Accretion and Outflows in TW Hya

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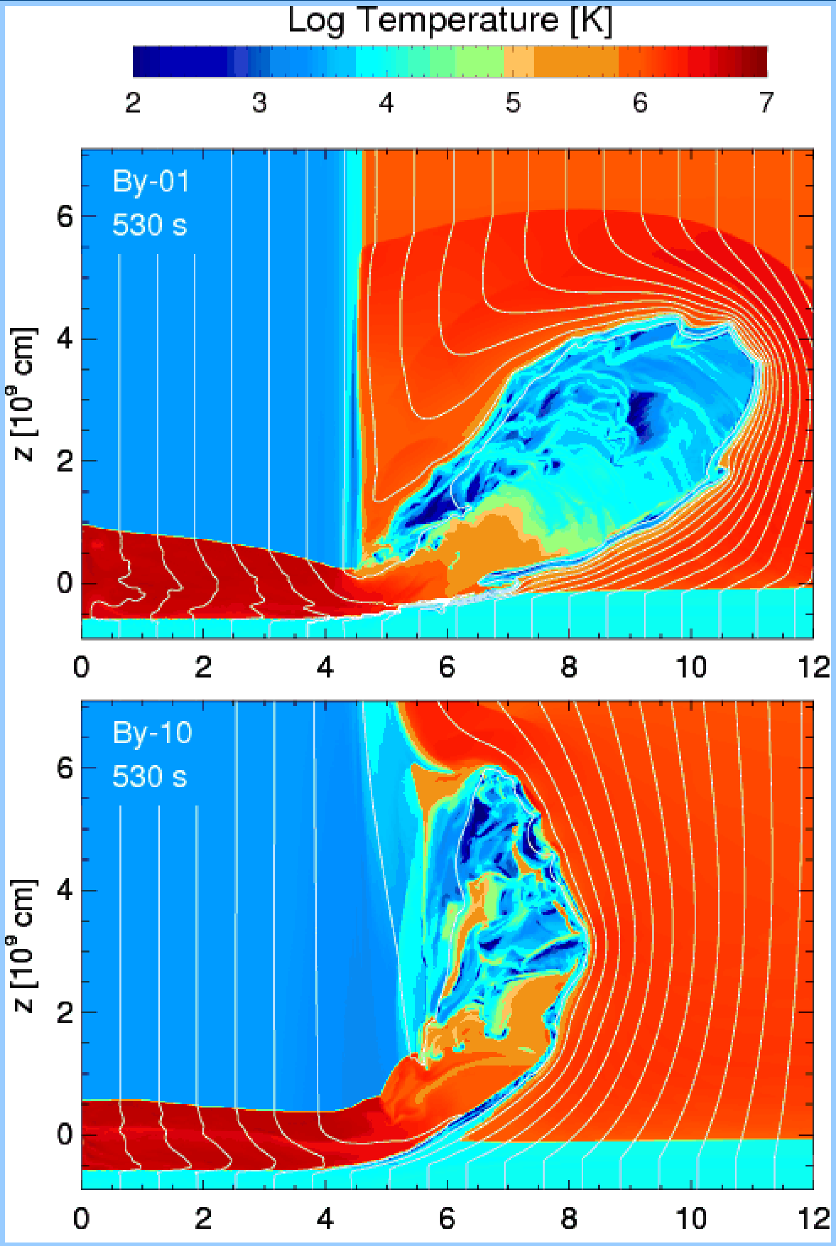
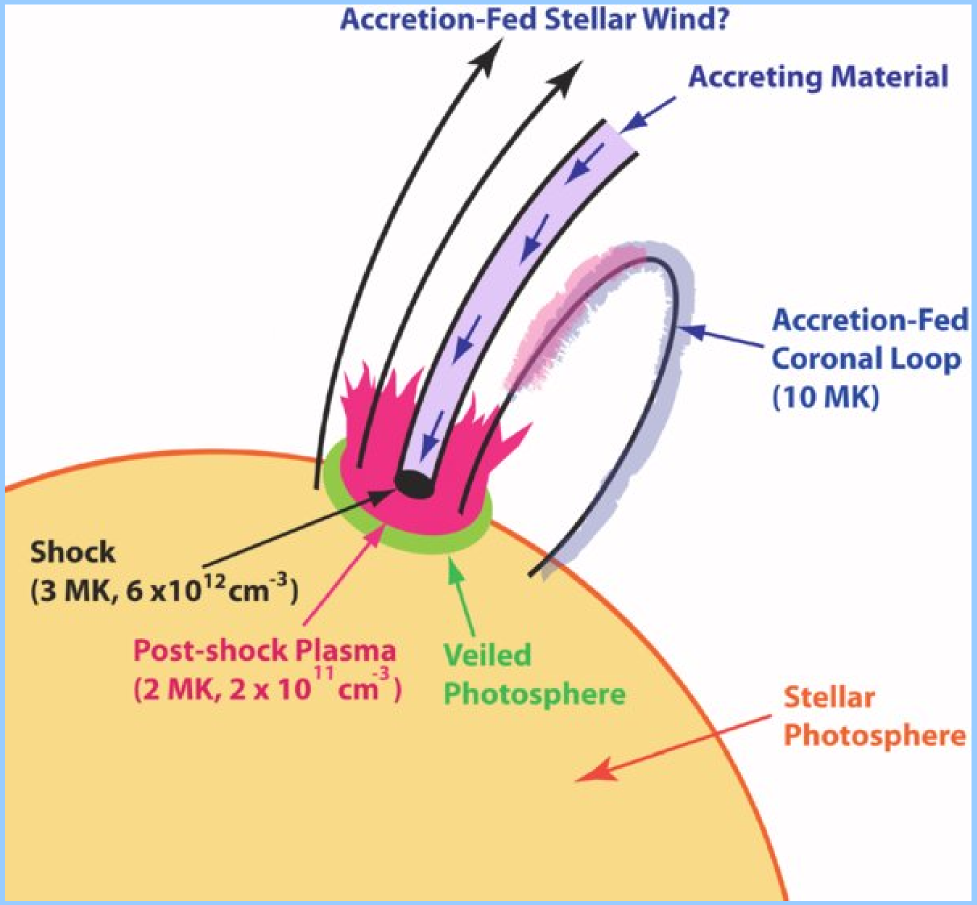
State-of-the-art accretion models

