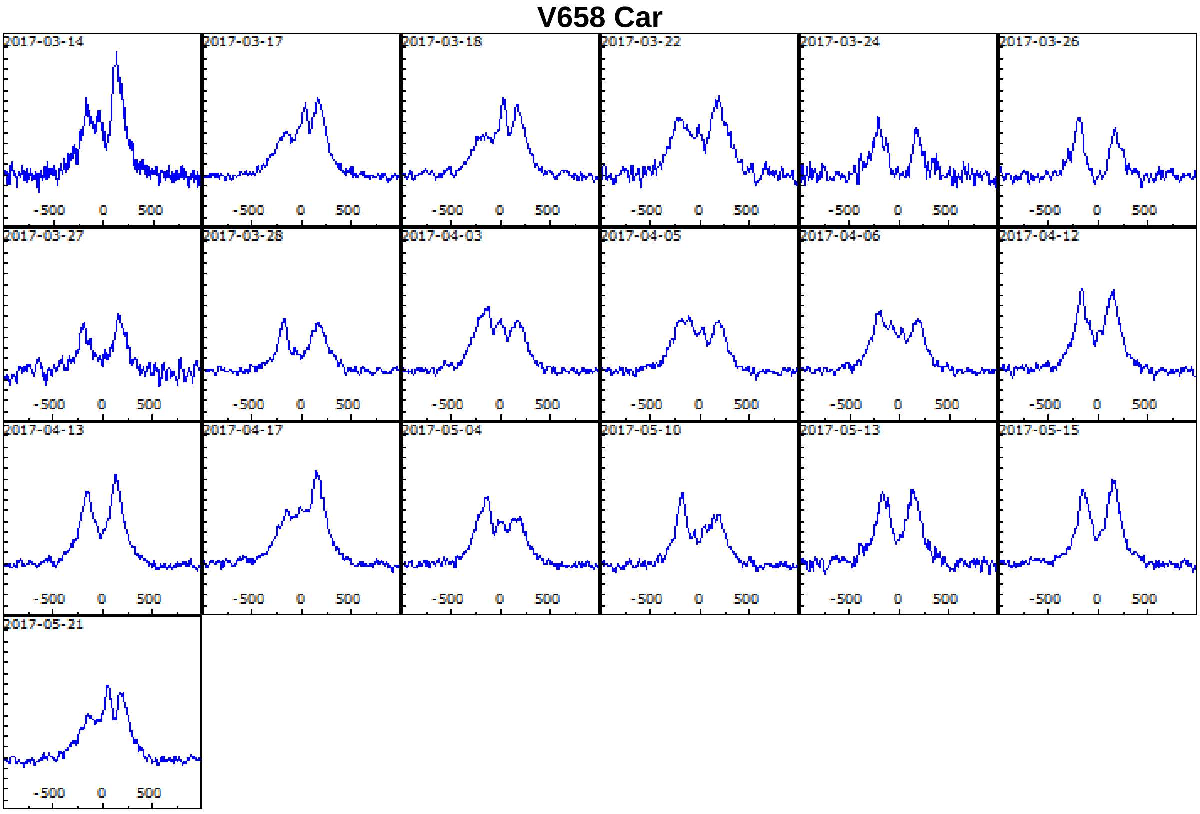


HL Lib 1yr

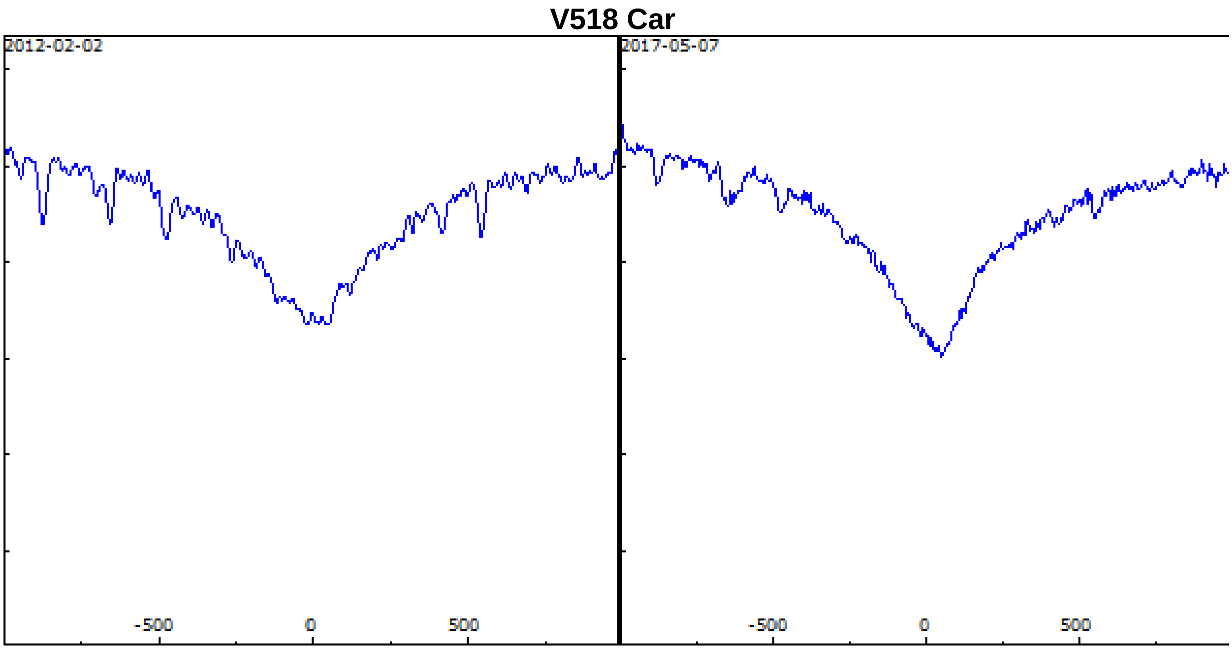


Kap Dra 1yr





Emission decrease of H-alpha line



Be monitoring projects

By Ernst Pollmann

Mass and Precession of the Disk in ζ Tau

Pollmann, Ernst, Emil-Nolde Straße 12, 51375 Leverkusen, Germany
Observatory of the Vereinigung der Sternfreunde Köln, Germany

Abstract

The monitoring of the Hα emission profile of ζ Tau for more than 5 years (JD 2455500 to JD 2457500) enables the study of the time behavior of the central absorption core (CA) of that profile. During this time section the circumstellar disk of ζ Tau had a minimum of mass. On the base of 145 high resolved spectra of the ARAS-spectroscopy group the strength of the CA minima has been evaluated. The period analysis of that time series data led to a period of 442 days. That period has been attributed to the nodding period and hence to the precession period of ζ Tau´s disk during the time section mentioned above.

Introduction

ζ Tauri (HD37202, HR1910) is a well known classical Be binary star with a gaseous circumstellar disk. Observations of the Hα emission line of that star reach back many decades. Since ζ Tau is a binary, any tilt of the disk will be modulated by the tidal force of the companion. This can manifest itself as nodding. During the observing period from approximately JD 2455500 to JD 2457500 the equivalent width of the Hα emission of ζ Tau decreased significantly what led to a depletion of the circumstellar disk. The depletion of the circumstellar disk led to a significant decrease of the equivalent width of the Hα emission of ζ Tau (Ruzdjak et al. 2009). The disk matter reached its minimum at JD 2456359, but afterwards new material was supplied into the disk, and the emission strength increased. The study presented here investigates how the minimum of the disk mass affects the precession period. In addition to monitoring the Hα equivalent width of ζ Tau, studying the time behavior of the central absorption (CA) core of that emission profile is also of interest. The depth of CA is defined as the difference between the local continuum level (equal to unity) and the minimum value at the line minimum intensity (Fig. 1). While the Hα emission line samples the disk as a whole, the region probed by the shell lines (CA) is restricted to the line of sight. The diagnostics they provide should not be neglected, as their properties (absorption depth) reflect the structure and dynamics of the disk in the observer’s direction (Escolano et al. 2015).

