

Monitoring the radial velocity of ζ Tauri

(by Ernst Pollmann)

The Be-binary star ζ Tau shows periodic behaviour in the radial velocity of the HeI 6678 absorption line. There is a serious request from professional astronomers to amateurs to contribute their observations to the monitoring of this parameter. Fortunately it's fairly easy, even with relative small instruments, to take part in this kind of monitoring project. One of the most interesting publications regarding radial velocity in zeta Tau is "Long term and orbital changes of zeta Tauri", by Ruzdjak et al [1].

It is a pleasing coincidence, that some of the current amateur observer community (B. Mauclaire, France; R. Bücke, Germany; E. Pollmann, Germany) started their long-term observing campaign of the HeI6678 line of this star at the time when the investigations of the researchers of the mentioned paper ended, approximately at JD 2454500.

Our findings on the long-term variability of the radial velocity of the HeI6678 line is shown in Fig.1 (100 measurements). After subtraction of the long-term component (4th order polynomial) we are left with the residuals in Fig.2. One of the aims of our investigation is to compare our period analysis of the residuals (see phase plot in Fig.3) with the results of Ruzdjak et al. (800 measurements) in Fig. 4 and table 3.

Our result:

Period [d] = 133.2 ± 0.8 (program PERIOD04)
 = 133.3 ± 0.9 (program SPS)
To = 2454499.000
K [km/s] = 8.0 ± 0.8
Rms [km/s] = 5.42

As can be seen, our findings are very close to those of Ruzdjak et al. for the most important parameters.

Sometimes significant intensity variations of the continuum in the area of the blue and/or red side, as well within the wings of the HeI6678 absorption line, are seen (Fig. 5). So-called "co-rotating circumstellar clouds and/or matter" in the outer photosphere of the primary could be the cause [2]. Because of this phenomenon we cannot expect a smooth continuum within this area all the time. Long-term monitoring of this behaviour has been running since 2007.

References:

- [1] Ruzdjak, D. et al., A&A 506, 1319-1333 (2009)
- [2] Balona, L. A. & A. B. Kaye, ApJ, 521, 407-413, 1999

Webpages:

Ernst Pollmann: <http://astrospectroscopy.de>
Benjamin Mauclaire: http://bmauclaire.free.fr/astronomie/spectro/atlas/bestars/zet_tau/
Roland Bücke: <http://astro.buecke.de>

