Stable and Unstable Regimes of Mass Accretion onto RW Aur A

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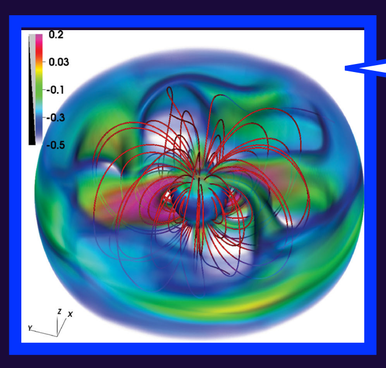
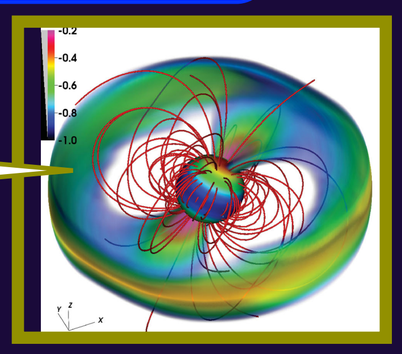
We present monitoring observations of the active T Tauri star RW Aur using optical high-resolution (R ≥ 10^4) spectroscopy with CFHT-ESPaDOnS. The observations were made in five autumn-winter semesters (2010B/2011B/2012B/2013B/2014B), with 2-4 observing runs for each semester, and 1-7 visits during each run, with intervals of 1-10 nights. The changes in the observed line profiles and published *V*-magnitudes qualitatively agree with the theory of magnetospheric mass accretion with enhanced and suppressed magnetic Rayleigh-Taylor (RT) instabilities. However, the large decreases in photometric flux and the weakness or absence of photospheric absorption during the faint periods challenge the existing theories.

Theoretical Predictions

(Romanova+ 2008, ApJ, 673, L71;
Kurosawa+ 2013, MNRAS, 431, 2673)



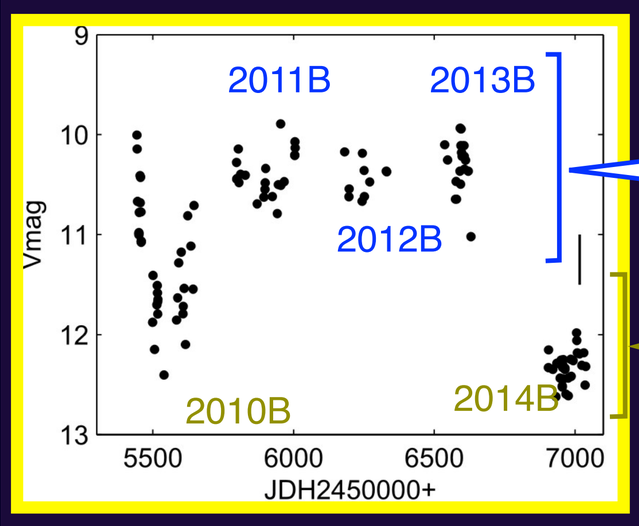
Unstable Regime
- High mass accretion rate →RT instability is enhanced
- Complicated time variation in line profiles



Stable Regime
- Low mass accretion rate →RT instability is suppressed
- Relatively stable line profiles

V-band magnitude

(Petrov+ 2015, A&A, 577, A73)

