Photometric and spectroscopic time series of cTTS RY Tau and SU Aur

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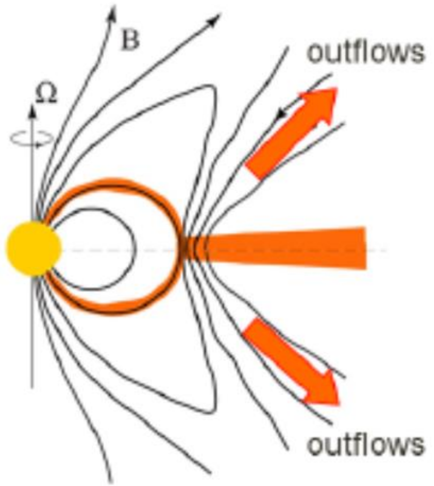
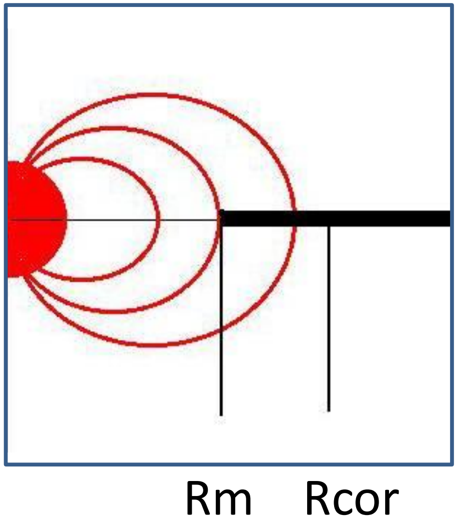
In classical T Tauri stars (cTTS) variations in the emission line profiles reflect the gas flows – accretion and winds.

We carry out long series of simultaneous spectroscopic and photometric observations of two cTTS, RY Tau and SU Aur, with the aim to quantify the accretion and outflow dynamics at time scales from days to years.

Magnetospheric accretion and outflows in cTTS



Romanova&Owoki, 2015



Unstable accretion: Rm < 0.7 Rcor

Typically, there is a combination of dipole and octupol, but the DIPOLE truncates the disk.

$$r_m \sim (\mu^2/\dot{M})^{1/7}$$

$$r_{cor} = [GM_\star/\Omega_\star{}^2]^{1/3}$$

The most unstable MHD processes take place at the boundary between the inner disk and stellar magnetosphere (Zanni & Ferreira, 2013)

"If CTTSs undergo solar-like magnetic cycles, we would expect cycles to exist in the position of the inner edge of the accretion disc and the locations of accretion footpoints." (Johnstone et al, 2014)

Problem:

Whether magnetic cycle affects the accretion and wind processes in a cTTS and can we reveal a magnetic cycle by monitoring the dynamics of accretion/wind flows?

SU Aur and RY Tau are intermediate mass objects with radiative core and convective shell

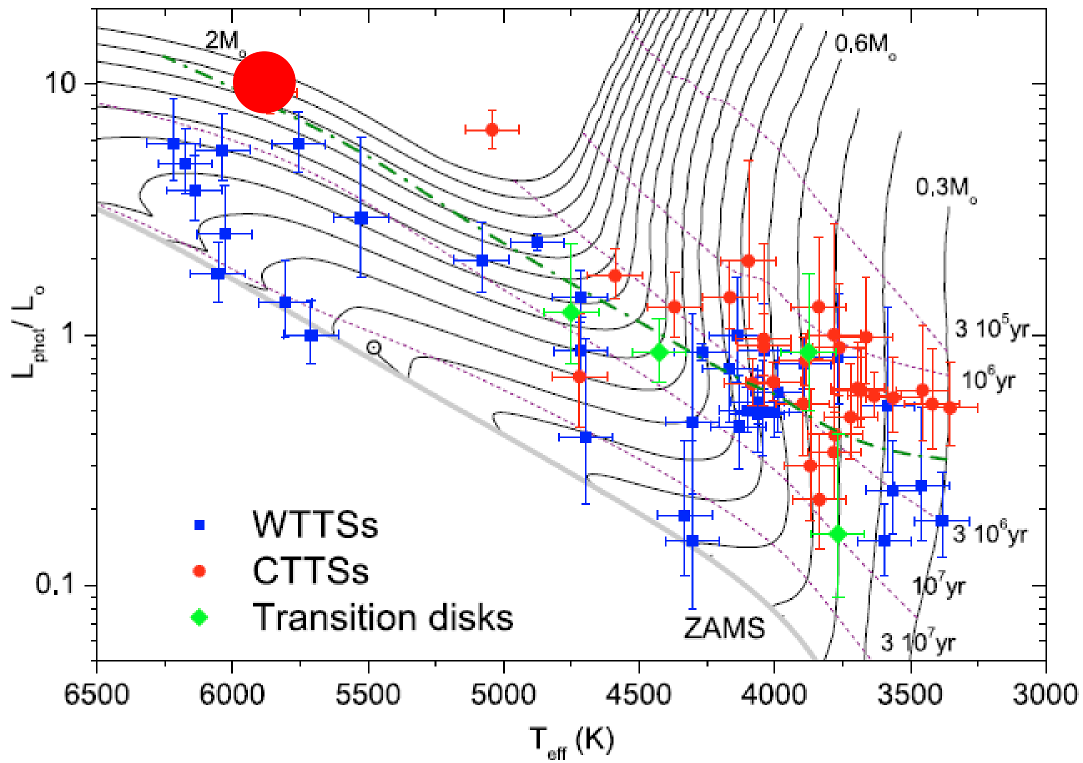
	RY Tau	SU Aur
L =	13	10 $L_\odot$
M =	2.1	1.9 $M_\odot$
Age =	4.7	6.6 Myr

