Chromospheric activity of some bright contact binary stars

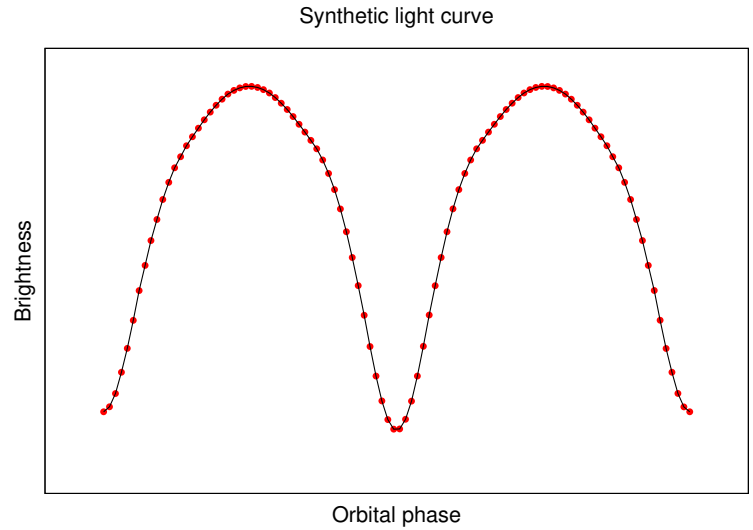
Tibor Mitnyan

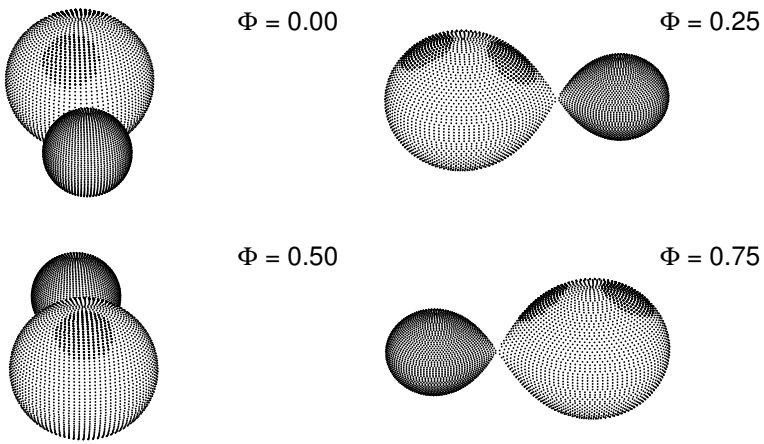
Baja Astronomical Observatory of Szeged University, Hungary

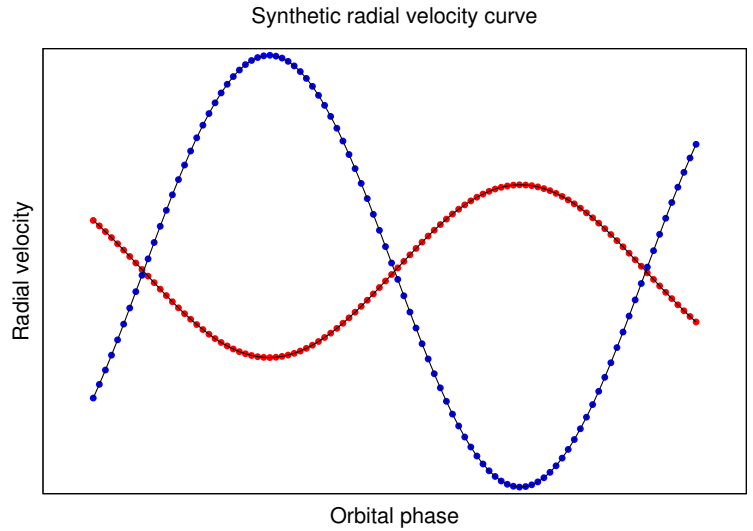
Universe of Binaries, Binaries in the Universe