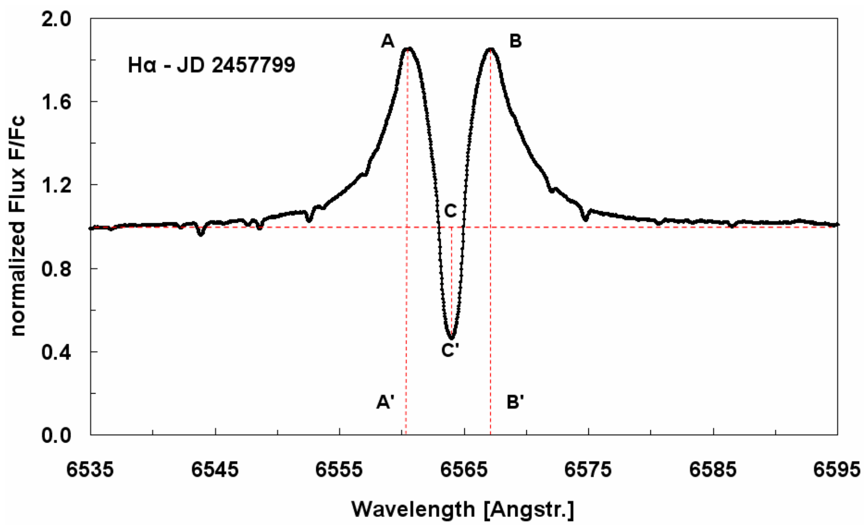


Fig.1: Measured quantities illustrated on a Hα line profile: (AA’) and (BB’) emission peaks, depth of the central absorption (CC’). The horizontal line marks the normalized continuum.

In the literature it is assumed (Schaefer et al. 2010) that the CA is caused by a different angle of the disk plane related to the observer´s line of sight, as a consequence of the disk precession around the primary star. It is also known that the precession of the disk depends on its size (radius) and its mass due to gravitational effects (Katz et al. 1982, Larwood et al. 1996, Lubow & Ogilvie 2001).

Observation and Results

The Hα spectra were obtained with 0.2m to 0.4m telescopes with a long-slit (in most cases) and echelle spectrographs with resolutions of R = 10000-20000. All spectra included the 6400−6700 Å region, with a S/N of ~100 for the continuum near 6600 Å. The spectra have been reduced with standard professional procedures (instrumental response, normalisation, wavelength calibration) by using of the program VSpec and the spectral classification software package MK32. The EWs reported here included the entire Hα emission profile (including both red and blue components) from 6540 – 6590 A. Fig. 2 shows the long-term monitoring of the Hα equivalent width (EW) as a result of collaboration between amateurs (mostly members of the ARAS spectroscopy group) astronomers. Fig. 2 represents the time interval which includes the EW historical minimum on JD 2456359.

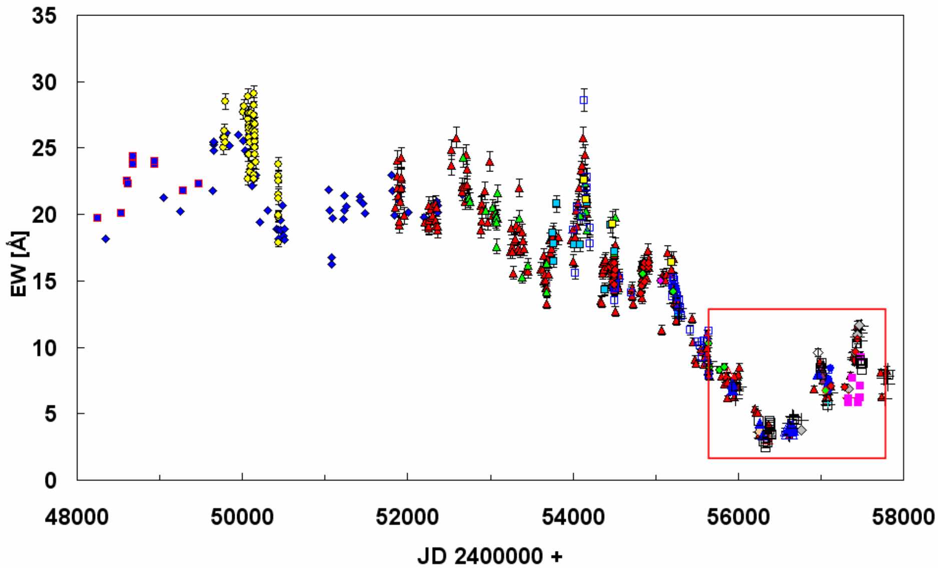


Fig. 2: Long-term monitoring of the Hα equivalent width (EW).
The red frame represents the time window of the historical EW minimum at JD 2456359. The time of the minimum around JD 2456300 corresponds to ~ JD 2456650 in time scale of Fig. 3

The higher disk mass (top-left-frame) in Fig. 3 corresponds to a precession period of (approximately) 1430 days (Schaefer et al. 2010).