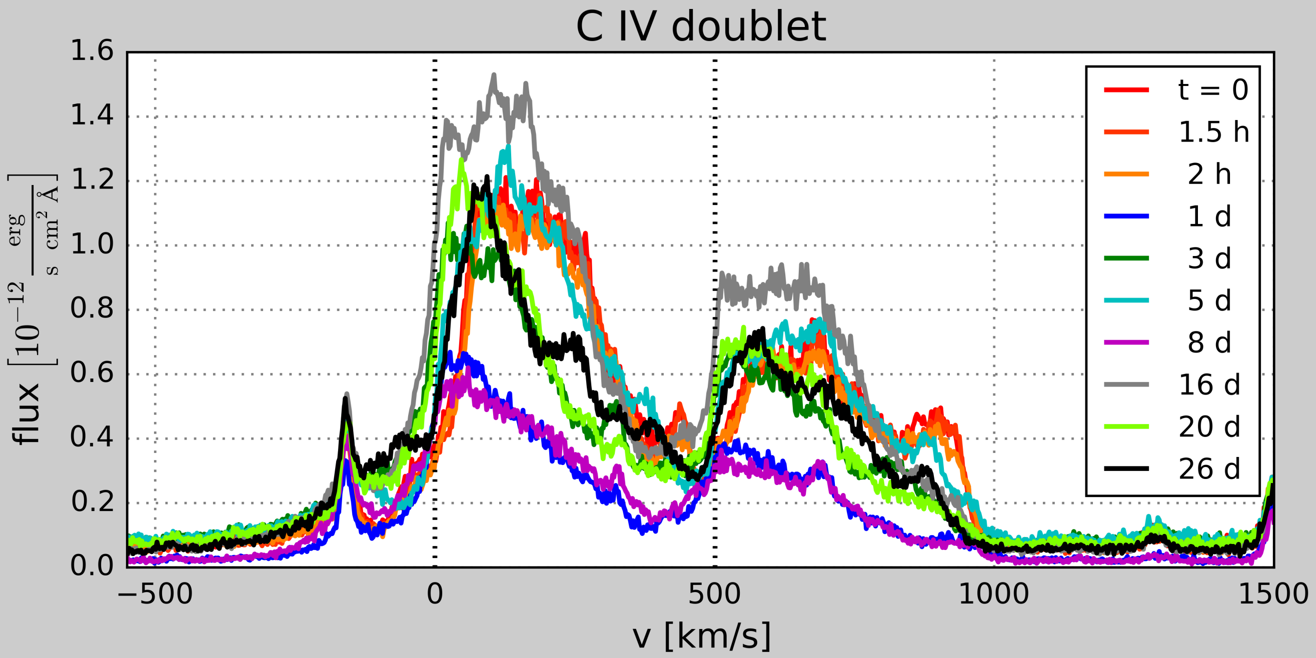


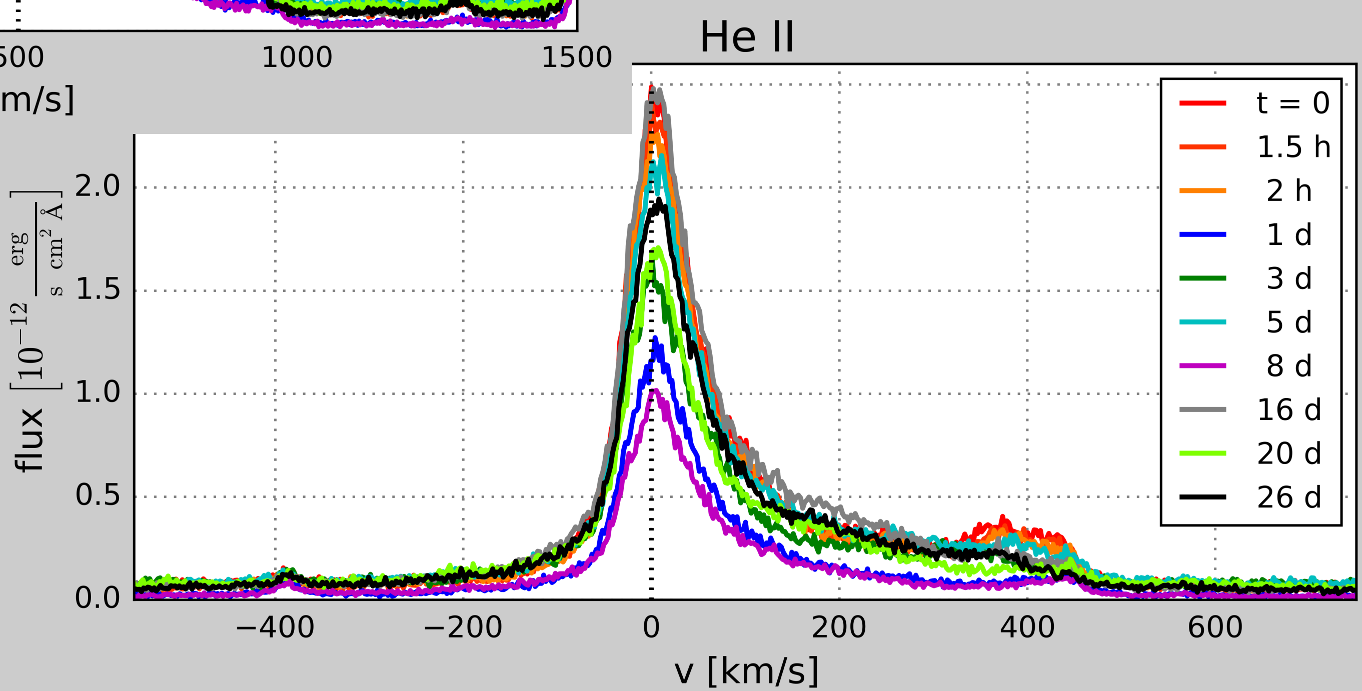


Brickhouse et al., ApJ (2010)

Orlando et al., A&A (2010)