Contact binaries

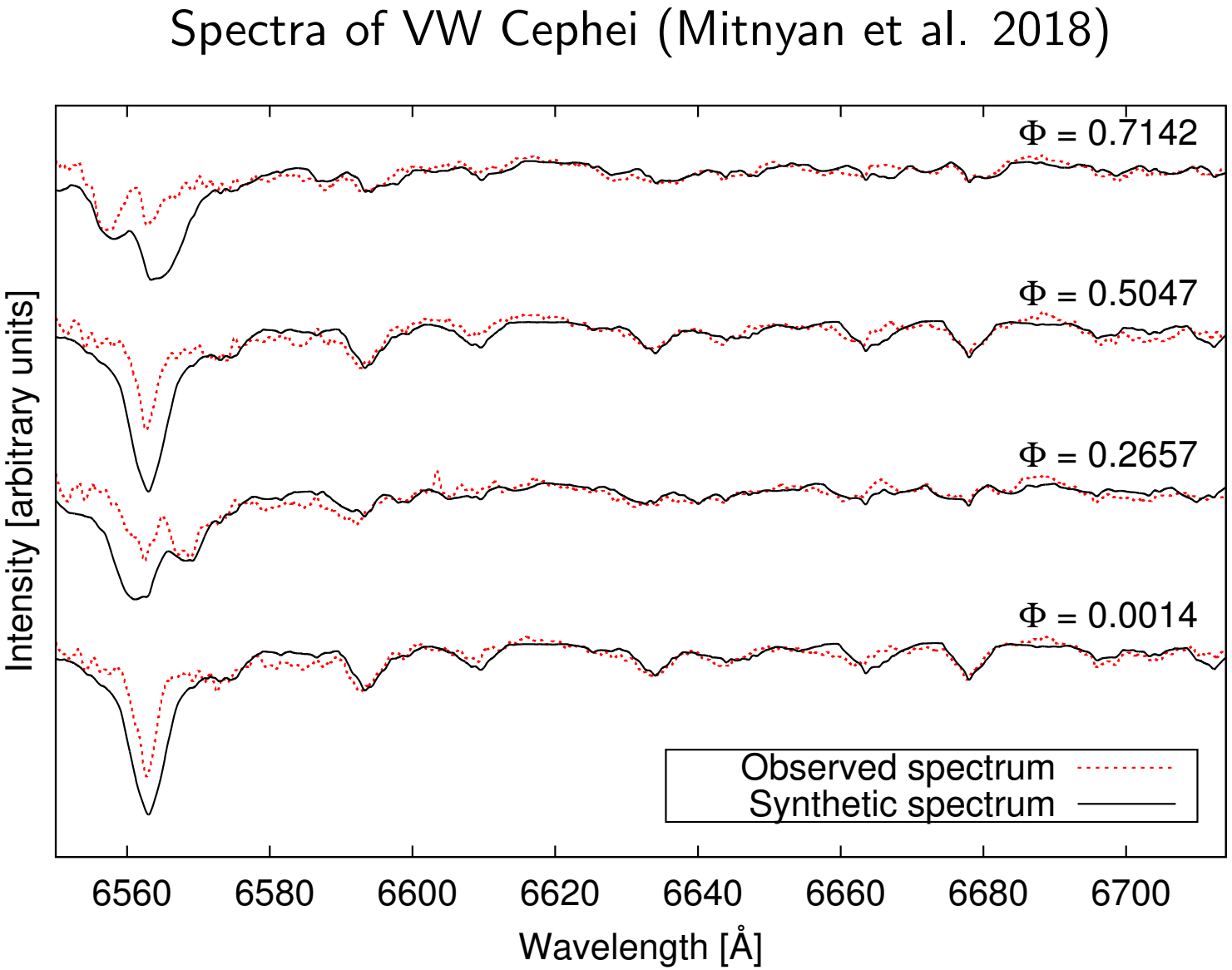
- Both stars fill their Roche-lobes
- Strongly distorted shapes
- Common convective envelope
- Mass/energy transfer
- Several members show activity signals



