HeI-6678 Emission Activity in γ Cas

(by Ernst Pollmann, Leverkusen and Dr. Berthold Stober, Glan-Münchweiler)

(published in Be Star Newsletter, Volume 38 - May 2005)

1. Introduction

γ Cas has been investigated for the most part in the Balmer lines, mainly in Hα. Recent studies considered He and Fe lines as well as the kinematics of the circumstellar shell (Hanuschik, R.W. 1994, Smith, M.A. 1995). While Hα–emission occurs at large distances across the entire shell, the ringlike zones of HeI emission are situated relatively close to the central star. Thus, the strong HeI lines (5876A, 6678A) have an important diagnostic value for activity close to the star's surface. It is believed that a local density enhancement - a one-armed density spiral - is embedded in the accretion disk of γ Cas. The precession of this density enhancement has been observed interferometrically by Berio, P. et al. (1999). They found that this enhanced equatorial density pattern may be located at 1.5 stellar radii from the star's surface. Stee, Ph. et al. (1998) proposed that He excitation and ionization, particularly HeI (6678A), extend to 2.3 stellar radii.

A possible correlation between HeI (6678A) variations and long-term V/R Hα-emission activity from the spiral density enhancement is of considerable interest. The emission in HeI (6678A) is determined by both the geometry of the circumstellar disk and its orbital velocity around the star. The rapid activity of HeI (6678A) emission in this star is best examined by spectroscopy with high time resolution over an extended period. Recent investigations of Smith, M.A. (1995), Harmanec, P. et al. (2000) and Miroshnichenko, A.S. et al. (2002) give detailed information about long-term monitoring of the phase dependent radial velocities related to the time performance of the equivalent width of the HeI5875-Emission. This report is concerned however in contrast to it with the behavior of the HeI6678-Emission.

2. Results

First spectra from Pollmann with a resolution R~8500 come from May 2002 obtained with the grating spectrograph of the 200 mm Schmidt-Cassegrain telescope of the Vereinigung der Sternfreunde Köln. The spectra of Stober were taken with a 300 mm Newton telescope and a Littrow-grating spectrograph (R~8000). Usually, about 100 CCD spectra, with integration times of 20-30 sec. were combined. Each single spectrum has been carefully examined for cosmic rays. In case of any cosmic ray appearence the respective spectrum has been rejected not to introduce artificial flaws within the nightly sum spectrum. The complete data reduction and equivalent widths measurement have been done according to a standard procedure as already described in Pollmann (1997). The accuracy of a EW measurement was determined in each sum spectrum according to the method of Chalabaev, A. and Maillard, J.P. (1983). The size of the error bars of individual data points correspond to the maximum standard deviation of 14%. Our S/N ratio was always between 400 and 1600. To evaluate the time behavior of emission activity and to reduce error bars, we combined individual values of the equivalent widths of the violet component EW(v) and the red component EW(r) to the sum EW (v+r) = EW(v) + EW(r) as it is shown in fig. 1.

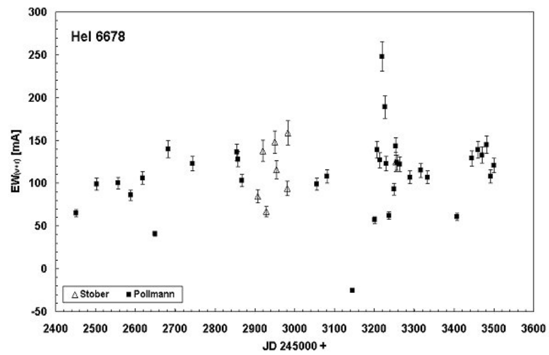

Fig. 1: Time behavior of the HeI6678-emission

In fig. 2 single spectra are combined as a "average normal spectrum"

for the period May 2002 - March 2004 (JD 2452452 - 2453081).

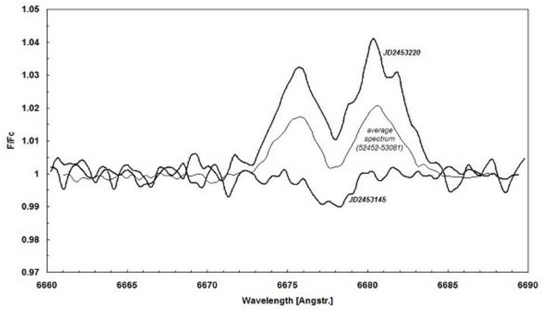

Fig. 2: Comparison of the "average normal spectrum" to the HeI-6678 absorption spectrum

at JD 2453145 and maximum emission spectrum at JD2453220

On May 19, 2004 (JD2453145) we observed HeI6678 only as weak absorption of EW (v+r) = 25 mA but followed by a strong and short outburst until about August 02 (JD2453220) with a maximum of EW (v+r) = -255 mA. To illustrate these two „events" the appropriate spectra are printed together with the "average normal spectrum" in fig. 2. Beyond that fig 3. points the sum spectra of the extreme events to the elucidation at JD2453145 and JD2453220 in the section 6500-6700 Angstr.

