The professional project VEGA/CHARA and participation of ASPA

Fig. 1

Dear colleagues!
With the following contribution I would like tell you something about the professional research project VEGA/CHARA. Although this project collaboration is not an open collaboration and the leader do not want to open it to people other than those who are already involved, they are very interested at our spectroscopic data, to better constrain their modeling of Be stars or to interpret their interferometric data. Thus in such way we can take part at the project adventure.

Fig. 2

But first of all I would like introduce the new astrospectroscopic community ASPA.
ASPA has been established by me, after I left the VdS-spectroscopy group in May this year. Meanwhile ASPA has 27 new members, who participate corresponding our aims, in a really practical manner at the astrospectroscopy, and to support this new group on this way.
ASPA is dedicated for beginners, advanced and professional ambitioned amateurs in the field of project consulting and collaboration in communities for observing of different objects.
To reach these goals, ASPA is cooperating with the internet portal ASTRONOMIE.de , and as member of the spectroscopy group of the Swiss Astronomical Society.

Fig. 3

Well, let´s come back to the project VEGA. VEGA a Visible spEctroGraph and polArimeter is dedicated astrophysical topics and questions within the visible spectral region

- Spectr. Resolution R until 30000 from 4000 to 9000 Å
- Spatial resolution less than 1mas
- For 4 telescopes simultanenously
- Simultanenously measurements of polarisation
- Simultanenously measurements of interferometry

As I said already, unfortunately the CHARA/VEGA collaboration is NOT an open collaboration and the head of the CHARA interferometer Harold Mc Alister do not want to open it to people other than those who are already involved. Nevertheless they would use spectroscopic data from amateurs to better constrain the modeling of Be stars or to interpret interferometric data.

The collaborated amateurs can be sure, that they will be within the loop and part of the paper that will be publish. Thus, in such a way, amateurs may take part of the CHARA/VEGA project.

The data, we did make available meanwhile are of great interest and they will try to use them in the coming months to interpret their preliminary data:

Data of γ Cas:

Fig.4 (top)

The first part of the data contribution here is the monitoring of the equivalent width of the emission line Hα of different participants and from different publications. The current time span is: 1975 to 2009

Fig.4 (below)

The second contribution is the measurement of the radial velocity of Hα mainly performed by my colleague Roland Bücke (Hamburg). This figure shows the current state of his observations.

Fig. 5

The amplitude of the RV is approximately 4 km/s only and until today there exist only the two investigations of Miroshnichenko and Harmanec with considerable differences in amplitude and period. At present it´s unknown whether there are other observers, who are investigating this subject.

Fig. 6

An other interesting subject at γ Cas is the monitoring of the equivalent width of the HeI6678 emission line.

Fig. a
present observed equivalent width for January 2003 through March 2009 and identifies an episode of unusually strong emission in the red and blue wings of the HeI 6678 absorption profile during 18th, 21 th and 26 th of September 2008.

Fig. b
In spite of the assumption, that the disk will be fed by material from the outer photosphere of the primary star, it should be emphasized, no correlation or response is found to the EW of Hα.

Data of P Cygni:

Fig. 7

This overview represents the enormous variation in EW of the Hα-Emission since the first data I could get from Scuderi from July 1988. My monitoring starts in May 1994 and meanwhile eight amateurs are involved with their contributions. That´s a wonderful collaboration of people from Europe and Japan.

Fig. 8

The comprehensive data set since 1988 enables a periode analysis. The often discussed period of 1300 days is clearly found in the upper Scargle-diagramm. The exact period is 1278 d. That this period is actually present, shows the corresponding phase plot. Smaller periods than this may be present, but hardly to find in this state of result situation.

Fig. 9

Corresponding our common project with the American organisation for variable stars AAVSO we are trying to continue the investigations of Nevjana Markova (from Bulgaria) to find out the anti-correlation between the Hα-EW and the photometric V brightness for investigation of the intrinsic line flux.

We request high-precision photometry of this bright luminous blue variable star. It is suspected that the photometric brightness and the Hα-EW might be correlated and variable on similar timescales.

A direct comparison in Markova´s investigations of photometric and spectroscopic data revealed the existence of a close relationship between the variabilities of the Hα EW and V in the sense that if the Hα EW decreases, the star becomes brighter in V and vice versa.