$M_{accr} \approx 4 \cdot 10^{-9} M_\odot yr^{-1}$

Sp = G2IV

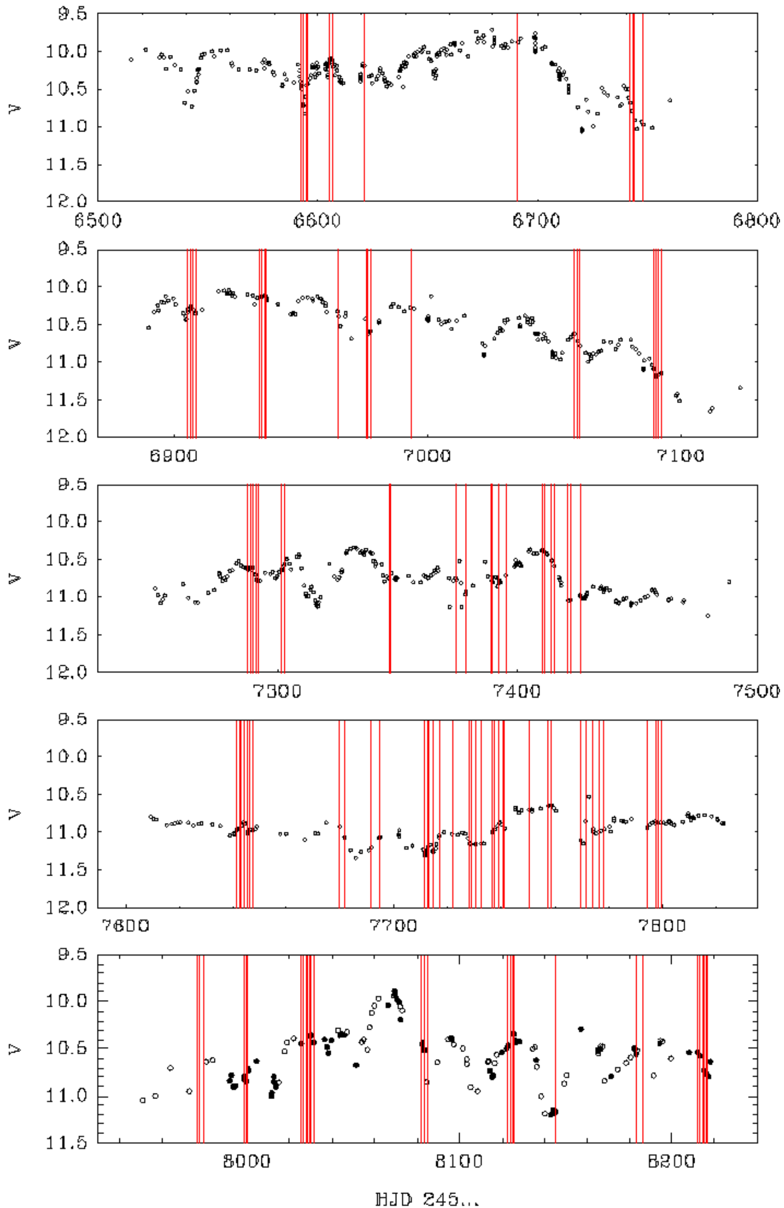
T_{eff} = 5945 K

Optical veiling < 0.1

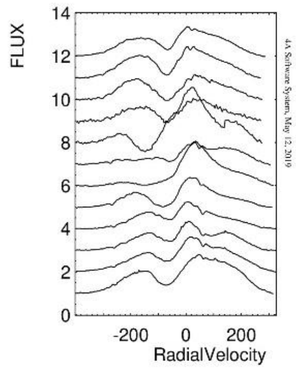


The photospheric line depths remain unchanged at different stellar brightness.
The optical light variability is solely due to the circumstellar dust.

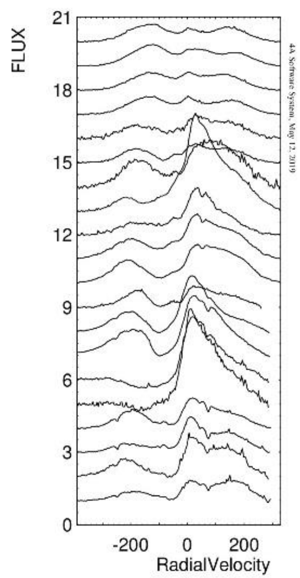
RY Tau: lightcurves and moments of spectral observations



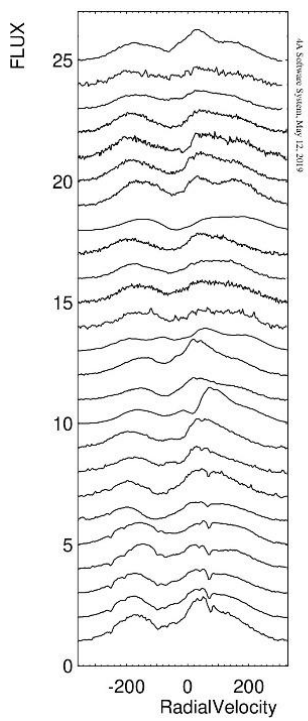
RY Tau: variability of Hα profile in six seasons of 2013-2018