PDM analysis and discussion

The bottom-right red frame in Fig. 3 also shows that within the time window highlighted in Fig. 2 the disk mass minimum coincides with the EW minimum. High-resolution spectra of ζ Tau were taken during the time window from JD 2455640 (March 2011) to JD 2457799 (February 2017) in collaboration with the ARAS group. This time window contains the time interval where the mass of the disc of ζ Tau reached its lowest value within the whole time this star has been observed. From those spectra the depth of the CA within the Hα emission profile was measured and the resulting time series is shown in Fig. 4.

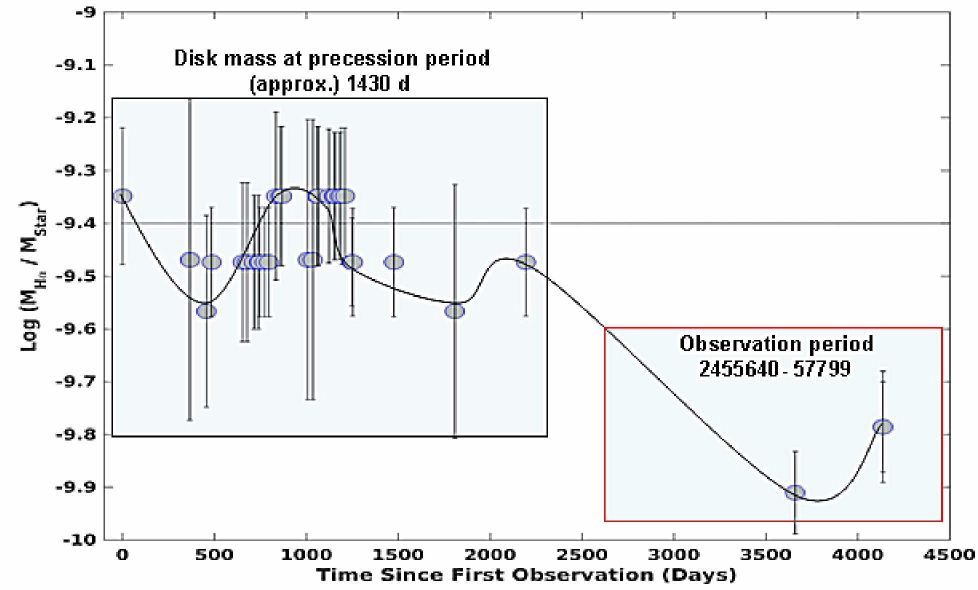


Fig. 3: Disk mass versus time since the first observation, taken from Tycner & Sigut, 2015. The zero-time corresponds to JD 2452977 (2003/12/03). The red frame corresponds to the same time window highlighted in Fig.2

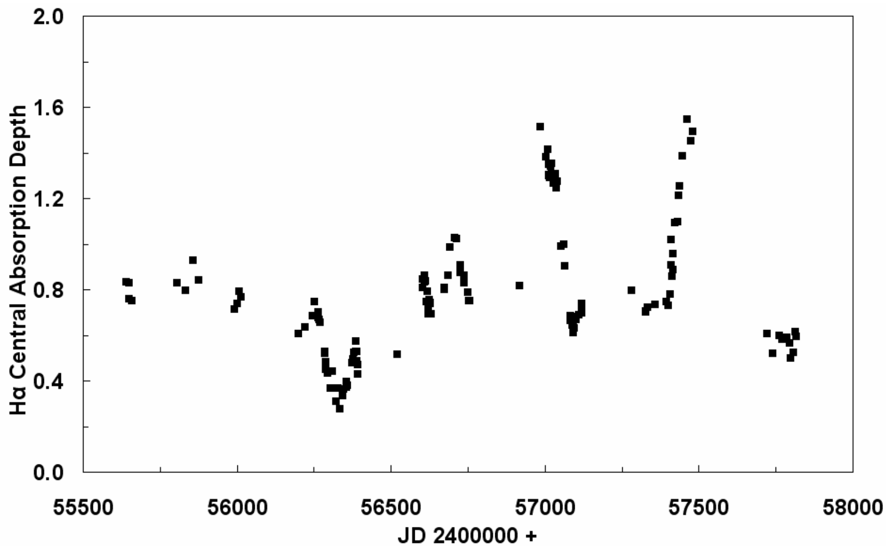


Fig. 4: The CA in Hα of ζ Tau is a function of time from JD 2455640 to JD 2457799 (red frame in Fig.2 & 3)

In other words, the CA investigation presented here was performed within a time window when the disk mass of ζ Tau was the lowest for the entire time of the star studies. Therefore a logical question is: "How does the disk mass minimum depend on the precession period during that time section?"