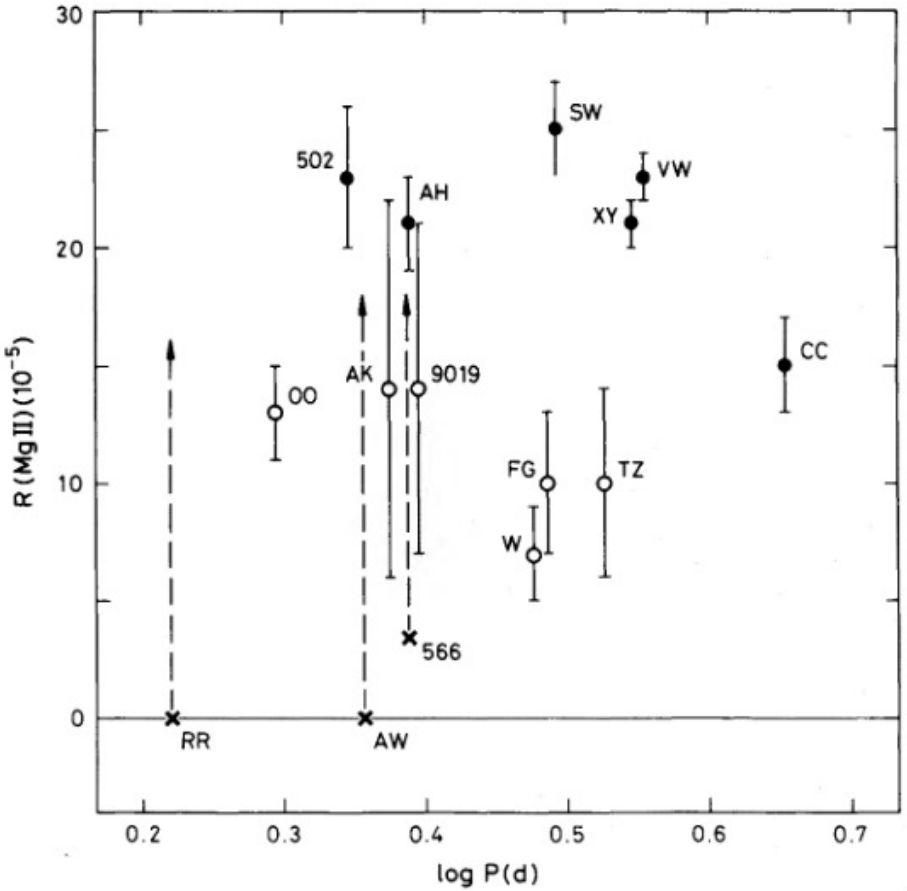


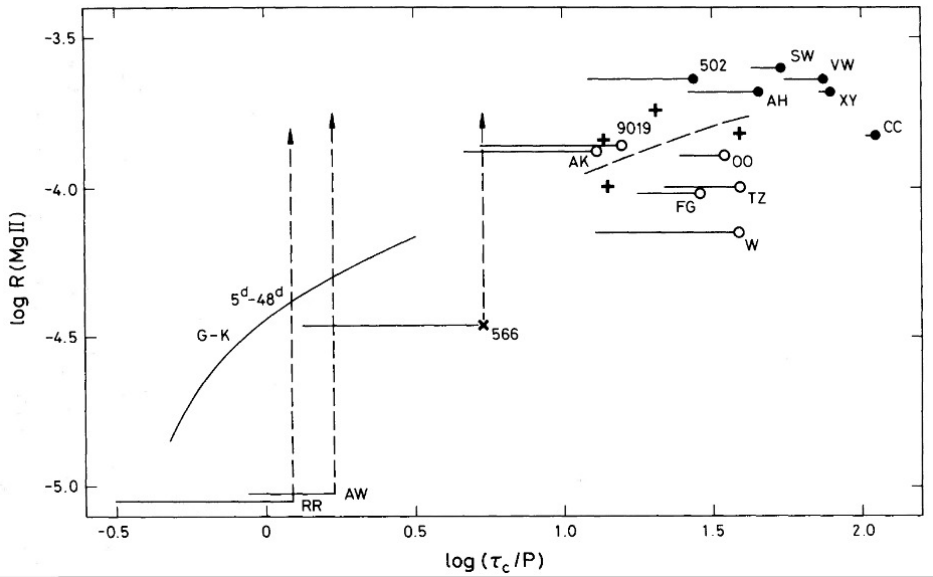


Signal of chromospheric activity in Hα



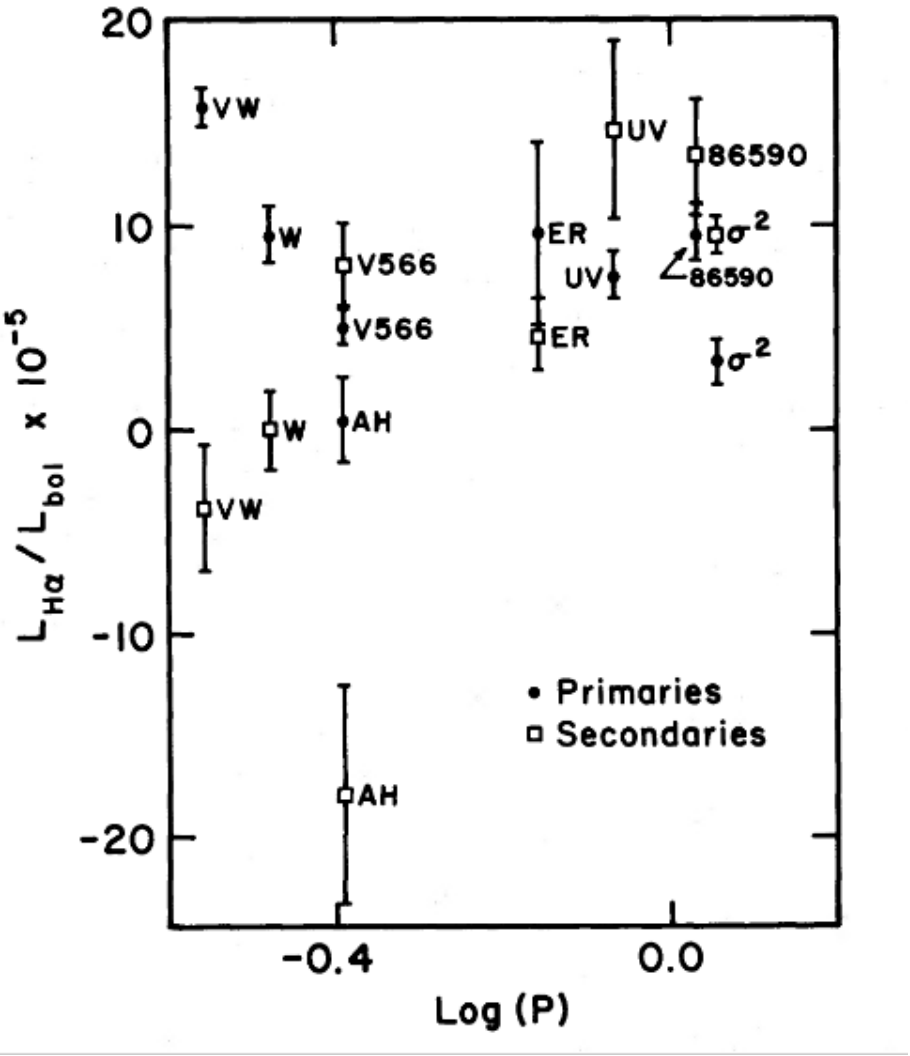
Previous studies in the literature (Mg II – UV)