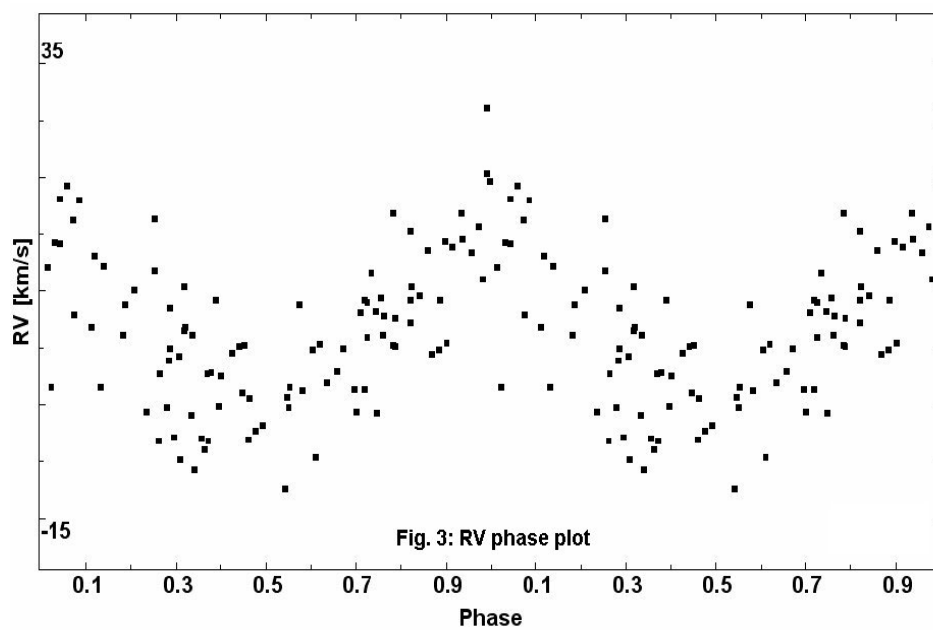
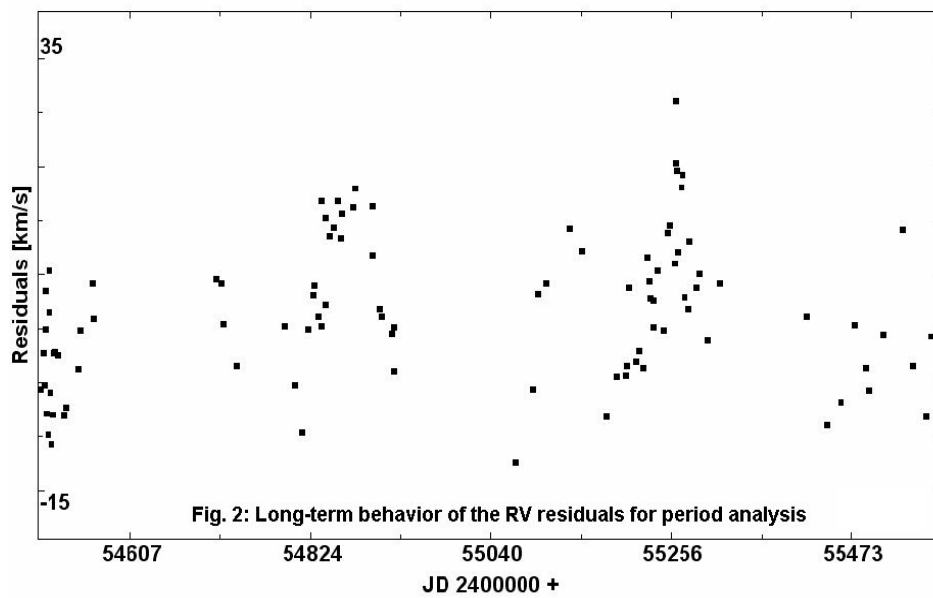
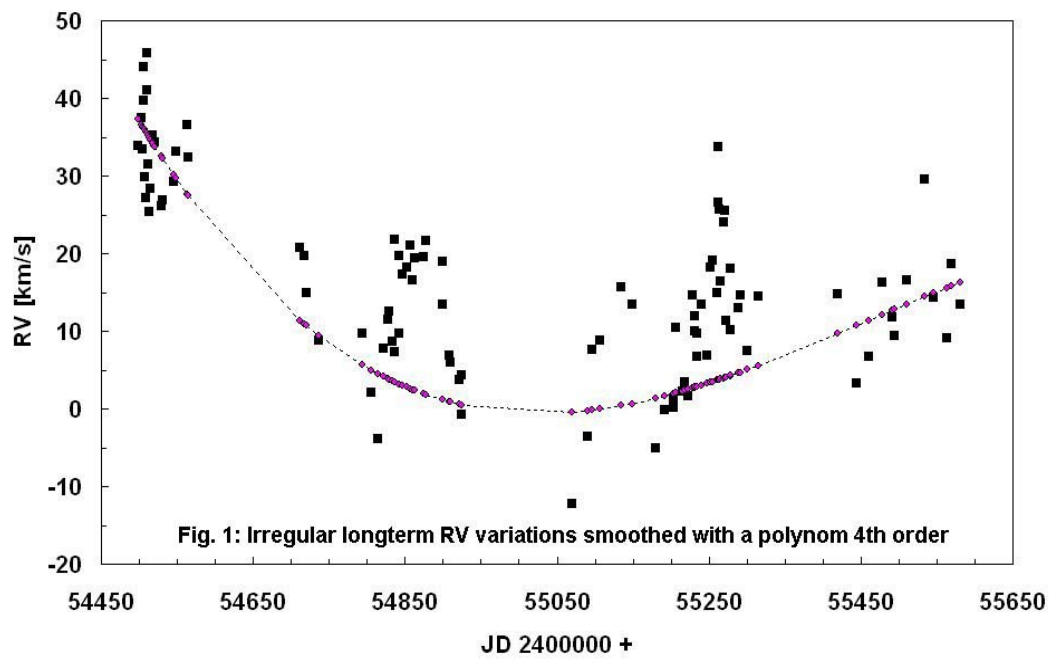
