



Applications of Fourier disentangling on the spectra of multiple stars

Mgr. Jan Elnér

Outline

- 1. What is NOT on my poster - motivation
- 2. Method of Fourier disentangling
- 3. Program KOREL
- 4. 96 Her
- 5. Summary

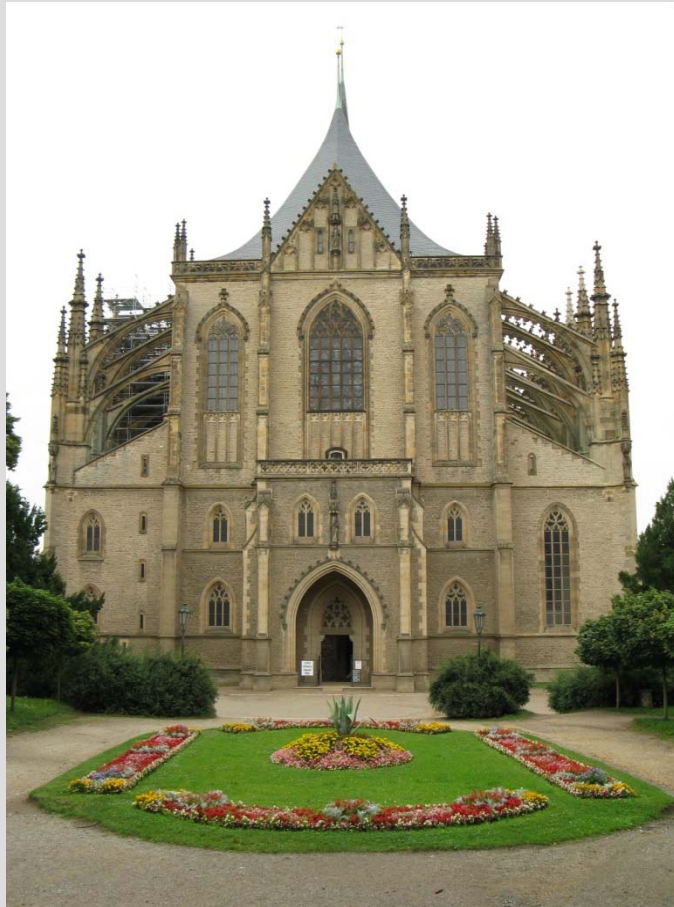
Cute kitties



Cute dogs



Historical monuments



Magnificent mountains



There are other interesting things, like ...

Fourier decomposition (disentangling) of stellar spectra

Simple disentangling

- Simultaneous decomposition of spectra and determination of their RV, or direct solution of orbital parameters (Simon & Sturm, 1994)

$$\begin{pmatrix} \mathbf{M}_{A1} & \mathbf{M}_{B1} \\ \dots & \dots \\ \mathbf{M}_{AN} & \mathbf{M}_{BN} \end{pmatrix} \begin{pmatrix} \mathbf{I}_A \\ \mathbf{I}_B \end{pmatrix} = \begin{pmatrix} \mathbf{I}(t_1) \\ \dots \\ \mathbf{I}(t_N) \end{pmatrix}$$

- Set of $M \times N$ linear equations, M – number of pixels in a typical exposition, N – number of expositions
- \mathbf{M} are matrices with units shifted off-diagonal for RV in pixels

Fourier disentangling

- Hadrava (1995)
- Calculates with Fourier images of the observed spectra
 - numerically easier
 - allows further generalization

Principle of the Fourier disentangling

- Principle of disentangling lies in minimalization of the sum of integrated squares of deviations between observed and modelled spectra

$$0 = \delta \sum_{l=1}^N \int \left| I(x, t_l) - \sum_{j=1}^n I_j(x) * \Delta_j(x, t_l, p) \right|^2 dx$$