The ion line emission

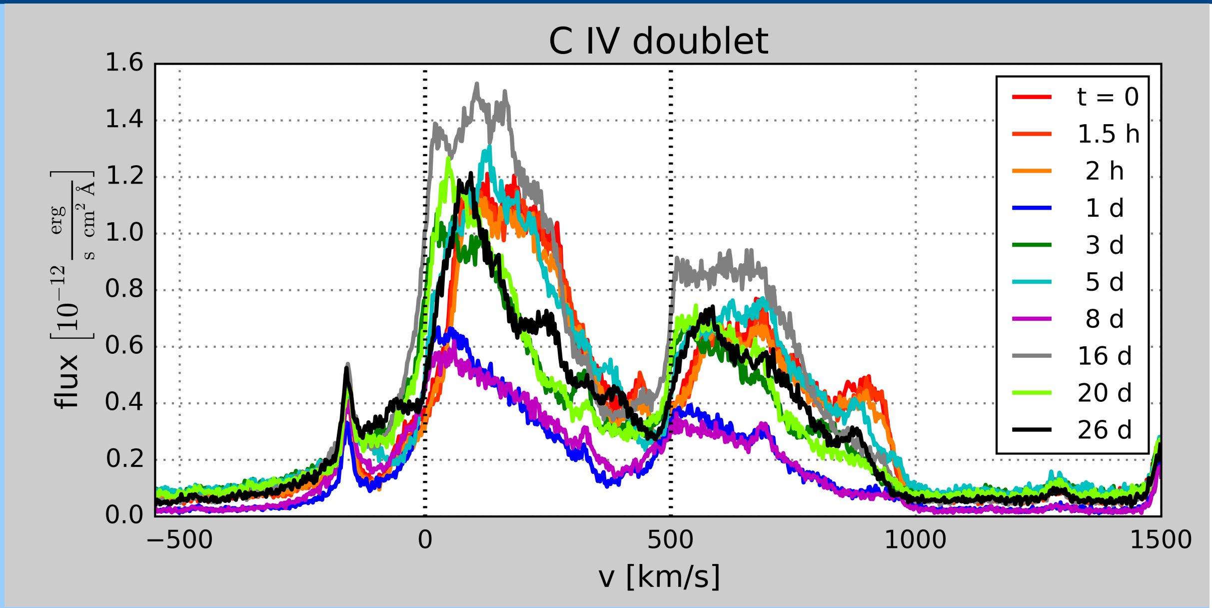


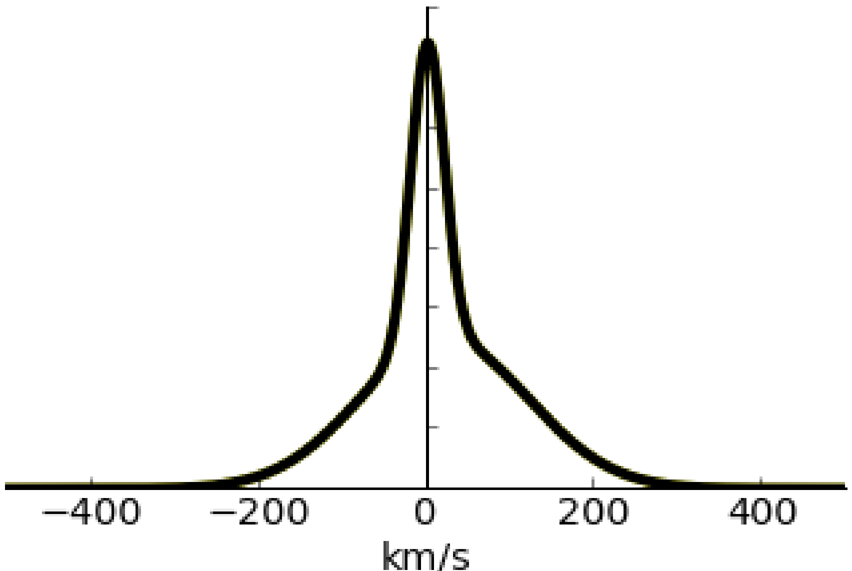


10 orbits HST/COS monitoring of TW Hya
PI: **Günther**

How can we explain the C IV (and other hot ion line) shapes?

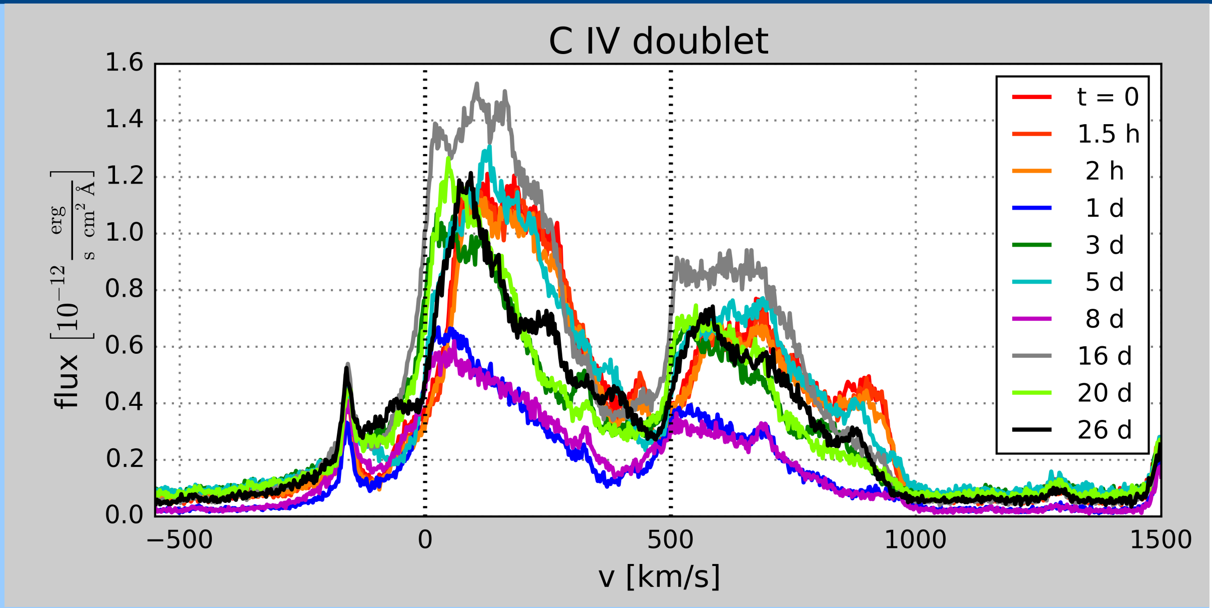
- Non-accreting TTS have two component C IV lines (Ardila et al. 2013)