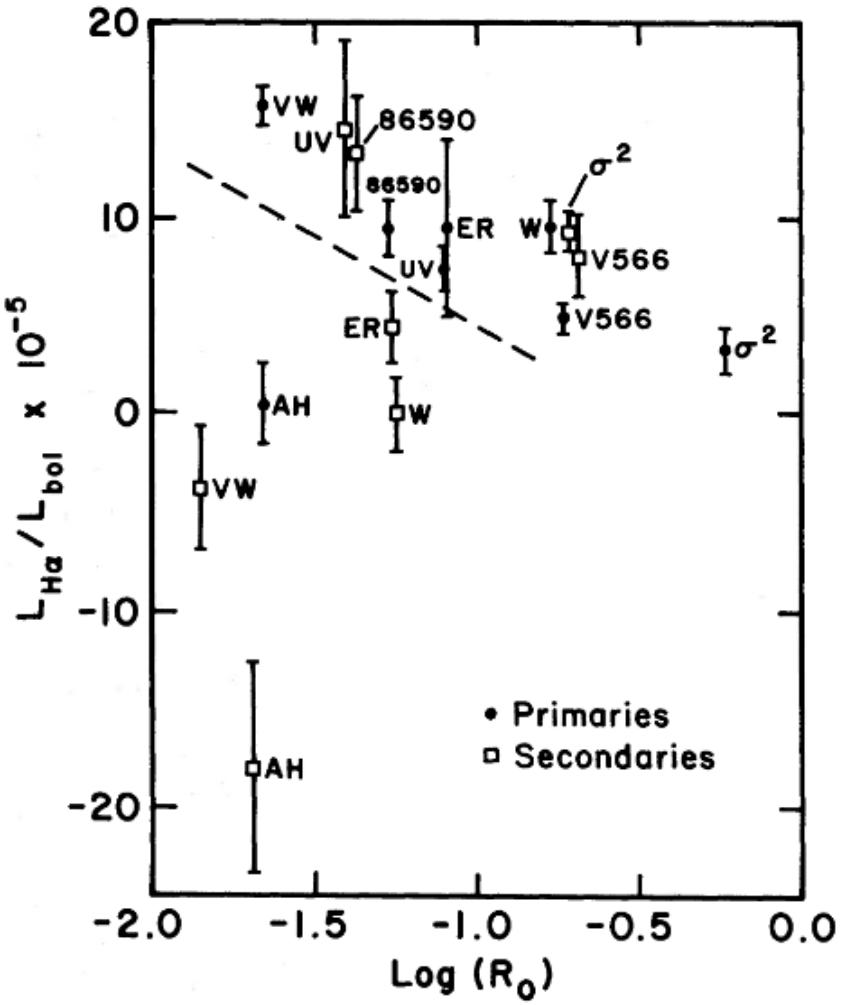




Rucinski (1985)

Previous studies in the literature (Hα – optical)





Barden (1985)

Main goals of the project

- Observing as many systems as possible
- Observing at least one orbital cycle
- Deriving new radial velocity curves
- Measuring the strength of the chromospheric activity
- Searching for correlations with different parameters
- Analyzing short-term variations

Observation campaign

Konkoly Observatory, Hungary
1m RCC telescope
$R \sim 20\,000$ echelle spectrograph
Magnitude limit: $V \sim 8.5$

NAO Rozhen, Bulgaria
2m RCC telescope
$R \sim 20\,000$ echelle spectrograph
Magnitude limit: $V \sim 10$

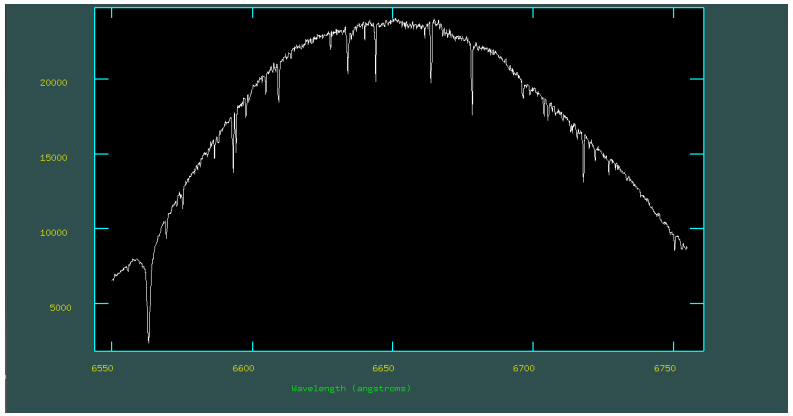
Observed objects: KR Com, V1073 Cyg, V2150 Cyg, LS Del, V972 Her, SW Lac, EX Leo, V351 Peg, V357 Peg, OU Ser, V781 Tau, HX UMa

