Periodic behavior of the HeI6678 emission in δ Sco

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δ Sco is a binary system with an eccentric orbit which is exhibiting a strong mass loss that has resulted in a circumstellar gaseous disk formation. This study of a correlation between Hα- and He I 6678 equivalent widths (EWs) and the He I 6678 line profiles have been performed at the observatory of the "Vereinigung der Sternfreunde Köln" (Germany) with a 0.4 m Schmidt-Cassegrain-telescope C14. A classical slit-grating-spectrograph with a spectral resolving power R ~ 14000 and a CCD-camera (768 x 512 pixel, pixel size 9μ) provides spectra within the range from 6500 to 6700 Å. The spectra have been reduced manually with the programs VSpec and MK32. A high signal-to- noise ratio (as a rule > 400) is necessary to obtain simultaneous information about the strength and line profile behaviour of Hα and the double-peak emission line of He I 6678.
Following the generally accepted assumption that the disk of this binary system is being fed in a kind of outbursts (Miroshnichenko et al., 2003), and since the He I 6678 line forms near the photosphere of the primary component one can expect a correlation between the equivalent width of the H-alpha and and He I 6678 lines (Fig. 1). Such a correlation might be interpreted as a result of a disk feeding process. However on the other hand we can not exclude, that this reflects only contemporaneous density variations within the line formation zones.

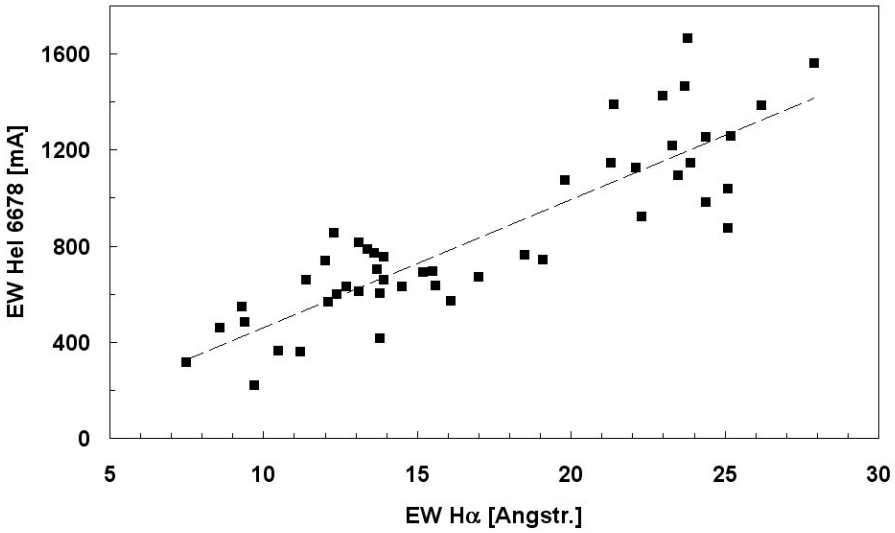

Fig. 1: Correlation between the equivalent width of HeI 6678 and Hα from 04/2005 to 08/2009

Since April 2005, during every observing season, the observed correlation impressively upports the existence of this disk-feeding process, in which the slope of the linear fit shown in Fig. 1 reflects the quantitative correlation. In addition to the analysis of the EWs measured in the same spectra, the He I 6678 line double-peaked profile exhibits a variable V/R ratio. For the first time it was possible to monitor the entire cycle of the V/R variations in 2009 (Fig. 2). In the earlier seasons, merely the descent could be measured. On this occasion I would like to

emphasize particularly that, amongst others, members of the French group, ARAS (http://www.astrosurf.com/aras), made a significant contribution to the frequent observations.

