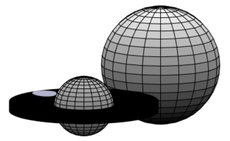
AU Mon: Probing the complex, unstable flows of a high rate mass transfer binary system

Antonio Armeni, anto.armeni10@gmail.com University of Pisa



Introduction & Methods

AU Mon (HD 50846) is a partially-eclipsing, double-lined spectroscopic binary caught in a stage of rapid mass transfer. Main features:

- Be-type gainer + G-type donor,
- permanent thick accretion disk around a MS star,
- $P = 11.1\,d$, $i = 80\,\mathrm{deg}$.
- Photometric variability $\sim 0.25\,mag$ on a timescale $\sim 37.5\,P$ (DPV). This **long cycle** can be thought of as two states, i.e. **faint** ($0.25 < \phi_L < 0.75$) and **bright** ($0.75 < \phi_L < 1.25$). See [1] for ephemerides.

I've performed a *multi-wavelength spectroscopic analysis* using the available archival data of the system:

- **UV**: IUE high resolution ($R \sim 7500$) spectra (in the 1200-3200 Å range),
- **Optical**: FEROS, HARPS and SOPHIE spectra ($R \gtrsim 50000$, from about 3700 to 9000 Å).

The poster displays some of the results of my Master degree thesis, still under preparation, supervised by Prof. S.N. Shore.

New Parameters for the Gainer

The accretion disk must be included when analyzing the spectrum of this system. Its gas temperatures range from 6000 to around 10^4 K [2].
Orbitally resolved sequences show that the H I lines (Balmer, Paschen series) have contributions from both the disk and the B star, while He I is from the star and its immediate vicinity in the inner disk. A good way to distinguish photospheric features is through the long cycle variations: the photosphere doesn't vary. Figure 1 (black vs. light blue spectra) shows the stability of the He I profiles. Others, e.g., Hδ and Mg II 4481, show a variable absorption component, enhanced at the faint state.
The new parameters were estimated by fitting the main optical He I lines together with the UV (1260-1400 Å), in which the main photospheric features Si III $\lambda\lambda\lambda 1295 - 1297 - 1299$ and C II $\lambda\lambda 1335 - 1336$.

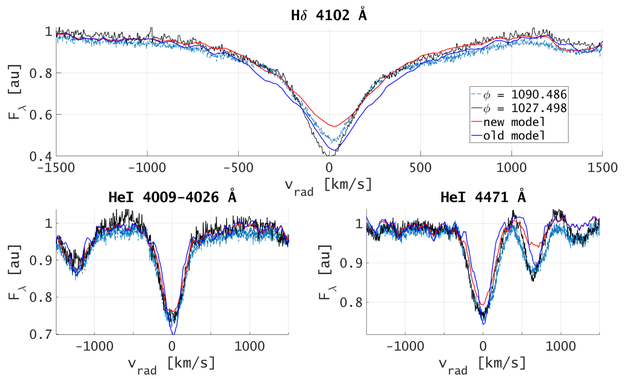


Figure 1: He I lines fit, along with $H\delta$ and Mg II 4481.

	Old [1]	New
$T_{eff}\,(10^3\,K)$	15 ± 2	21 ± 1
$\log(g)$	3.5 ± 0.3	3.75 ± 0.25
$v_{rot}\,(km/s)$	116 ± 2	225 ± 25

Table 1: Old vs. new parameters for the gainer.

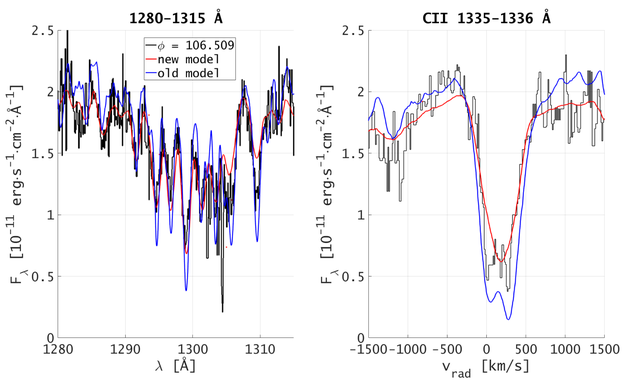


Figure 2: Left panel: far UV region. Right panel: the C II doublet.

The Long Term variability in the UV

- 20% flux variations are observed between bright and faint state spectra in the 1200-3200 Å range.
- The structure of the additional component is consistent with an out-of-plane **Rayleigh** (neutral) scattering continuum.
- Variations in the resonant transitions of less ionized species (Si II, Al II, Mg II and others) are observed at faint state. These lines are formed in a "cooler" **environment** around the gainer, and they go from showing only the interstellar component to producing a $\sim 200\,km/s$ broad absorption.

The long term variation can therefore be interpreted as cyclic changes in the accretion structure rather than temperature changes in either star [3]. Some scenarios:

- changes in the equilibrium disk thickness would explain the additional structure which is traced by the lower ions;
- the variation of the SED produced by different states of accretion would change both the physical structure of the disk and its thermodynamic state;

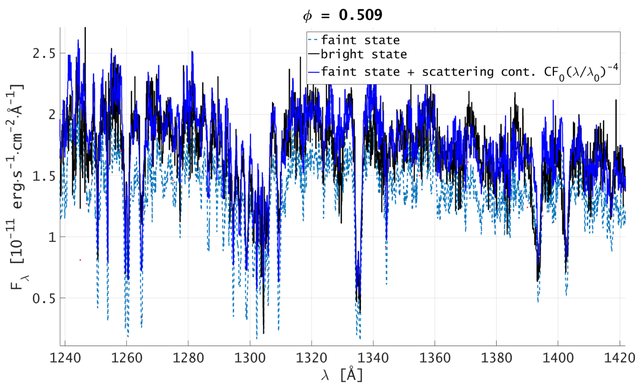


Figure 3: Bright vs. faint state: the scattering continuum.

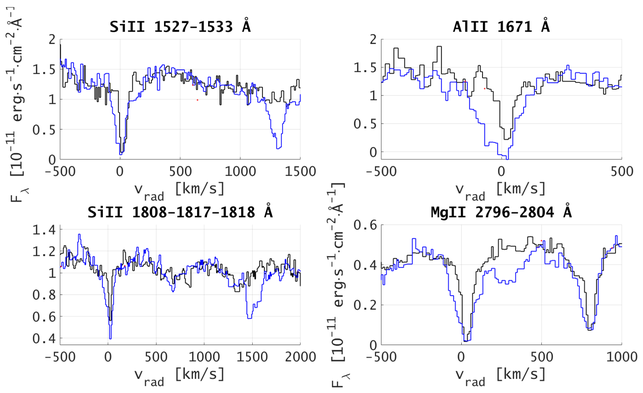


Figure 4: Bright vs. faint state: the resonance lines.

- the additional continuum is likely produced by a **disk-wind** which could be triggered by an excessive loading of mass into the disk.

Conclusions, Future Perspective

- The gainer is hotter and rotates faster than previously derived. A **boundary layer** may contribute to the B-star spectrum.
- The LT variability can be explained by changes in the accretion structure.

It would be important to produce continuous **light curves** for the system, especially at long cycle maximum. Spectro-photometry during the eclipses would help to ascertain the presence of scattering components.

References

[1] M. Desmet et al. In: *MNRAS* 401.1 (2010).
[2] G. Djurašević et al. In: *MNRAS* 409.1 (2010).
[3] G.J Peters. In: *Interacting binary stars, ASP Conf. Ser.* 56 (1994).