Data reduction

Automatic IRAF script for:

- basic corrections of spectra
- extraction of orders
- wavelength calibration
- blaze function correction

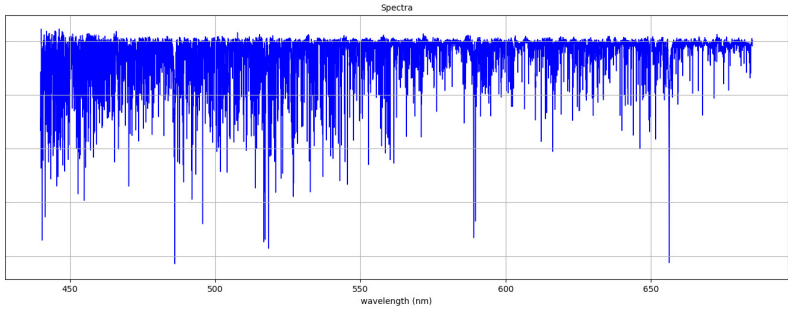
A calibrated spectrum in IRAF



Automatic iSpec script for:

- continuum normalization
- barycentric correction
- subtraction of telluric lines
- creating 1D spectra

A normalized 1D spectrum in iSpec

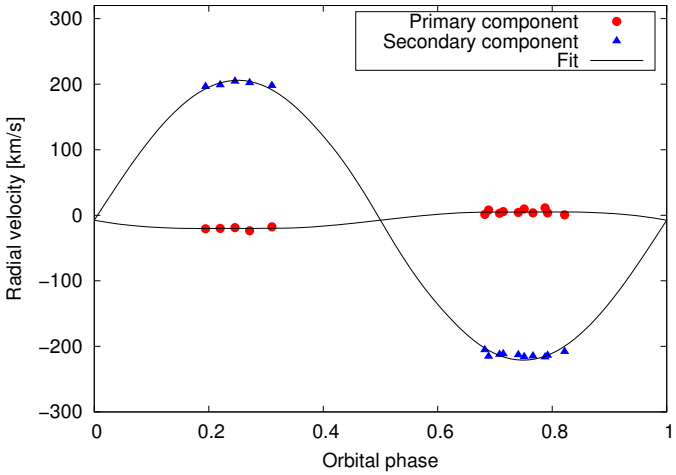


Analysis methods

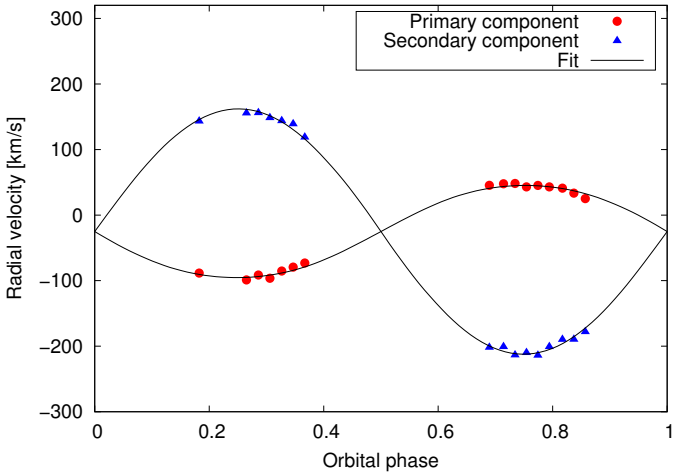
- Radial velocities with the cross-correlation technique
- Radial velocity curve fitting with PHOEBE
- Python code for spectrum synthesis
- Convolution of model atmospheres with synthetic rotational broadening functions
- Subtraction of the synthetic models from observed spectra
- Hα equivalent width measurement on the residual

Results – radial velocity curves (Mitnyan et al. in prep.)