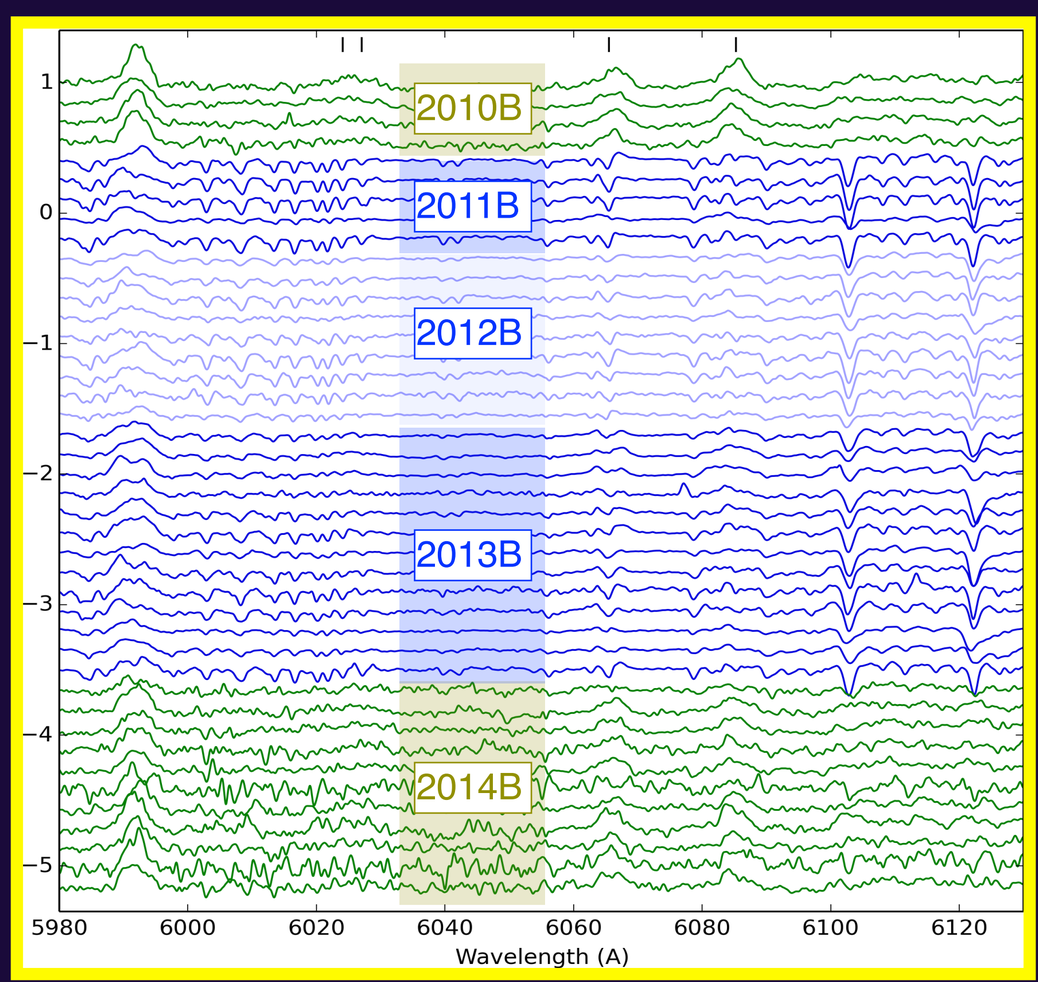


Bright, consistent with high mass accretion rate

Faint, consistent with low mass accretion rate

Our spectroscopy supports this explanation as shown below.