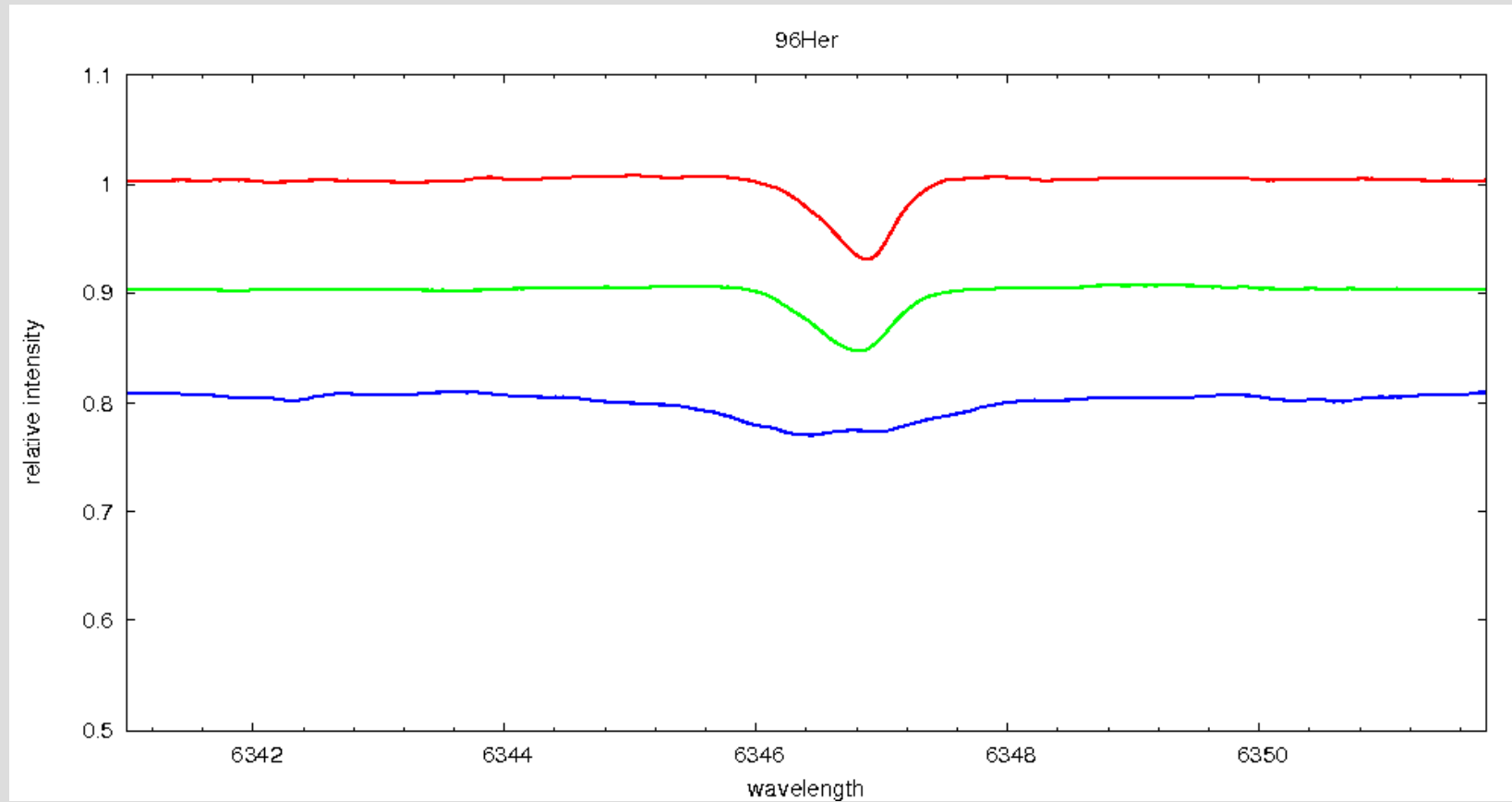
KOREL

- Developed by dr. Hadrava (1995, 1997)
- Fourier disentangling
- Decomposition of time series of multiple systems' spectra (max. 5 components)
- From k spectra of n stars ($k > n$) finds individual spectra and corresponding RV by the method of least squares
- It is possible to determine orbital elements of the system – using simplex minimalization method