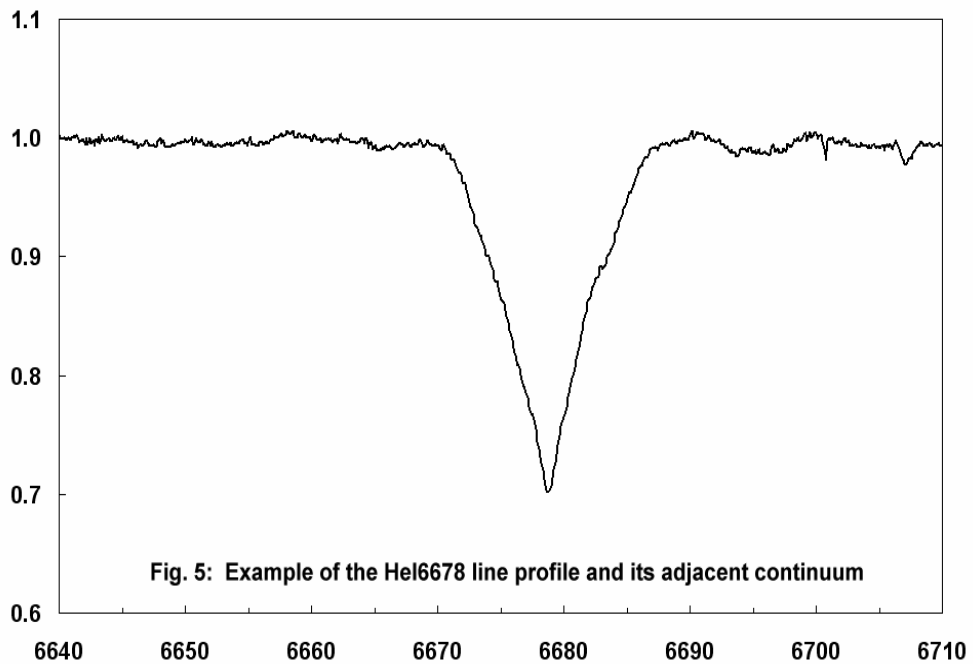
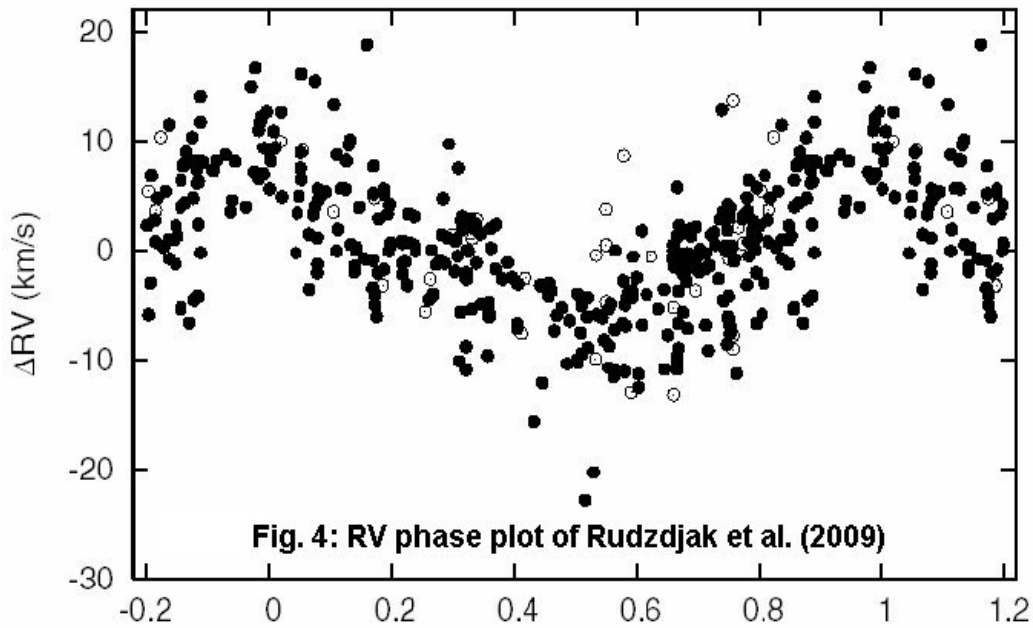