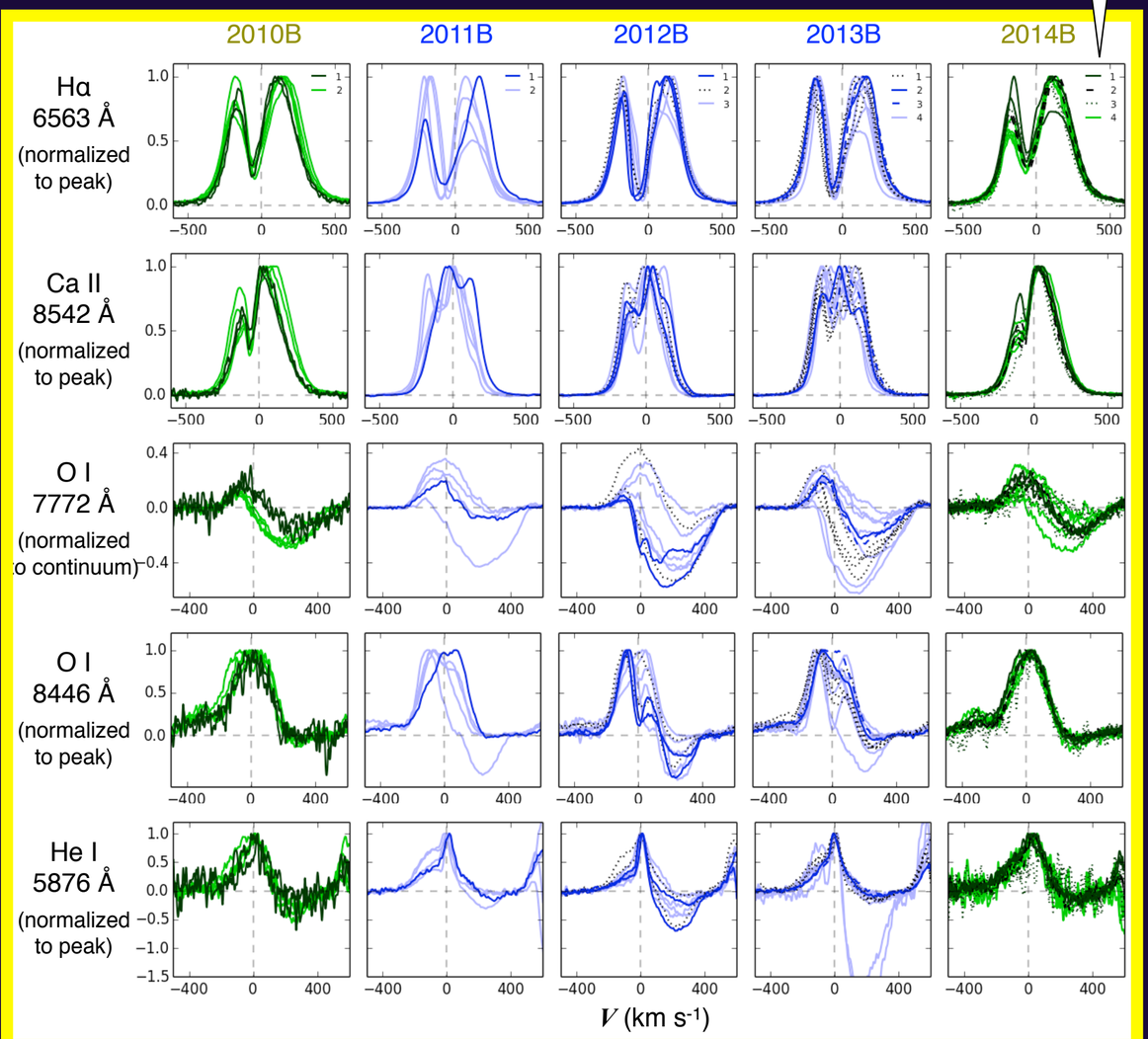
Continuum (5980-6130 Å)



- Photospheric absorption consistent with the standard veiling theory ($F_{veiling}/F_*$=0.7-5) **2011B-2013B**
- Photospheric absorption is absent or marginal (covered with Fe I/ Fe II/Ne I lines?) **2010B, 2014B**

Line Profiles

Observing run



- Complicated changes in the Ca II profiles **2011B-2013B**
- Large changes in redshifted absorption of the O I and He I lines

- Stable Ca II profiles **2010B, 2014B**
- Small changes in redshifted absorption of the O I and He I lines

Unsolved Issues for the Faint Stable States

The standard veiling theory cannot explain:
- the absent/weak photospheric absorption
- the large photometric variation (Δ*V*=2-3 mag.)

→The absorption may not be due to the stellar photoshere but to another layer? (Petrov+15)