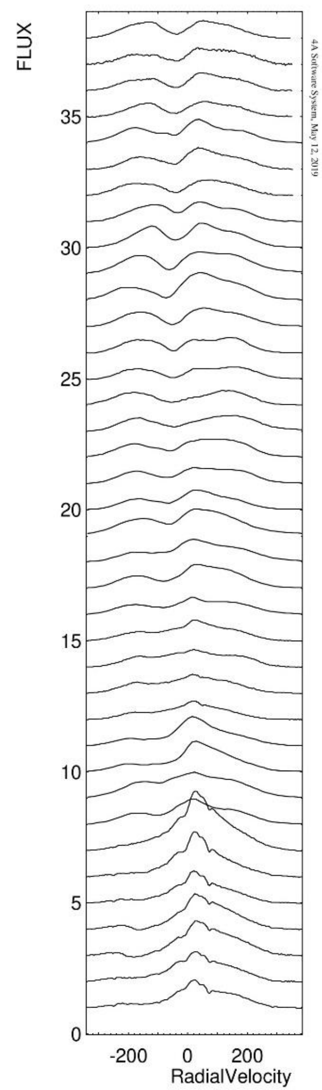
2013



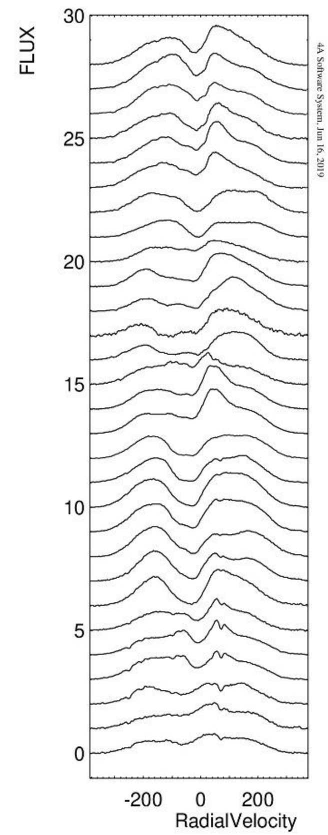
2014



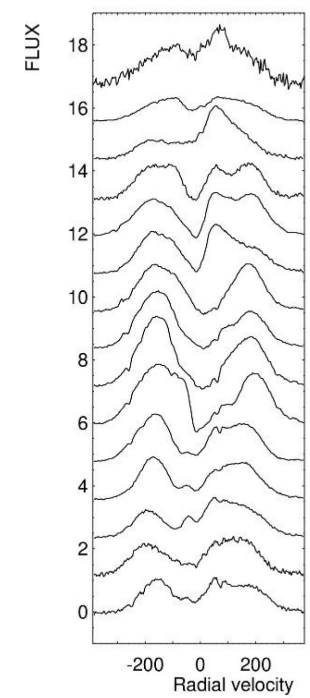
2015



2016



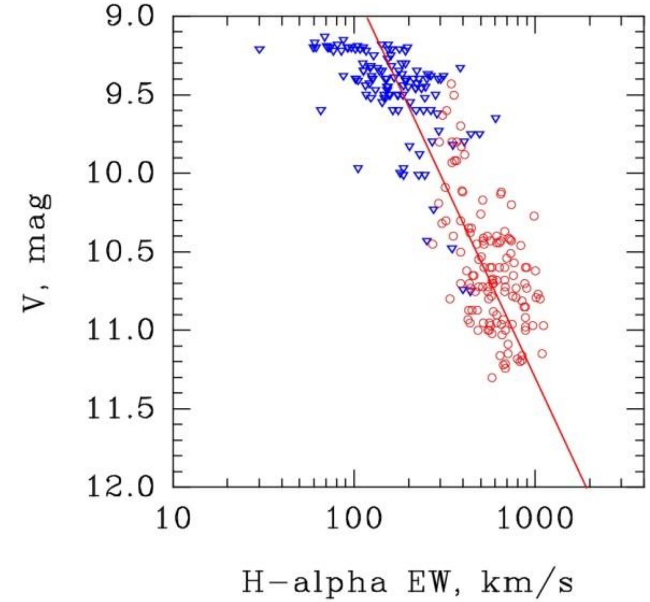
2017



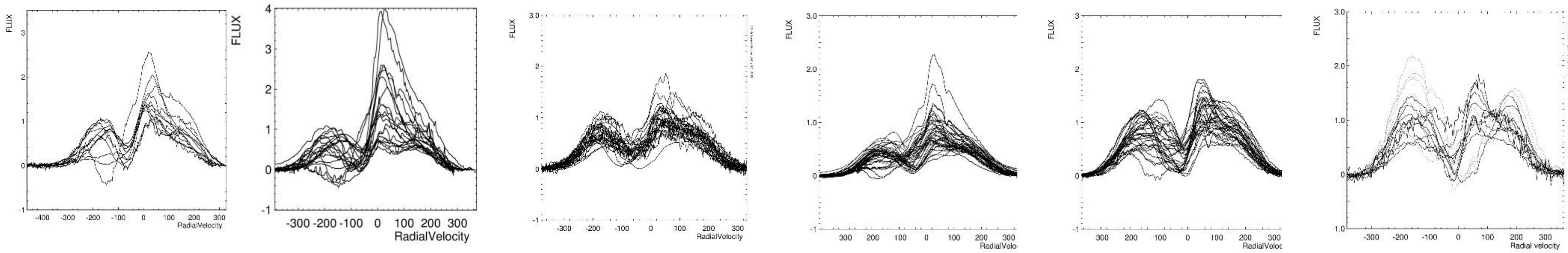