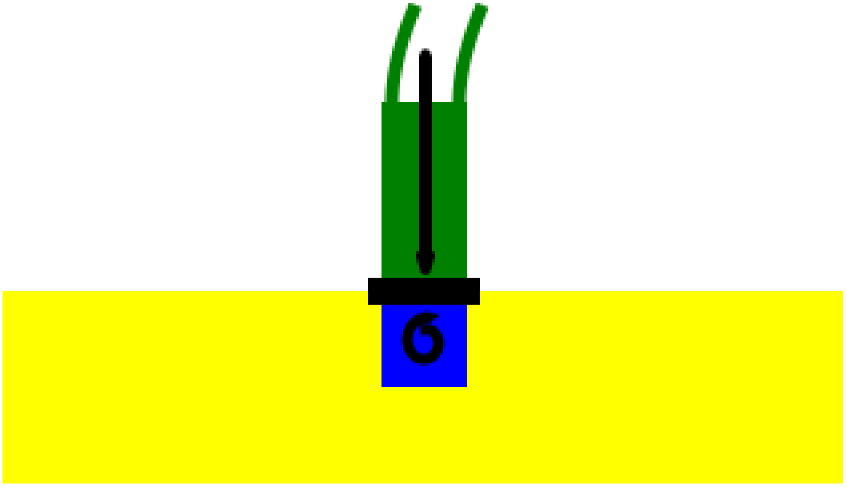


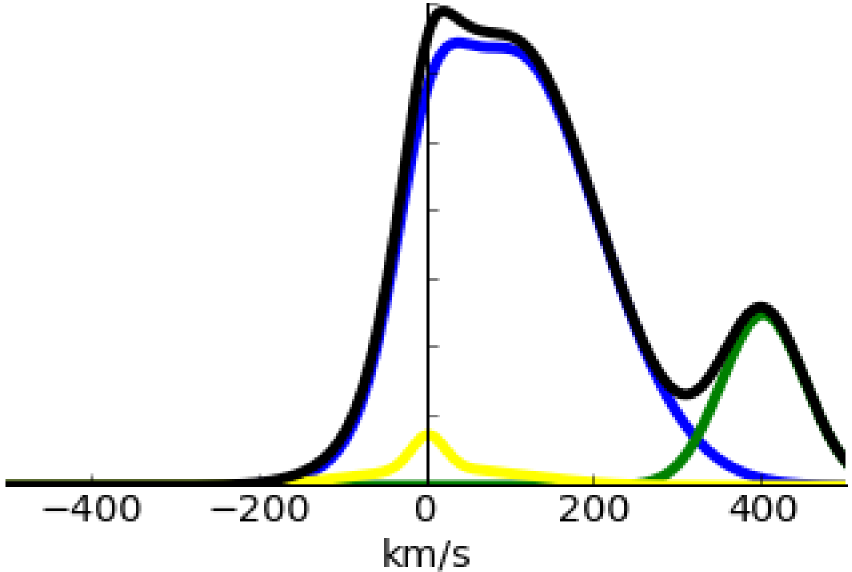


How can we explain the C IV (and other hot ion line) shapes?