The results could mean, that the observed variabilities of the line strengths in Hα are caused either by changes in the photospheric continuum or by change in the wind density. For this reason the influence of a variable continuum has to be taken to account if studies of the wind and the mass loss rate are performed.

Fig. 10

Similar to the investigations of the other project stars (like γ Cas and δ Sco) we are trying to find out, whether also at this star its shell becomes fed through photosperical outburst. The current results seems to show, that there is no correlation between both.
The question is why?
One explanation could be: P-Cyg as a LBV-star is not really a Be star. Thus its circumstellar environment is not really a disk (Keplerian or whatever) but a strong radiatively driven wind, mostly spherical, even if not homogeneous. Thus it is not curious that its shell, which is in fact a wind, is not fed by the same physical processes as for "classical" Be stars.

Data of δ Sco:

Fig. 11

This figure shows the Hα time behaviour compared with its FWHM. For the moment the last professional CHARA campaign in 2008 on δ Sco was not successful, mainly due to instrumental problems (vibrations and delay lines).

The main intention of drawing this both plots is, to monitor how they are anti-correlated. The star does not seems to be rotating at the critcal speed. From its projected rotational velocity (Vrot sin i = 148 km/s) and the inclination ~ 38°, one can calculate that Vrot = 240 km/s.

This value is only ~ 40% of the critcal rotation speed (Vcrit = 620 km/s; for a primary´s mass of 15 M* and radius of 7R*). At the same time the innermost parts of the disk need to be rotating at the critcal speed (Porter 1998). The intermediate FHWM velocity of ~ 300 km/s in the monitoring at the outbursts in 2000 is in agreement with this considerations. The anti-correlation of FWHM velocity and Hα-EW shows impressive, the more the disk is increasing in its diameter, the less should be FWHM (regarding Kepler).

Thus may be the radiative pressure is playing an important role (among others) for the acceleration of the primary matter into the disk. Before this background it make sense to monitor the behavior of the HeI6678 emission lines in the following plots:

Fig. 12 Behavior of HeI6678

The HeI6678 emission lines are a excellent indicator of disk material very close to the photosphere region of the primary component. The lines are showing considerable variations in its V/R ratio.

An effect, possibly due of a photospherical outburst, which are creating a eliptical ring, where the central star is not in the center. Also the development of so called density "blobs" within the ring or disk on a more or less Keplerian orbit is imaginable. The plot shows the behavior of V/R for 5 observation periods since 2000. Particularly before this background a period analysis of the V/R ratio should be interesting.

Fig. 13

I used the program AVE and received in a first step as result the period of 544 days. Thomas Rivinius (from ESO, Chile) found 536 days. The other small peak at 230 days is a so-called "alias-frequency".

The differences results of the fact, that in his calculation a sinus fit of the main peak in the Scargle-diagram has been performed with an additional weighting method. Nevertheless the results are nearly the same within of a 2sigma uncertainty.

The smaller peak at 230 days is a so-called alias frequency, a well-known phenomenon, resulting from the discrete sampling and the fact, that the data has been taken not nonstop.

A well known effect is the 10 days aliasing, which are caused by the day-night-cycle in astrostronomical observations. But in this case it´s a 1-year-alias. The frequencies 1/230 and 1/544 are rather exactly around 1/365 differently.

Which of both is now the correct?

In this case it looks however strong for the 544 peak: the peak in the Scargle-diagram is more higher, and the curve looks better. Those are no evidences, but good references, the 544 peak it´s the correct value. There is no doubt of the periodical behavior of this line.

Fig. 14

But there is another interesting question:
during certain phases of the periods we found, does appears a so-called triple-peak-emission. The question is, what´s the reason of this feature and why appears it only between the phase sections approximately 0.7-0.9 ?

Thomas Rivinius suspect in this phase sections a higher ionisation level within the corresponding ring areas than in others caused by a lower gas density. In addition it seems, that a triple-peak feature appears also within the Balmer lines Hα, Hβ, Hγ and within the lines of FeII5317 and SiII6347.

Before this new findings the visibility period in 2010 will be particularly interesting and further because of the periastron passage of the companion star.

Comments of the VEGA/CHARA astronomer Philippe Stee:

These informations and diagrams helps a lot to have a global feeling about was is going on and what are the time scales of the physical phenomenon we are following. We will keep in touch but we still have a lot of work to do before starting to write the beginning of a paper !

Ernst Pollmann