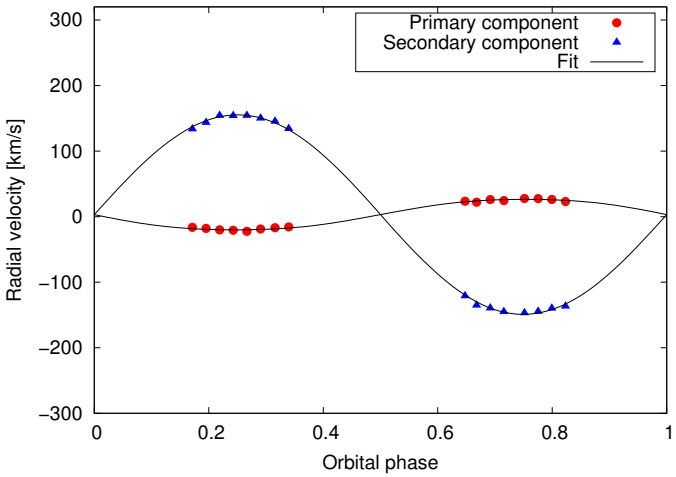
KR Com



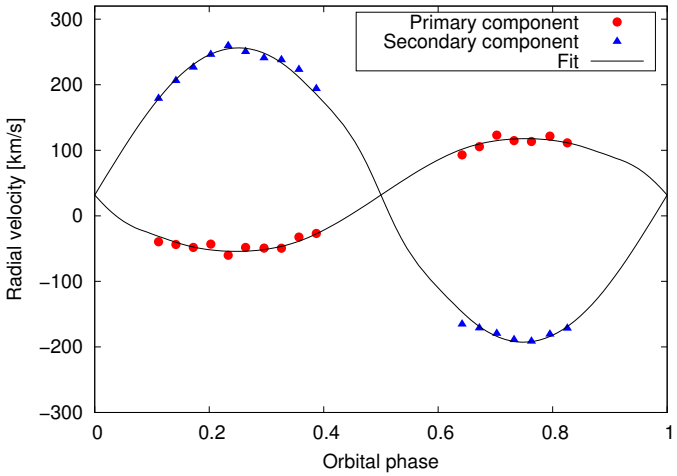
LS Del



V972 Her

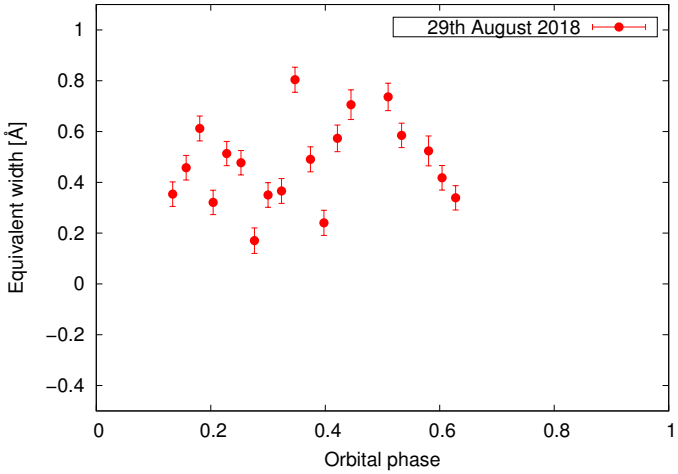


V781 Tau

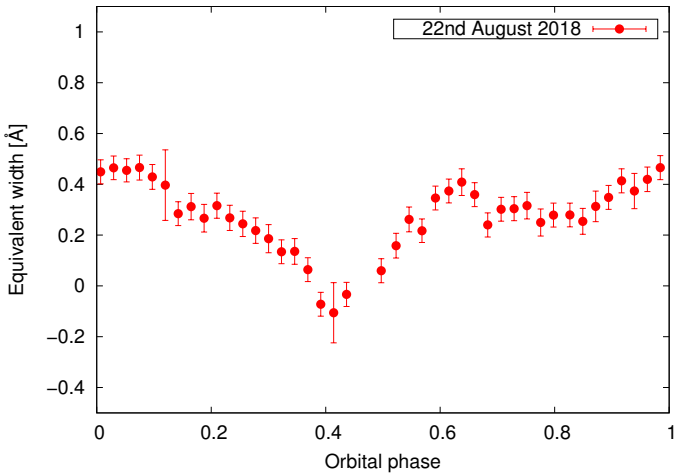


Results – short term variations (Mitnyan et al. in prep.)