2018

$$\text{Flux} = (I_\lambda - 1) \times 10^{-0.4\times(V-10)}$$

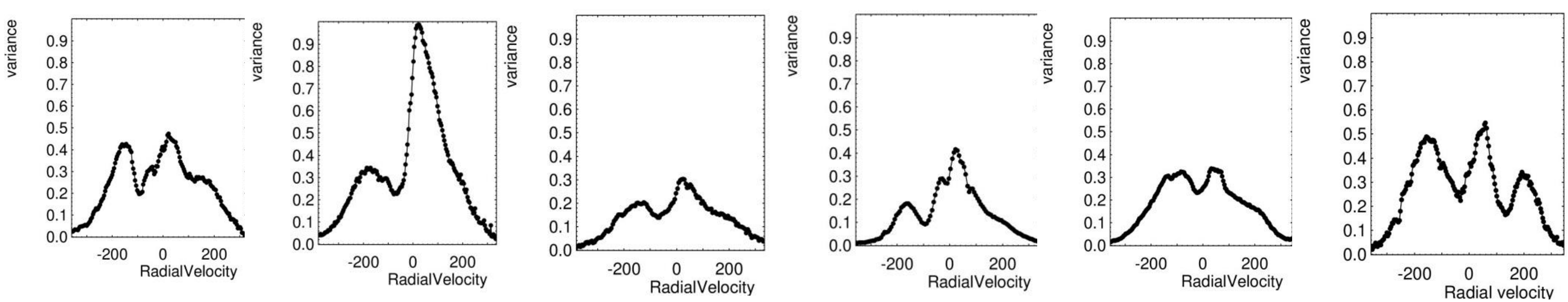
$$\text{Flux unit} = 3.67 \times 10^{-13}\ \text{erg cm}^{-2}\ \text{s}^{-1}\ \text{Å}^{-1}$$