Figure 4 shows the Hα CA time series (the time window shown in red in Figs. 2 & 3) of the normalized high-resolution spectra from JD 2455640 to JD 2457799. Phase dispersion minimization (PDM) analysis on the time series was performed with the use of the program AVE (Barbera 1998), and produced the phase plot of Fig. 5 with the discriminant factor plotted in Fig. 6.

In contrast to Escolano et al. (2015), who found only marginal CA variations of the shell lines between approximately JD 2449000 and JD 2455000, the CA as measured in this work covered a considerable range of F/Fc from 0.28 to 1.55. The PDM analysis led to a CA period of 442 ± 5 d. But the question is, what are the mechanisms responsible for that periodic behavior? The periodic tilt of the disc as an effect of the precession could be manifested as a nodding, and could subsequently affect the variability in CA. Also, it is well known that the precession is, among other factors, a function of mass. Nevertheless it remains unclear whether the Hα CA period of ζ Tau found herewith can be understood as a consequence of changed precession period and changed disk mass, as shown in the plot from Tycner & Sigut (2015) in Fig. 2. But if we attribute the CA variability to a nodding caused by disk tilting, then “this” is the precession period. This investigation will continue during the coming years.

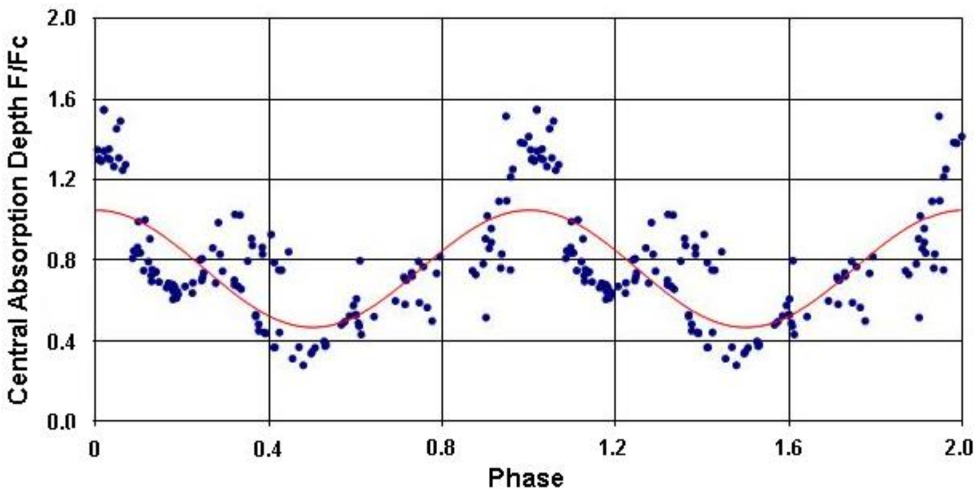


Fig. 5: Phase plot of the PDM analysis in Fig. 6;
Period = 442 d (± 5), Epoch = JD 2455571 (± 16)