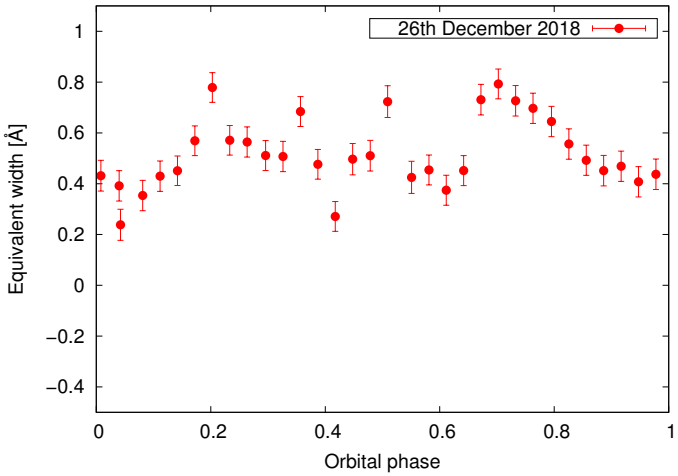
V2150 Cyg



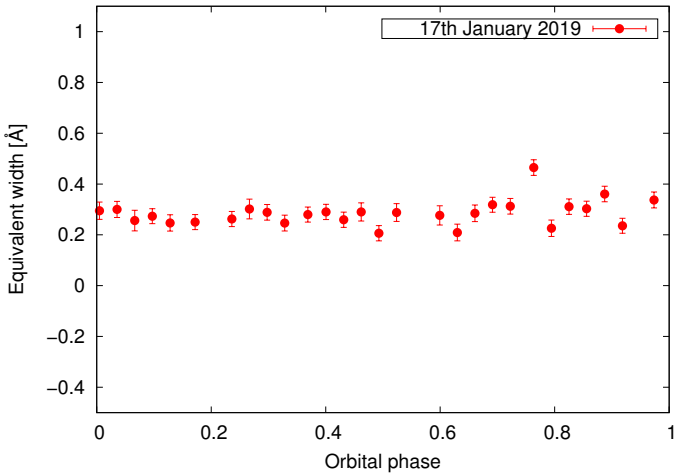
SW Lac



V781 Tau

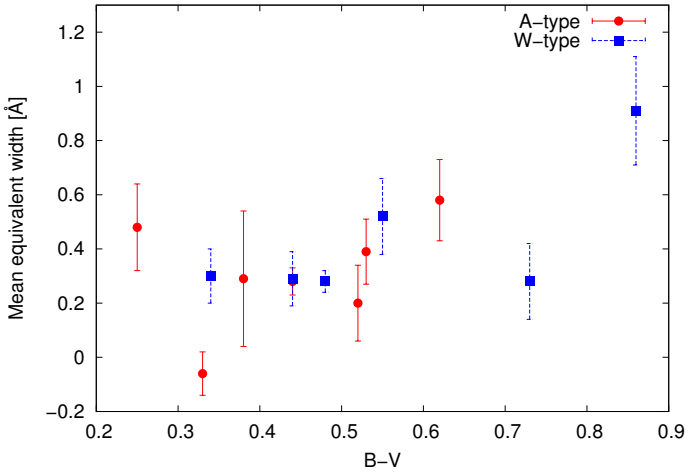


HX UMa

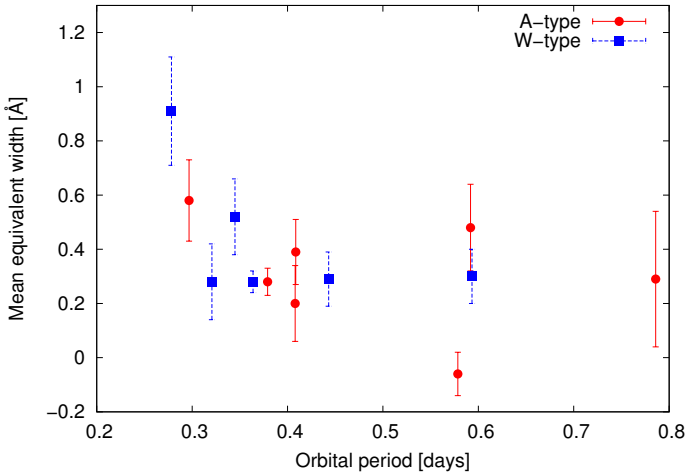


Results – parameter correlations (Mitnyan et al. in prep.)