The V/R measurements of the five cycles presented here permitted an analysis of its possible periodicity (Fig.2). Thom Gandet, Thomas Rivinius and Ernst Pollmann independently calculated the following periods:

Gandet: 535 d ± 5 d
Rivinius: 536 d ± 4 d
Pollmann: 541 d ± 15 d

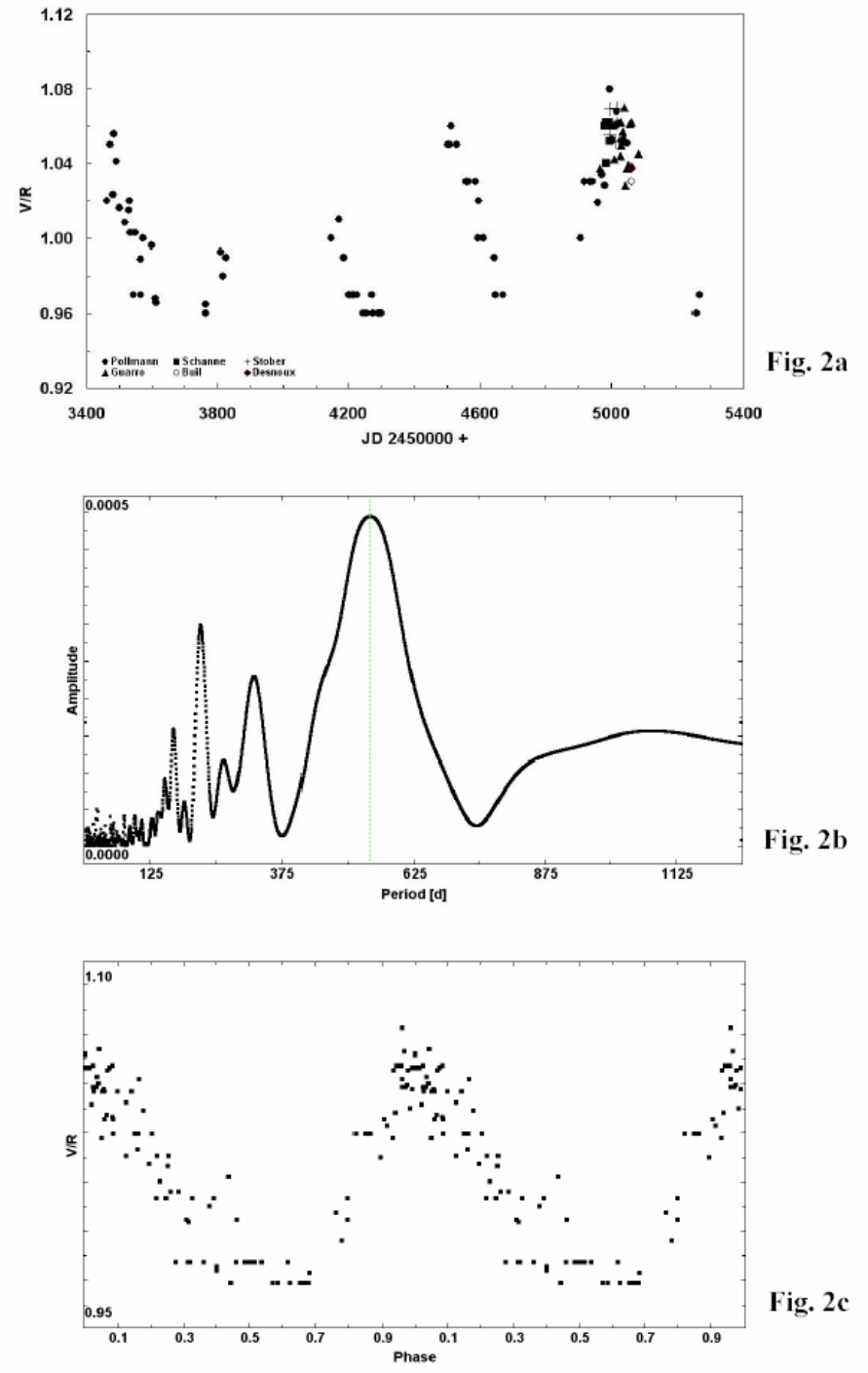

Fig. 2a

Fig. 2b

Fig. 2c

Fig.2: Plots of the periodogram analysis with program AVE

a) V/R-time behaviour
b) Periodogram of the data shown in fig. 2a
c) Phase plot of the data shown in fig. 2a

The ephemerides of the V/R variability are the following:
JD 2453420 (± 8-12) + 535 * E (Gandet)
JD 2453935 (± 10) + 541 * E (Pollmann)

The V/R-ratio has been measured only in the spectra for which both peaks are apparent. In the observations reported here, the triple peak structures were observed on the following dates:
2006: 04/02, 05/02, 05/11, 06/02, 06/23, 06/29, 07/02, 08/13, 08/18,
2009: 05/29, 06/13, 06/19, 06/21, 07/04, 07/12/ 07/18.