- Pre-shock: freefall velocity
- Post-shock: tubulence, <¼ freefall velocity

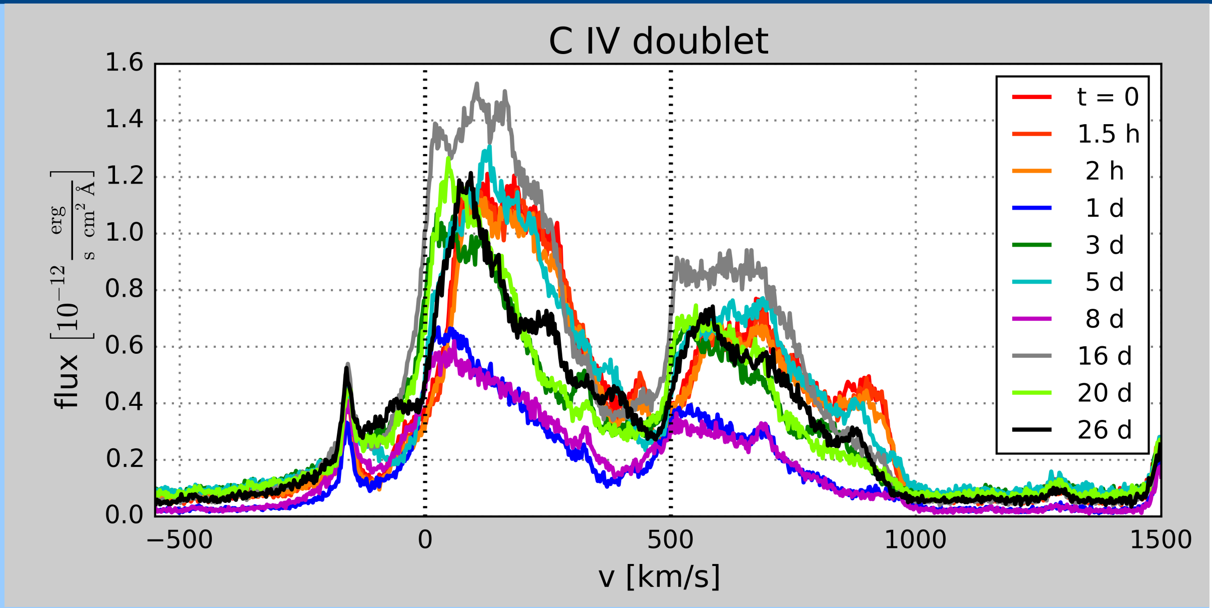


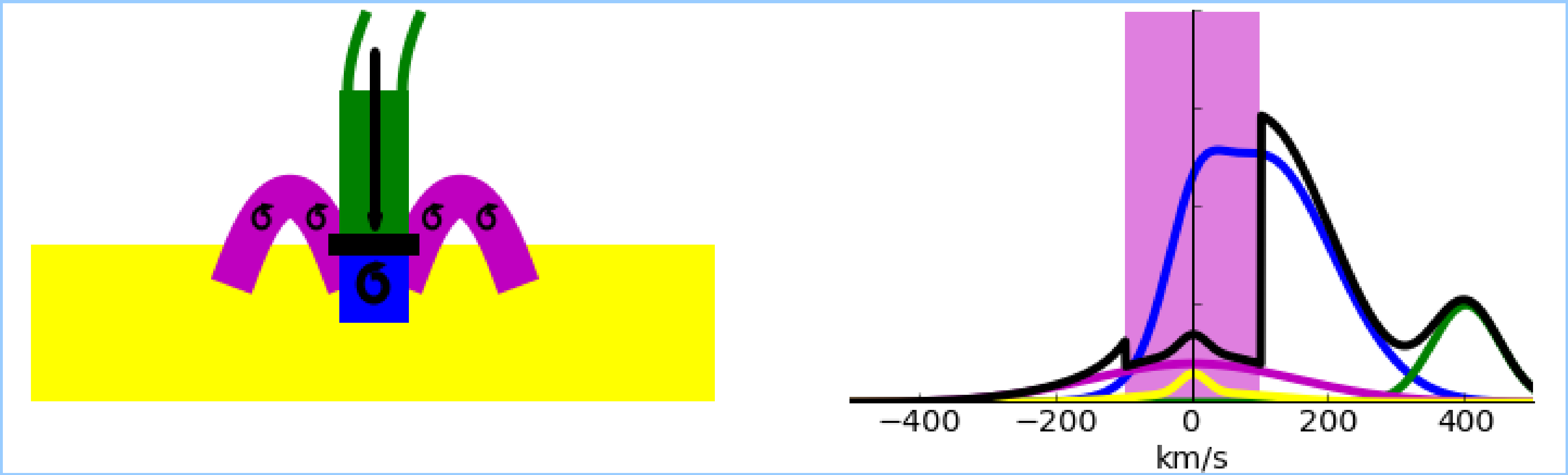