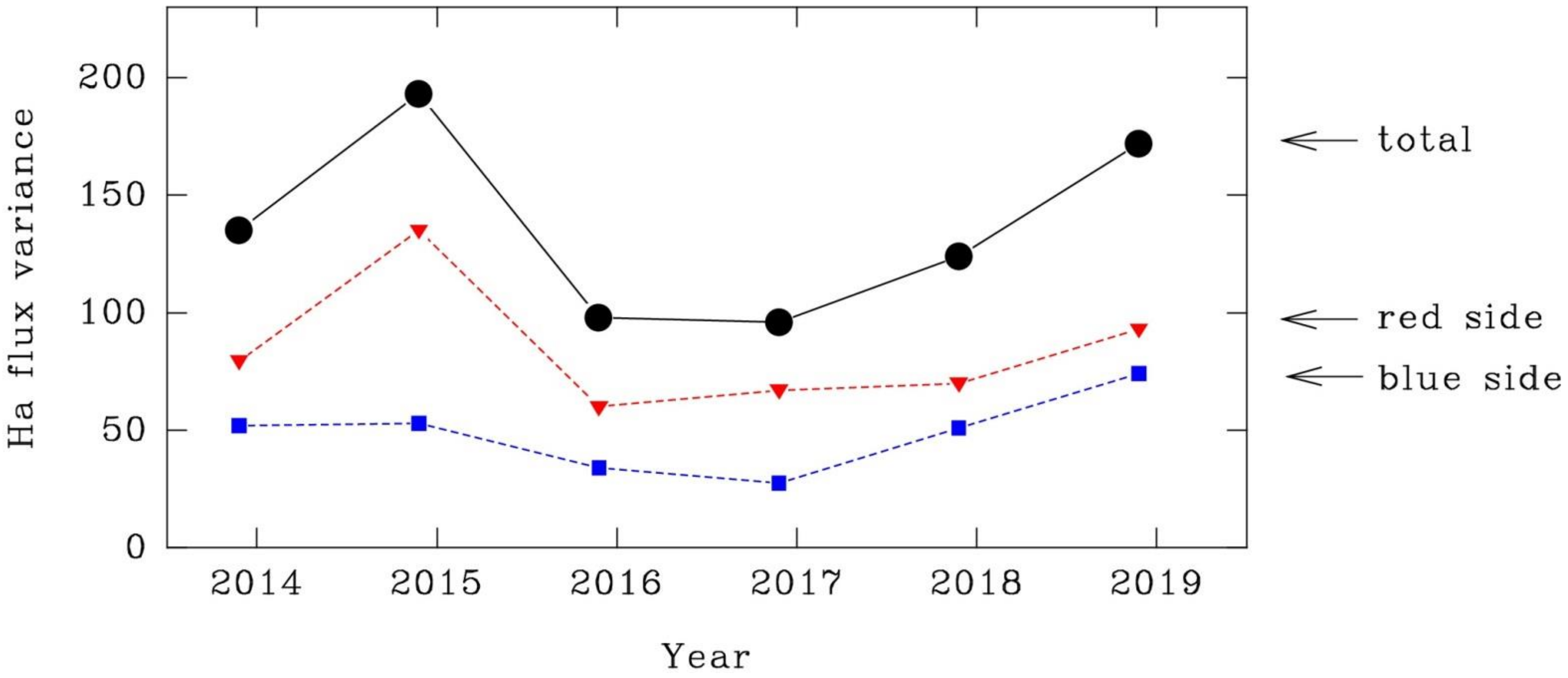
Flux profiles



Flux variance profiles

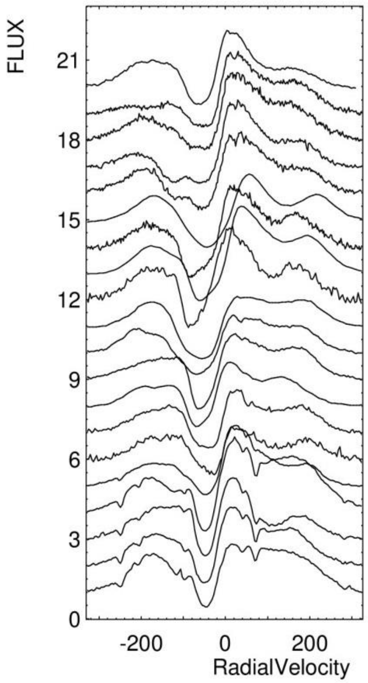


The main result: variations of the wind activity in RY Tau.