Table 3. Trial solutions for the H I shell RVs, He I RVs and a combination of H α emission-wing RVs with He I RVs measured via cross-correlation in Jarad (1987).

Element	Sol. 3	Sol. 4	Sol. 5
P (d)	132.920 ± 0.013	133.000 ± 0.034	132.901 ± 0.044
$T_{RV \text{ max.}}$	47016.4 ± 3.6	47027.2 ± 3.5	47027.9 ± 1.3
K (km s^{-1})	9.74 ± 0.41	7.6 ± 1.2	8.29 ± 0.61
rms (km s^{-1})	8.09	16.25	4.44
No. of RVs	801	509	178

Solution 3 for the H I shell RVs was formally calculated as an eccentric orbit solution with $e = 0.25$ and $\omega = 305^\circ$, the remaining two solutions are derived for a circular orbit.



Dying the V/R variations in ζ Tau

The V/R monitoring of the H α emission of ζ Tau (Fig. 1) shows a significant decrease in the difference between the V/R maxima and minima (= V/R amplitude) within the time period considered here, from April 1991 to the present (~ 21 years). This V/R amplitude is shown in Figure 2, on the average time between maximum and minimum in each of the ascending branches.

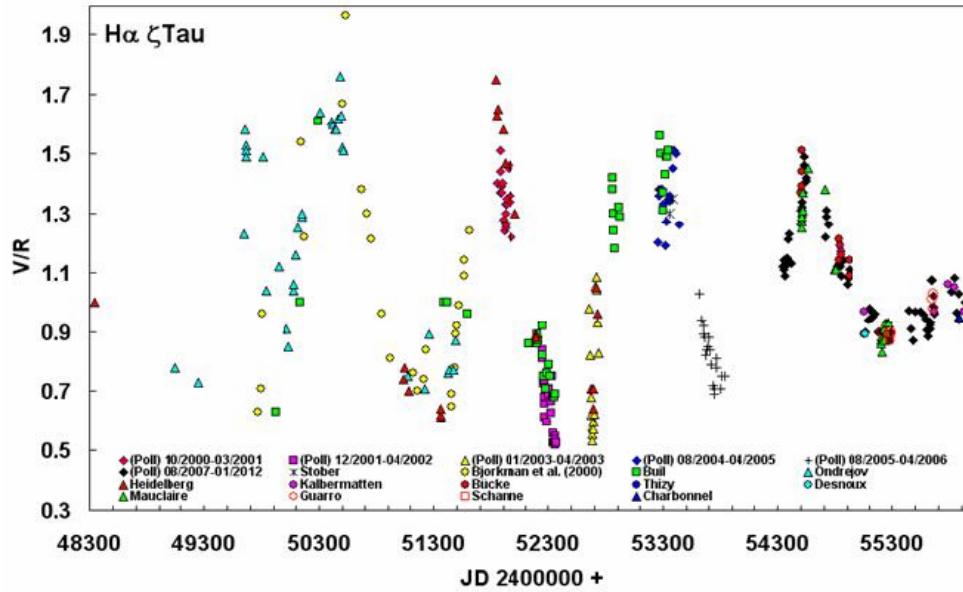


Fig. 1: H α - V/R longterm monitoring April 1991 - January 2012

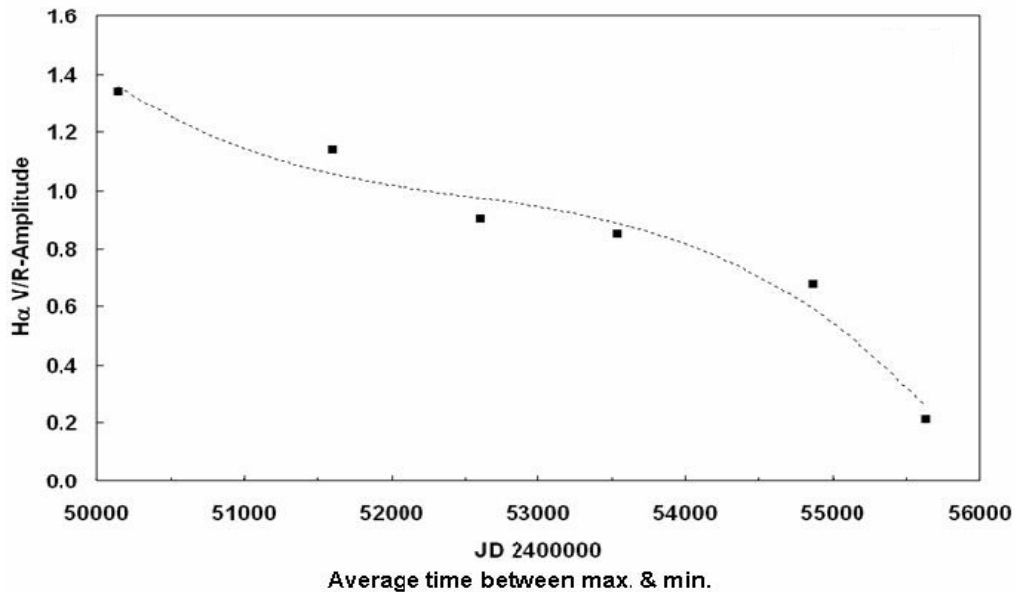


Fig. 2: Reducing of the V/R amplitude versus time for the observation period in Fig. 1

The question is, what are the physical causes in the Be star disk, which lead to this decrease. In general, the periodic variation of the V/R ratio of ζ Tau represents local density differences in the precessing Be star disc (period ~ 1400 days, see Figure 3). Against this background, one could assume that the previously observed difference in density in the disk within the time period considered here is almost balanced.