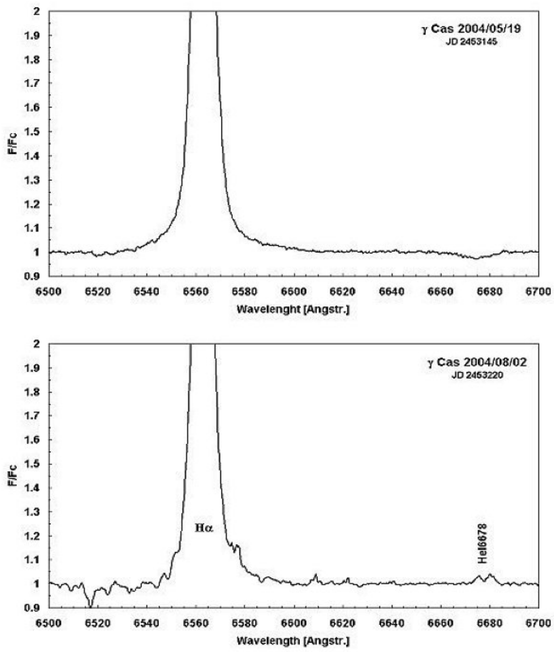

Fig. 3: To the elucidation the spectra of the "extreme events"

at JD2453145 and JD2453220 in the 6500-6700 Angstr.-section

To find any correlation between HeI6678 activity and Hα-emission we show EW(v+r) and simultaneous EW(Hα)-measurements in fig. 4. With an uncertainty in Hα of approximately 2% and as previously mentioned with approximately 14% in EW(v+r) and with a correlation coefficient (R2) of 0,009 (linear regression) no correlation between both measured variables is to be recognized.

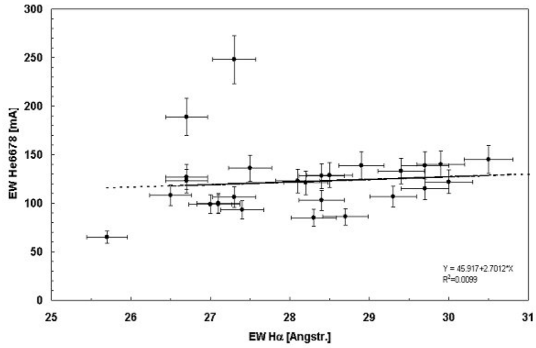

Fig. 4

What could mean that?

First is the question whether we have to expect an interrelation of this kind at all. Because they are the emergence product of the emission activity circum stellar material of the system, one would like to believe that both lines would have to actually stand in relationship. Therefore one could expect e.g. with increasing mass loss an almost simultaneous increase of the EW of both lines.

If on the other hand the density increase continues outward, the HeI6668 intensity would become smaller, during one should observe in Hα a change of profile, caused by further distribution in the disk. Another factor, which affects the behavior of both lines, could be the magnetic activity close to the photosphere of the primary star. So, it is rather difficult to forecast, which kind of interrelations can be observed, if at all one. In order to be able to answer this kind of questions, probably still very many more observations will be necessary.

Therefore the goal of this paper can be only, to wake more attention also with other or more observers regarding this certain problem.

One can be said however with certainty, that all changes in the double peak profile of the HeI667 line have their origin in the disk dynamics as one can also assume that both photospherical density changes and disk density changes can have been present with a probably time-dependent mass loss. If on the other hand the disk density is low close of the photosphere, no double peak emission would be observably as also the photospherical component in the line profile changes would dominate. If however the mass loss increases, the disk density resulting from this increase becomes stronger, goes double peak profiles into action, whereby disk density changes control the observed variability in the equivalent width.

It seems, that in certain exceptional cases g Cas shows a more or less constant photospherical emission activity of the HeI-6678-Linie of 1-2% of the continuum, as visible in our average normal spectrum and as seen by Smith, M.A. (1995). For this reason a further continuous monitoring seems to be of large interest.

References:

Berio, P., Stee, Ph., Vakili, F., Bonneau, D., Mourard, D., Chesneau, O., Thureau, N., Le Migrant, D.,

Hirata, R., 1999, Astron.& Astrophys. 345, 203-210

Chalabaev, A., Maillard J.P., 1983, Astron.& Astrophys. 127, 279-288

Harmanec, P., P. Habuda, S. Stefl, P. Hadrava, D. Korcakova, P. Koubsky, J. Krticka, J. Kubat, P. Skoda, M. Slechta, M. Wolf, 2000, Astron.& Astrophys. 364, L85-L88

Hanuschik, R. W., 1994, Proceedings of IAU Symposium 162, Eds. Balona, L.A. et al. (eds.), Kluwer Academic Publishers, pp. 265-266

A. S. Miroshnichenko, K. S. Bjorkman, V. D. Krugov, 2002, Publ. of the Astron. Soc. of the Pacific, 114: 1226-1233

Pollmann, E., 1997, Be-Star-Newsletter, 32, 11

Smith, M. A. 1995, ApJ, 442; 812-821

Stee, Ph., Vakili, F., Bonneau, D., Mourard, D., 1998, Astron.& Astrophys. 332, 268-272