How can we explain the C IV (and other hot ion line) shapes?

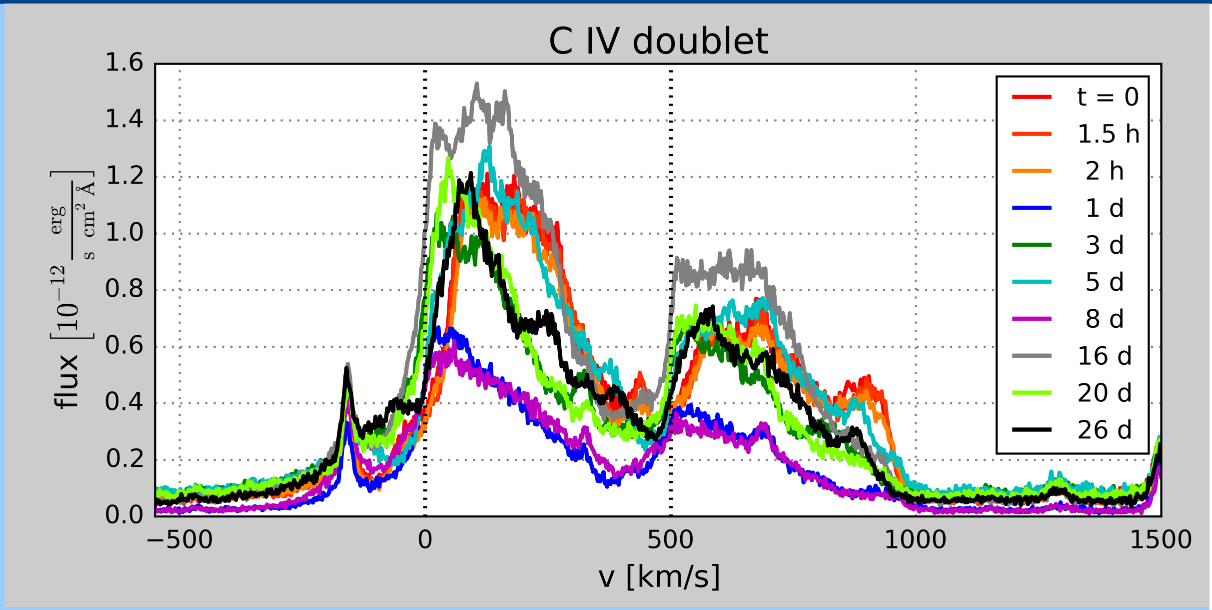
- Splatter: turbulent, variable bulk < 100 km/s absorbtion