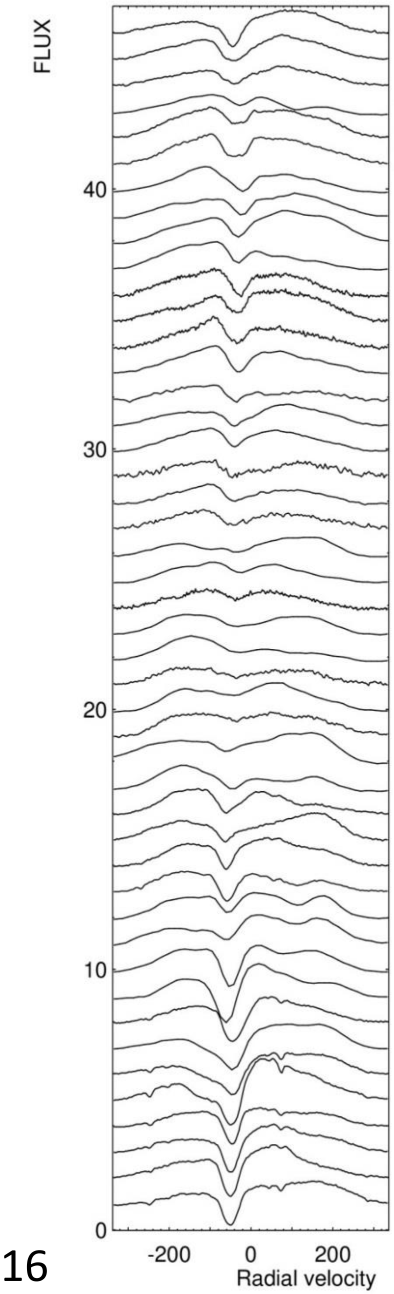


Variance of Hα emission flux in 2013-2019

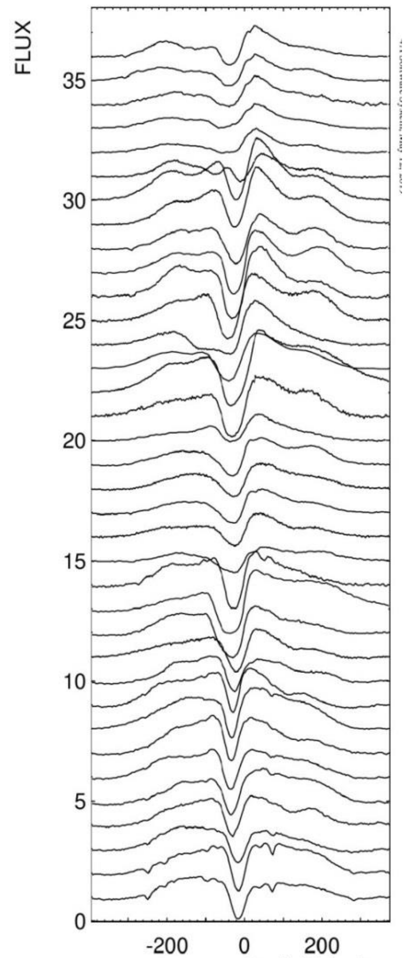
SU Aur: variability of Hα profile in four seasons of 2015-2019