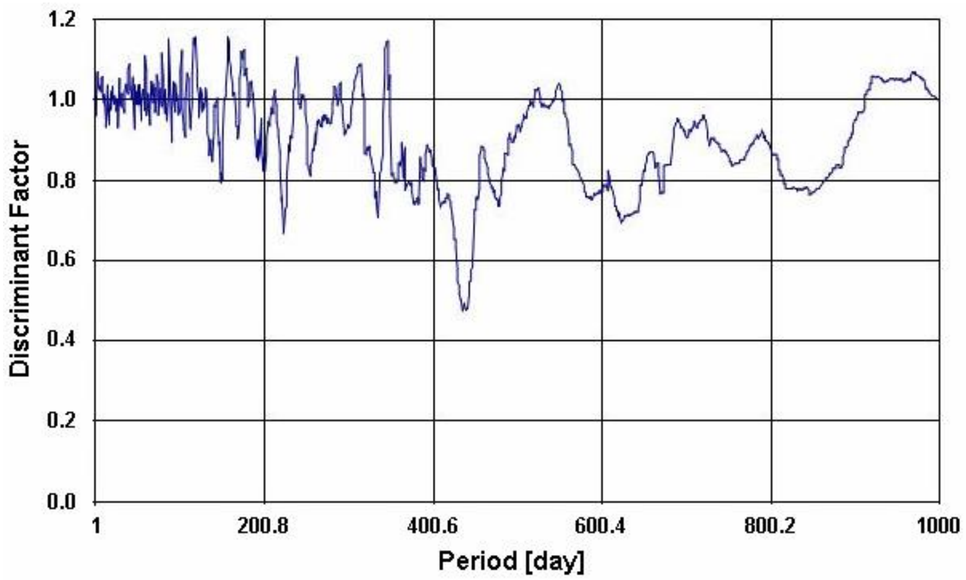


Fig. 6: PDM-Analysis of the time series in Fig. 4

Acknowledgements
The spectra used for the evaluation of the CA of Hα were taken by the following observers of the ARAS spectroscopy group: J. Guarro, C. Sawicki, O. Garde, T. Lester, M. Leonardi, B. Mauclaire, N. Montigiani, A. Miroshnichenko, B. Koch, Ch. Buil, St. Ubaud, P. Fosanelli, H. Kalbermatten, St. Charbonnel, E. Pollmann.
I am grateful for the ARAS collaboration. I am also grateful to Sara and Carl Sawicki (Alpine, Texas, USA) for their helpful improvements and suggestions in language; and to Prof. Dr. Anatoly Miroshnichenko (University of North Carolina at Greensboro) for his comprehensive support improving this work in several aspects.
References:
Barbera, R., 1998, AVE code, version 2.51, http://www.gea.cesca.es
Escolano, C., Carciofi, A. C., Okazaki, A. T., Rivinius, Th., Baade, D., and Štefl, S., 2015,

A&A 576, A112
Katz, J. I., Anderson, S. F., Grandi, S. A., & Margon, B., 1982, ApJ, vol. 260, p. 780-793
Larwood, J. D., Nelson, R. P. , Papaloizou, J. C. B., Terquem, C. , 1996, Mon. Not. R. Astron. Soc. 282, 597-613
Lubow, S. H., Ogilvie, G. I., 2001, ApJ, vol. 560, 997-1009
Ruždjak, D., Božić, H., Harmanec, P., Fiřt, R., Chadima, P., Bjorkman, K., Gies, D. R., Kaye, A. B., Koubský, P., McDavid, D., Richardson, N., Sudar, D., Šlechta, M., Wolf, M., Yang, S., 2009, A&A 506, 1319-1333
Schaefer, G. et al., 2010, The Astron. Journal 140. 1838-1849
Tycner, Ch., Sigut, A., 2015, "The Variable and Asymmetric Disk of ζ Tau", poster, IAU General Assembly, Meeting 29, 08/2015, id. 2255073

BeSS report Materiel & Method

For each star having a spectrum loaded in BeSS database for the monthly report the last six spectra in BeSS are displayed. A visual check is performed to detect any change in the H-alpha profile. Sometimes a copy/paste is needed for subtle evolutions.
For each star, which exhibits a change, the above series are generated with the following steps. Each spectrum is zoomed on the H-alpha line. Each profile is scaled on the continuum on a region around 6580 angströms. The Heliocentric correction is applied, and the x-axis is converted into Doppler velocity centered on H-alpha.
If too many spectra of the object are available, a shorter period of observation is displayed and thus the length period is indicated (1yr, 3yrs).
All data are processed with Visual Spec with dedicated function to automatically load BeSS spectra and automatize most of the above processing.

Authors

Valérie Desnoux
Valerie.desnoux@free.fr
Aras Site at http://www.astrosurf.com/aras/
BeSS database at http://basebe.obspm.fr/basebe/
ArasBeAM portal at http://arasbeam.free.fr/

Ernst Pollmann
ernst-pollmann@t-online.de
International Working Group ASPA
Active Spectroscopy in Astronomy
http://www.astrospectroscopy.de
http://www.astronomie.de/astronomische-fachgebiete