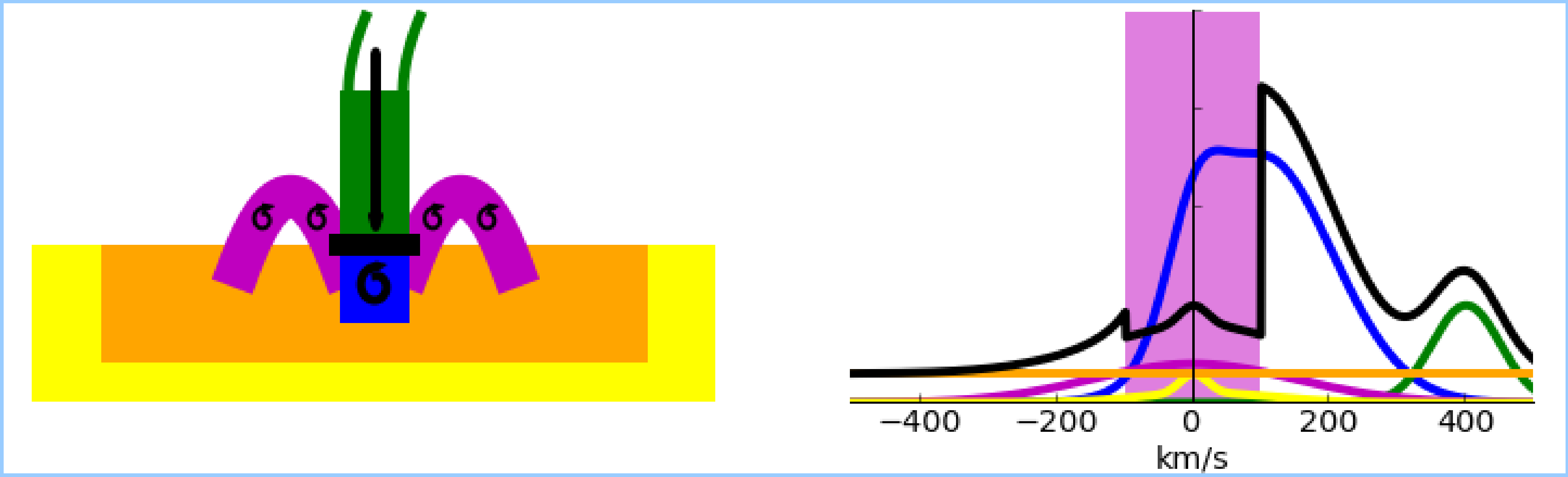




How can we explain the C IV (and other hot ion line) shapes?

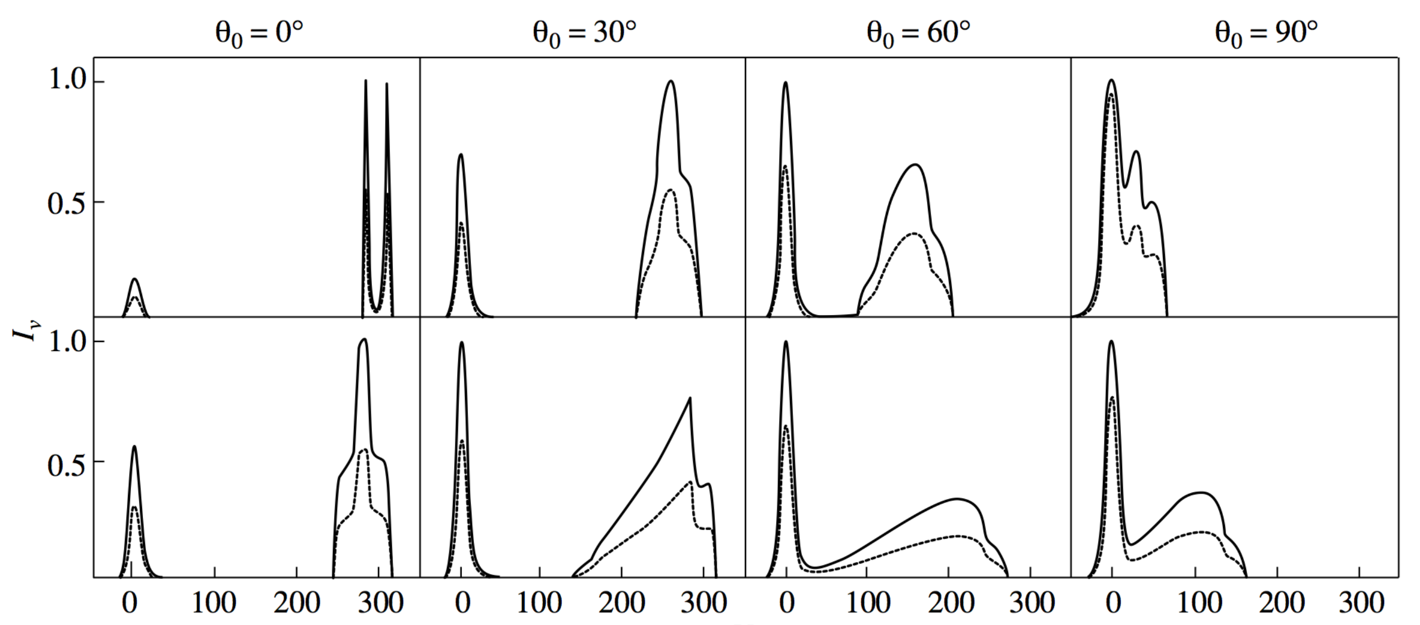
- Heated photosphere: 20,000 K varies with accretion