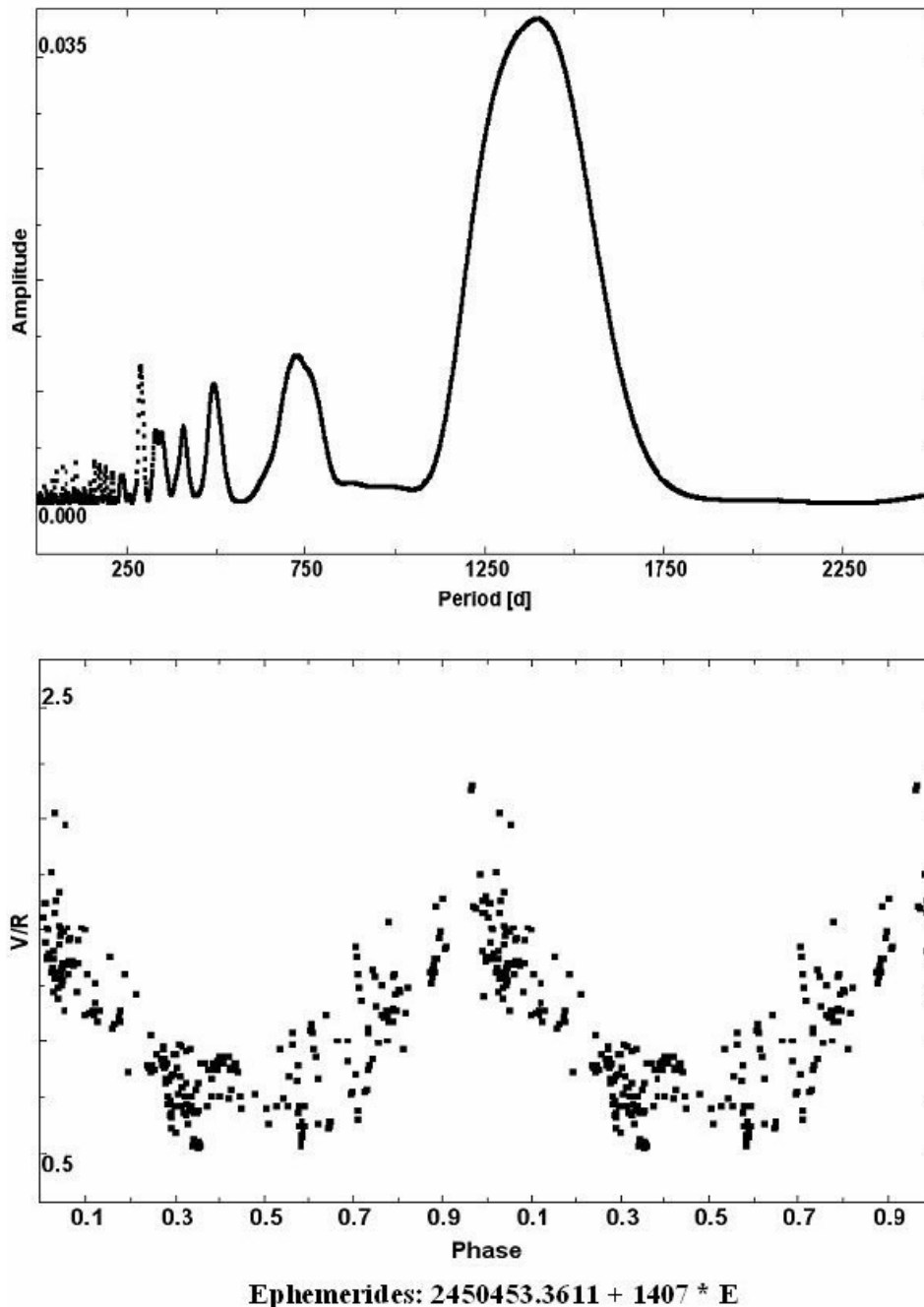


Fig. 3: V/R period analysis; above: Scargel periodogram, below: phase plot

It is remarkable that this amplitude reduction is associated with the fact that the H α -EW is currently at a historically low level (see Figure 4), which means nothing else than that the total mass of the circumstellar disc on a minimum is decreased, similarly as in the winter 1988.

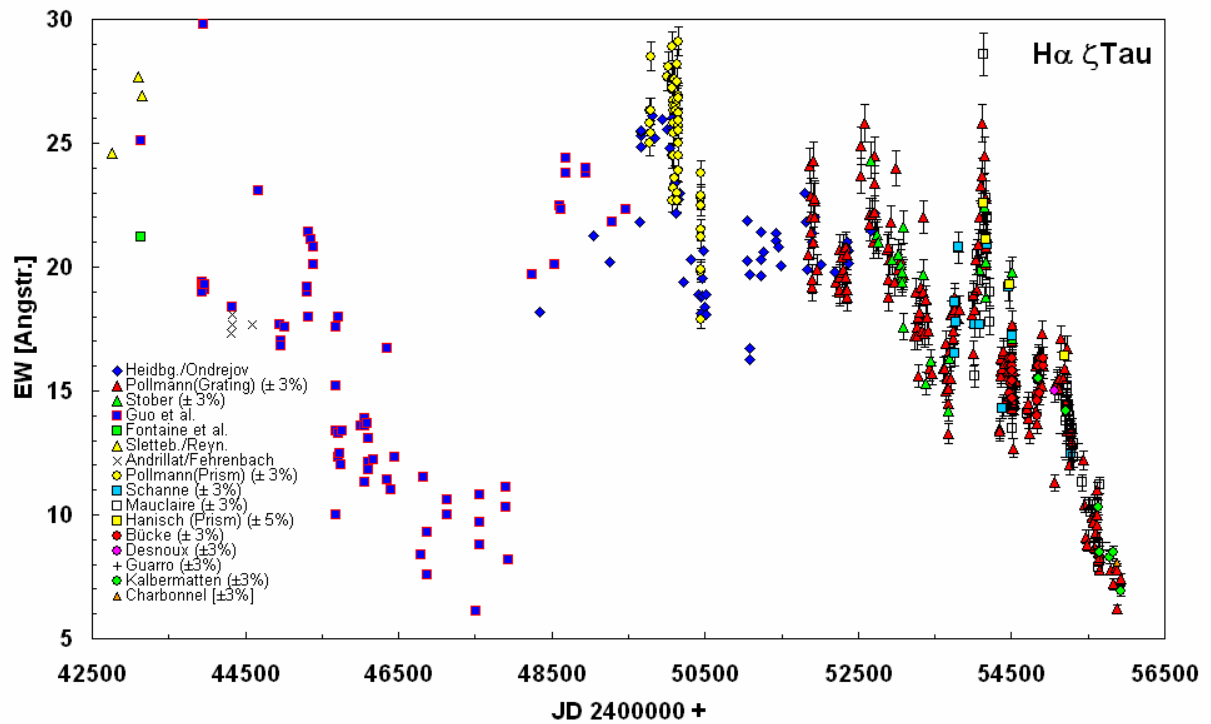


Fig. 4: H α longterm monitoring of ζ Tauri

The dying of the V/R variation does mean certainly, that the density contrast does have decreased. It is also possible that a connection with the entire EW exists. But after D. Ruzdjak et al. (A&A 506, 1319-1333, 2009) the V/R variation can also stop, without EW decreasing. So, it could be also a coincidence.

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