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# H$\alpha$ OBSERVATIONS OF THE BINARY SYSTEM HR 2142

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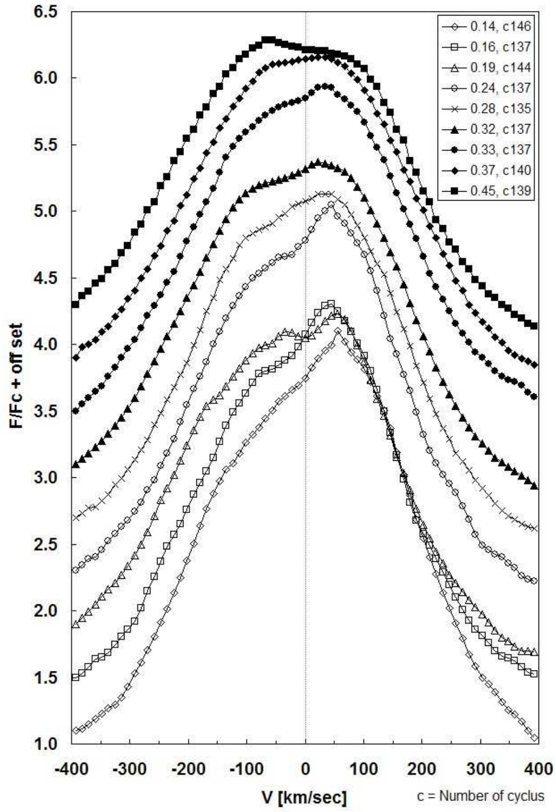
HR 2142 (HD 41335, V696 Mon) is a Be star of visual magnitude 5.2 mag. In the past 50 years it was the subject of many studies. Its projected rotational velocity ($v \sin i$) is very high (350–400 km/s) (Peters, 1972; Slettebak, 1982). The extreme width of the emission lines made it difficult to classify the spectrum, but today HR 2142 is classified as B2IVe. The most remarkable characteristics of its spectrum are the Balmer emission lines with a central reversal or absorption feature from the circumstellar envelope. Since the discovery of periodic profile variations in the Balmer lines HR 2142 has been considered to be a binary system with an orbital period of 80.86 days (Peters, 1983, 2001; Peters & Gies, 2002). The circular orbital solution was obtained from RV measurements based upon measurements of the wings of the broad Balmer and He lines (Peters, 1983). The ephemeris from that paper:

$$T = \text{JD } 2441990.5 \pm 1.1, \qquad P = 80.860 \pm 0.005 \text{ days}$$

was used for calculation of the phases here. The periodic behaviour mainly pertains the appearance of primary and secondary shell phases (Peters, 1972). This is indicated by the appearance of shell (absorption) lines in the emission Balmer profiles and by periodic H$\alpha$ $V/R$ variations.

Since the azimuthal distribution of this plasma material is complex and the H$\alpha$ profile comes from extended disk regions, a tomographic study for mapping the $V/R$-variations is considered particularly useful. It may contribute to clarify whether the variability is further strictly periodic or whether there are references of disturbances by disk instability (completely without companions) or tidal disturbances. Therefore Monika Maintz and Thomas Rivinius, then staff astronomers from the Landessternwarte Heidelberg in Germany, suggested a collaboration with amateur astronomers who could provide line profile observations with a more frequent coverage than it is possible at large observatories. In general the strength of central reversal depends on the inclination of the binary's orbital plane to the line of sight. High inclination causes a strong central absorption, because the infalling gas intersects the line of sight. With a dispersion of at least 35 Å/mm and $R \sim 12000$ these $V/R$ variations can be observed with instruments now available to amateurs.

The spectra discussed here were obtained with a 20-cm ($f/4$) Schmidt–Cassegrain telescope at the observatory of the Vereinigung der Sternfreunde, Köln, connected with a slitless spectrograph: dispersion = 27 Å/mm, $R \sim 14000$. Fig. 1 illustrates my findings with 30 individual H$\alpha$ spectra that were obtained from September 2003 to April 2006.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0.16, c137
0.19, c144
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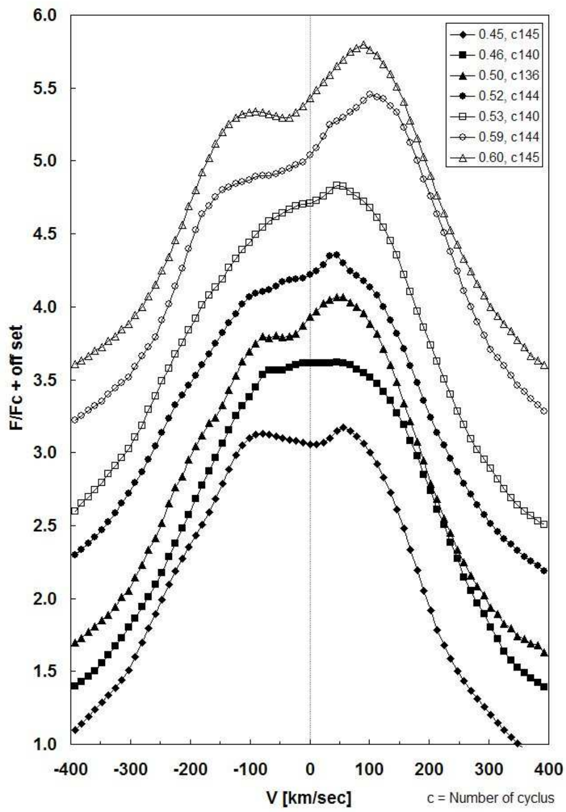
0.37, c140
0.45, c139
F/Fc + off set
V [km/sec]
c = Number of cyclus