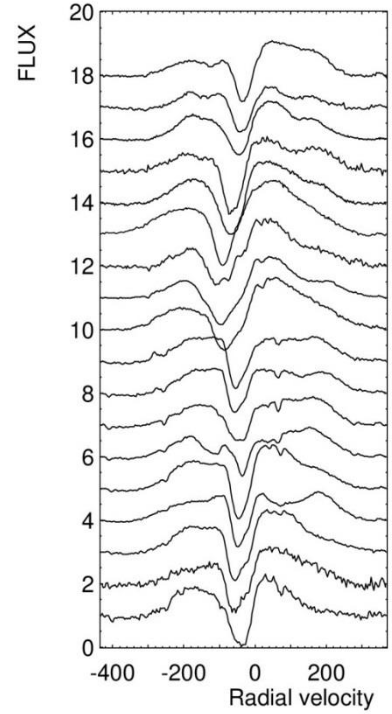
2015



2016

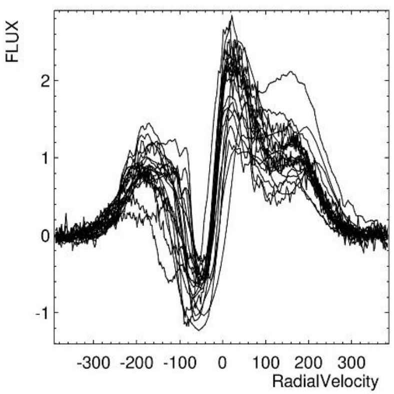


2017

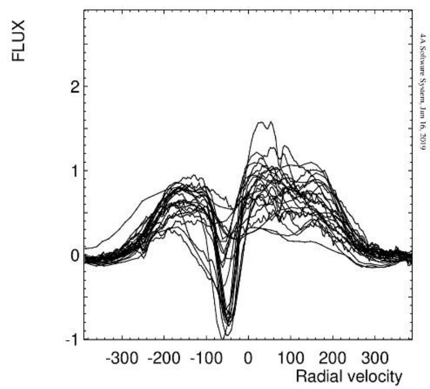


2018

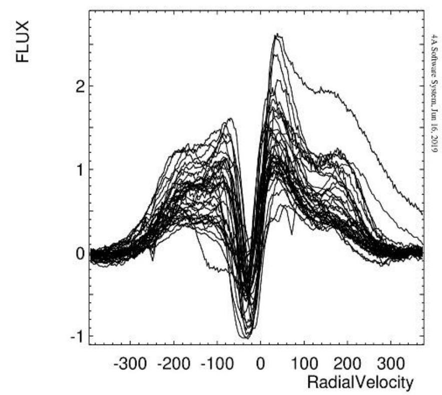
SU Aur,   Hα flux profiles



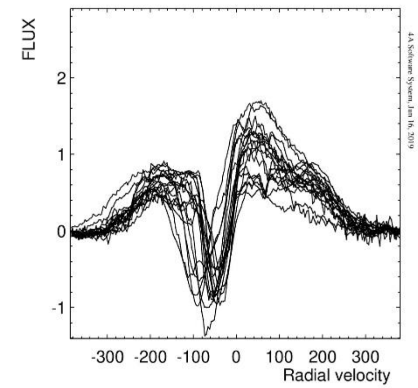
2015-2016



2016-2017

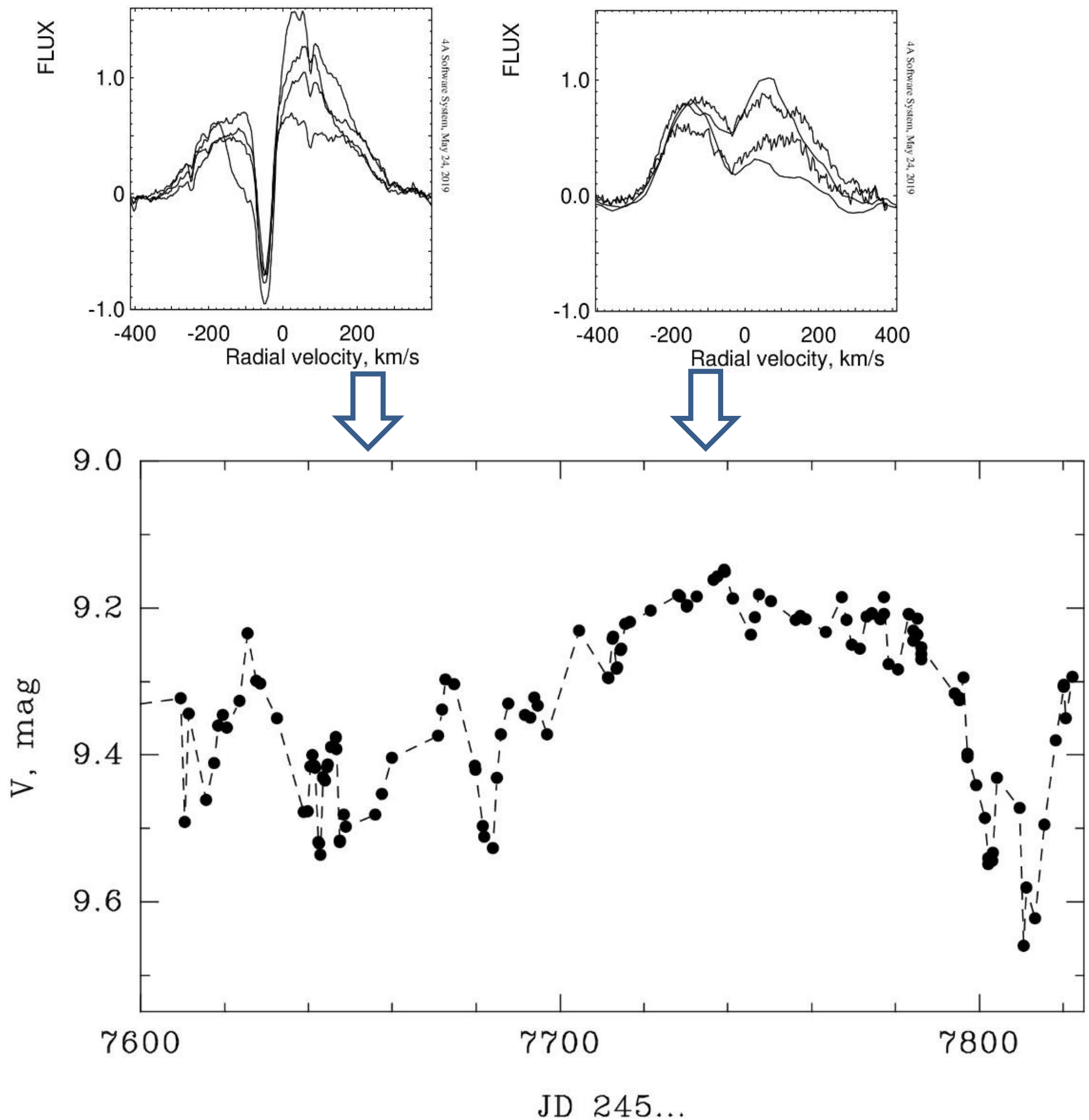


2017-2018



2018-2019

SU Aur: in the quiescent state (2016) the wind feature has almost disappeared for two months, at minimal circumstellar extinction



EW ≈ 3.5 Å

$M_{accr} \approx 10^{-9}$

No wind, no dust?

CONCLUSIONS

If there is a magnetic cycle in RY Tau, it may be around 6 years. In order to confirm this result, we plan to continue the series for at least two years more.

In SU Aur we observe alternation of high and low activity on a time scale of two years. During the quiescent state the outflow became extremely weak for a period of two months.

In both stars the optical light variability is solely due to the circumstellar dust.

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Wind dynamics and circumstellar extinction variations in the T Tauri star RY Tau

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2019 MNRAS 83 32

Dynamics of wind and the dusty environments in the accreting T Tauri stars RY Tauri and SU Aurigae

Petrov, P. P.; Grankin, K. N.; Gameiro, J. F.; Artemenko, S. A.; Babina, E. V.; Albuquerque, R. M. G. de; Djupvik, A. A.; Gahm, G. F.; Shenavrin, V. I.; Irsmambetova, T. R.; Fernandez, M.; Mkrtichian, D. E.; Gorda, S. Yu.

Thank you!