An inspection of the V/R phase curve shows that the third emission component was observed only within the phase interval ~ 0.67 to ~1.1 (see fig.3). This might be due to the presence of a density enhancement in front of the star and hidden behind it at other phases.

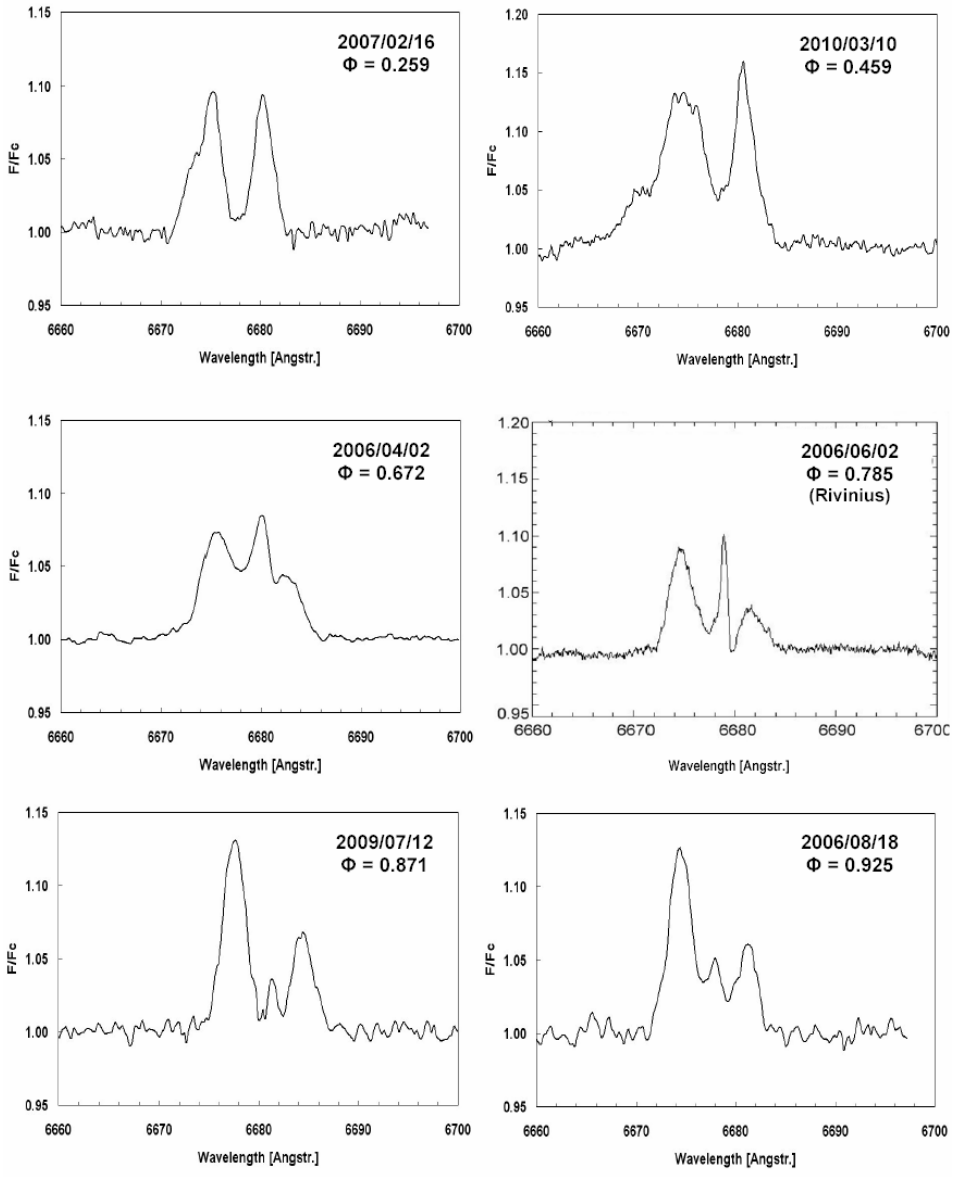

Fig. 3: Examples of the He I 6678 line profile labeled with observing dates and the V/R cycle phases.

Reference
Miroshnichenko, A. S., et al. 2003, A&A, 408, 305-311