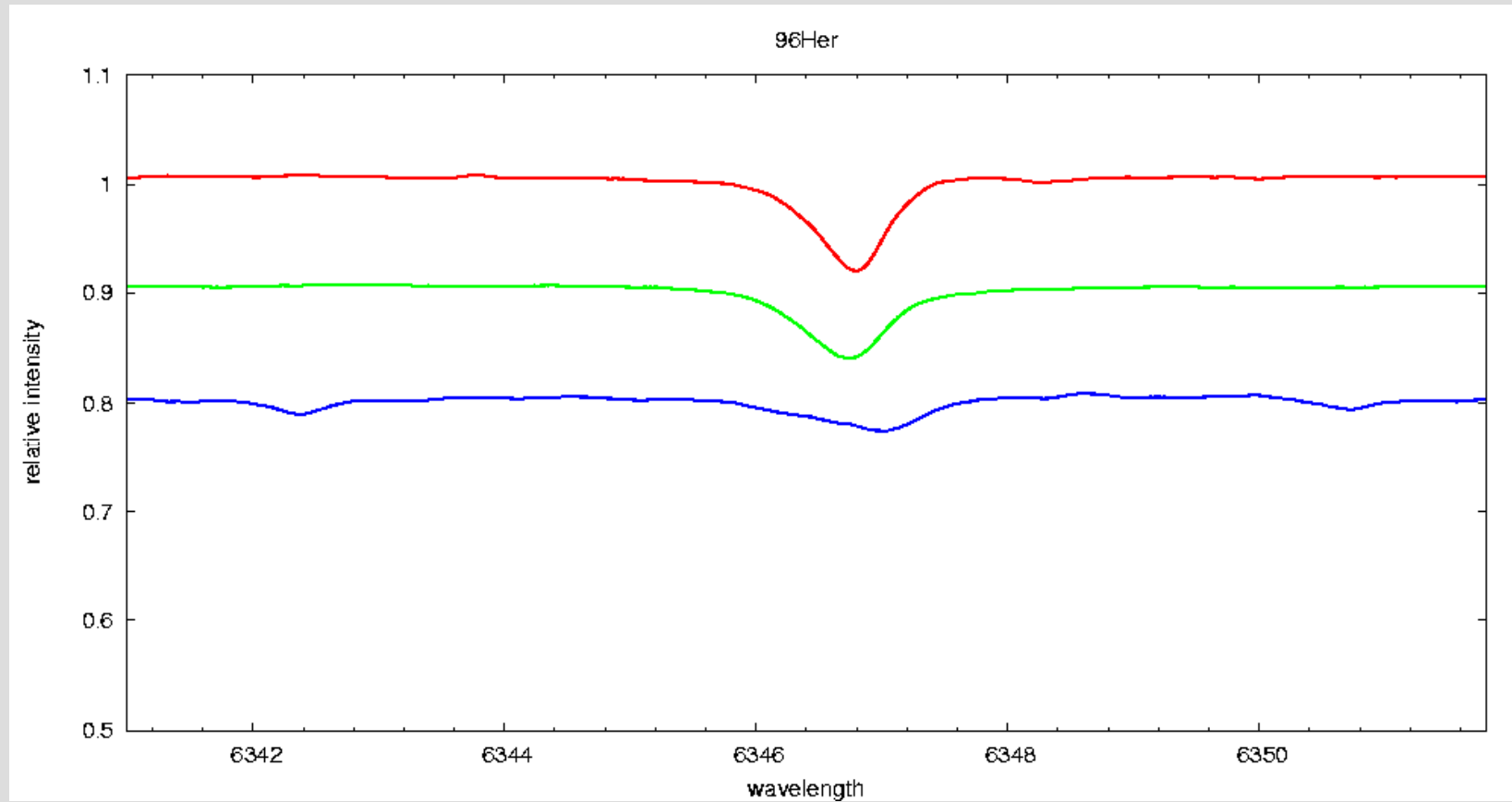
96 Her

- All components visible in the spectrum are B2-3V
- Variation of RV discovered in 1911 (Mitchell)
- Presence of another component (besides the binary) confirmed by several observations
- Suspicion for apsidal motion, precession of the orbit of the close binary A+B, orbitally bound changes in brightness

All spectra – 3 components



All spectra – 2 stellar components + 1 telluric



96 Her – summary

- Cca 70 spectra processed and used for calculations with KOREL
- Third component was separated from the composite spectra – its nature is not definitely distinguished – small sensitivity to longer periods
- Orbital parameters in individual datasets differ



That's all for now...

Thank you for your attention