0.45, c145
0.46, c140
0.50, c136
0.52, c144
0.53, c140
0.59, c144
0.60, c145
F/Fc + off set
V [km/sec]
c = Number of cyclus

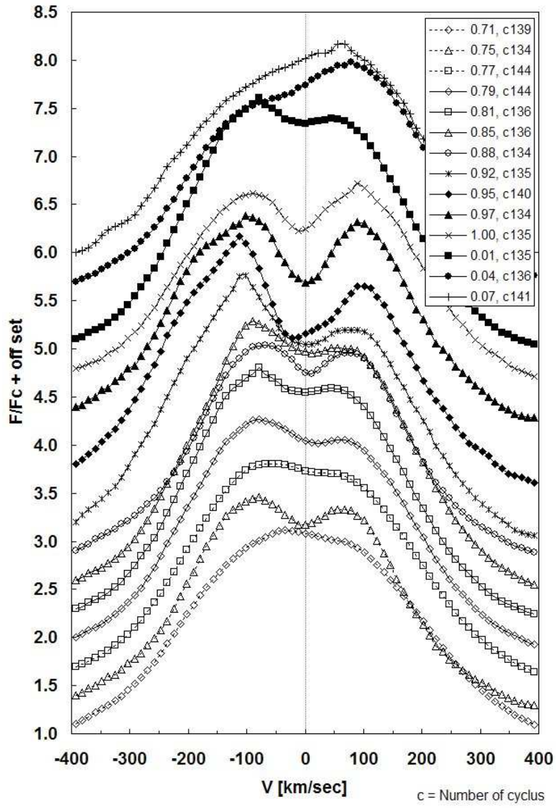



**Figure 1.a–c.** The three panels show the H$\alpha$ profiles arranged according to the orbital phase. It can be seen that the $V/R$ ratios during the orbital period are mostly less than 1, while between phases 0.75 and 0.07 the $V/R$ ratios larger than 1 are more common. During the shell phase the absorption component in H$\alpha$ is flanked by the emission. On the other hand, we do not see any strict periodic behaviour of the $V/R$ ratio like in some (but not all) other binary systems. This fact can be an indication of a complicated behaviour in the circumstellar matter in the system of HR 2142

Depending on the orbital phase, we see the enhanced emission either red- or blueshifted as $V/R$ variation. The central reversal develops around phase 0.0 or 1.0, when an additional plasma material infall is in front of the Be primary. At this phase the companion is between the observer and the Be star. The extent, to which the disk is symmetrically distributed with respect to the line of sight, affects the observed strength of the $V$ and $R$ peaks.

Within the three observational periods different orbits are phasedly represented. Fig. 1 shows variations with the orbital phase and some changes from cycle to cycle. The legend at right identifies the orbital phase of each spectrum. The phase-dependent $V/R$ behavior derived from these spectra is shown in Fig. 2.

The uncertainties on EW and $V/R$ were determined by measurements of standard stars on three nights for a total of 8 hours of observation. For both values uncertainty was less than 3% for individual measurements at one night. A sharp decrease in $V/R$ between phases 0.9–1.04 is clearly visible. The derived $V/R$ ratios of the spectra between 09/2003–04/2006 have maximum values of 1.07 at phase 0.85 (2003/2004), 1.22 at phase 0.93 (2004/2005) and 1.16 at phase 0.9 (2005/2006). In addition there is a remarkable $V/R$ change between phases 0.5 and 0.6. At these phases, the companion is behind the primary component. The $V/R$ change is also observable here, similar to the situation at phase 1.0, although it is less pronounced because of the eclipse of the primary.

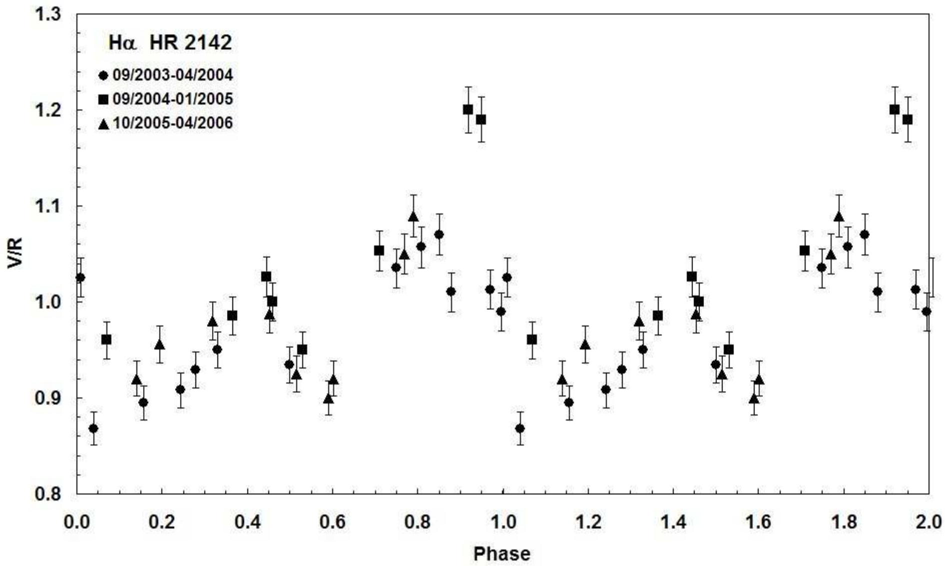



**Figure 2.** $V/R$ variation of H$\alpha$ based on observations from 09/2003–04/2004, 09/2004–01/2005, 10/2005–04/2006

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