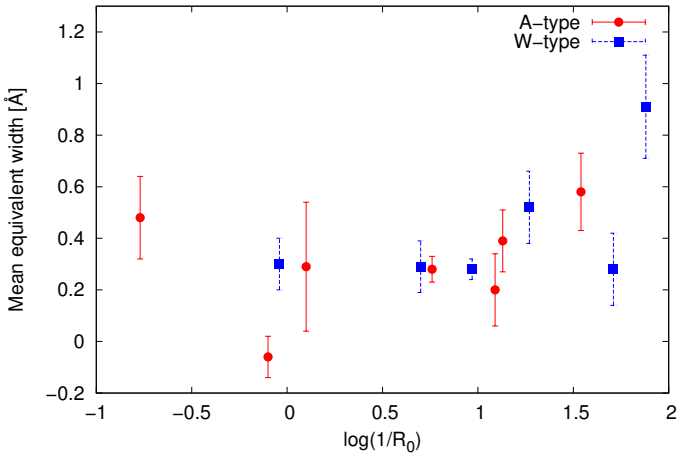
Hα EWs vs. B−V



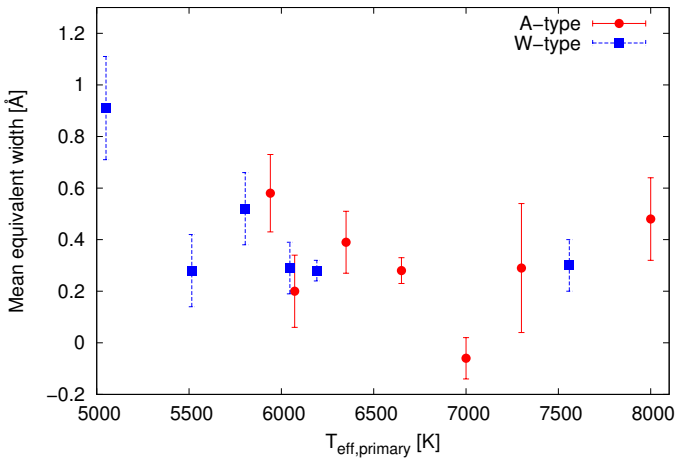
Hα EWs vs. orbital period



Hα EWs vs. inverse Rossby number

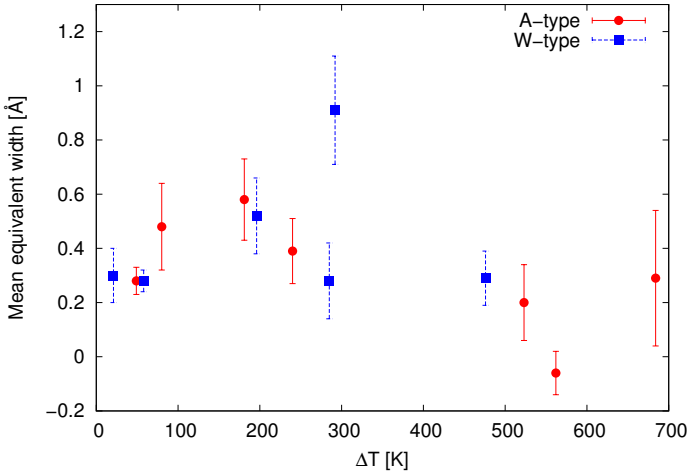


Hα EWs vs. $T_{\mathrm{eff,\,primary}}$

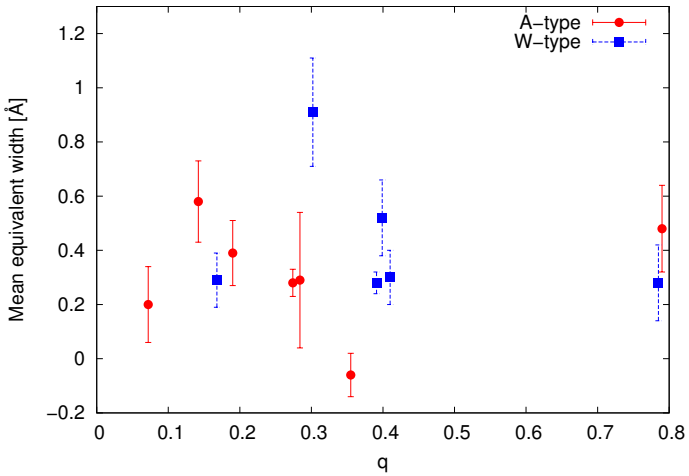


Results – parameter correlations (Mitnyan et al. in prep.)

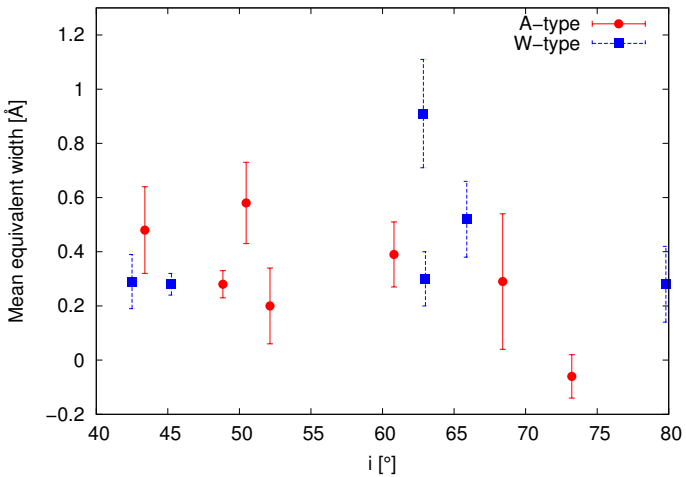
Hα EWs vs. temperature difference



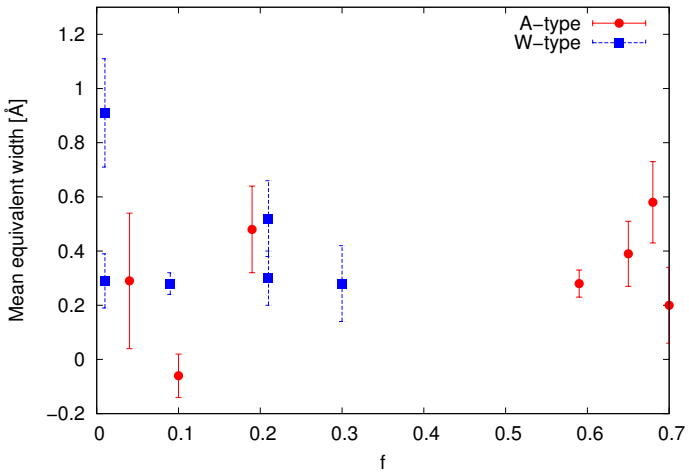
Hα EWs vs. mass ratio



Hα EWs vs. inclination



Hα EWs vs. fill-out factor



Summary

New results

- Re-determination of mass ratios and systemic velocities
- Short-term chromospheric activity variation diagrams for 12 CBs
- Parameter correlation diagrams based on 13 CBs

Conclusions

- Trends are more or less present on the correlation diagrams
- Increasing the sample size could help to find their true nature
- The eternal problem: more observations are needed

Thank you for your attention!

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References

Barden, S. C., 1985, ApJ, 295, 162
Mitnyan, T., Bódi, A., Szalai, T. et al., 2018, A&A, 612, A91
Rucinski, S. M., 1985, MNRAS, 215, 615

IRAF: http://iraf.noao.edu/
iSpec: https://www.blancocuaresma.com/s/iSpec/
PHOEBE: http://phoebe-project.org/1.0/