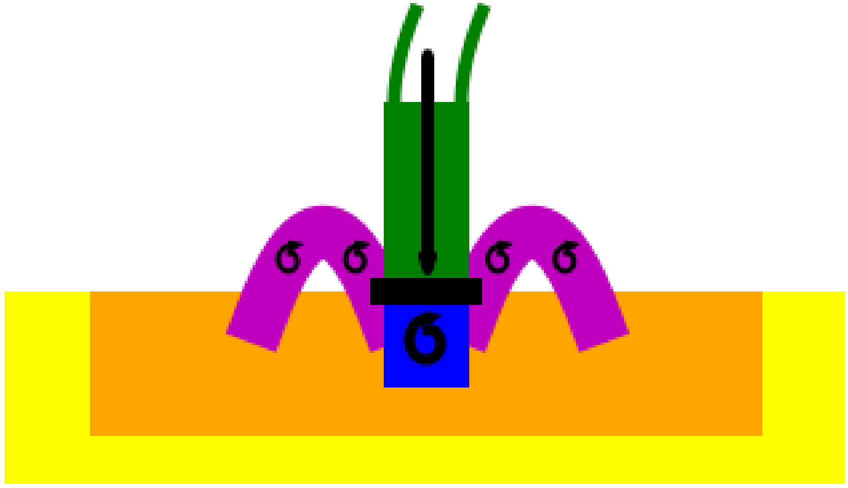


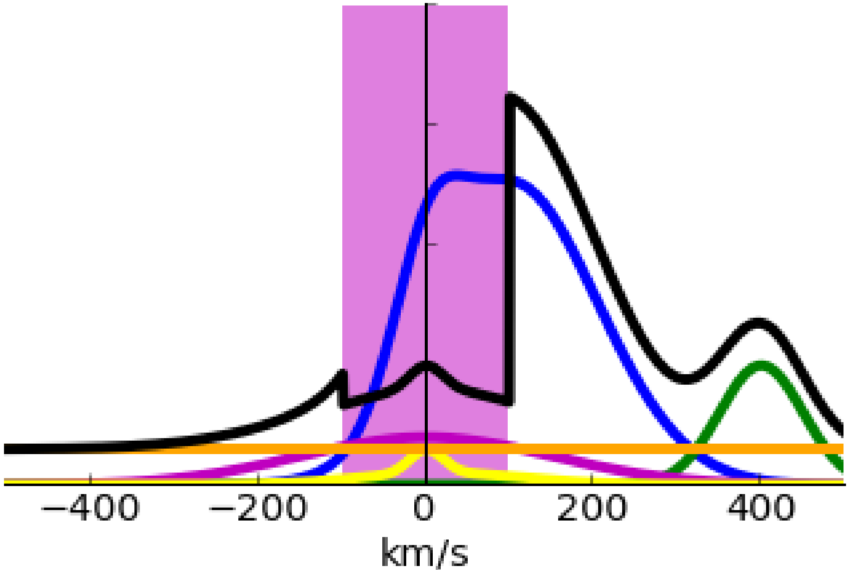


Physical basis for my cartoon

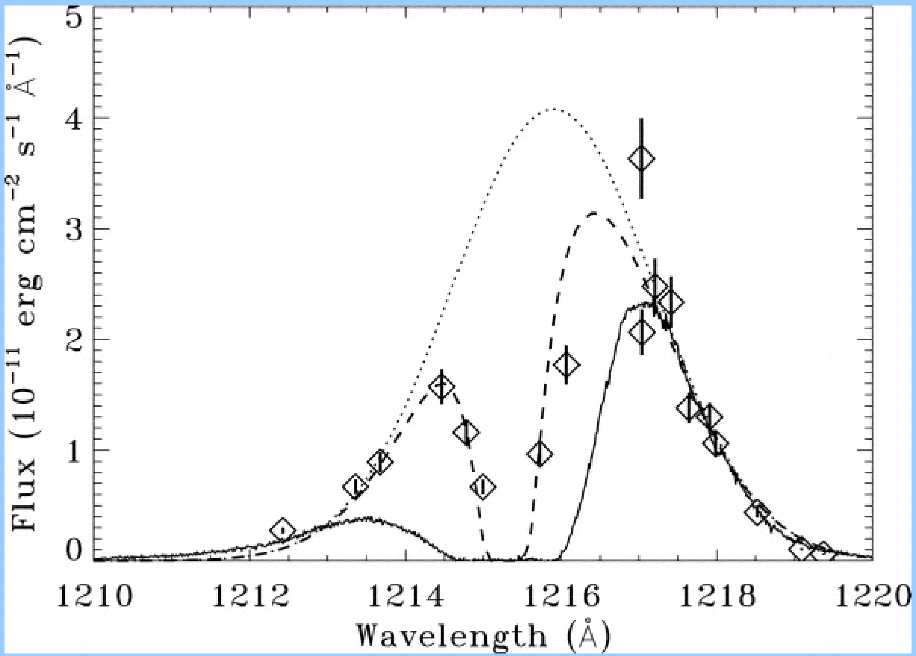
My cartoon is more than a cartoon: While I don't have a full radiative transfer model now, the individual components are based on exiting data or published models, such as Lamzin, AR (2003).





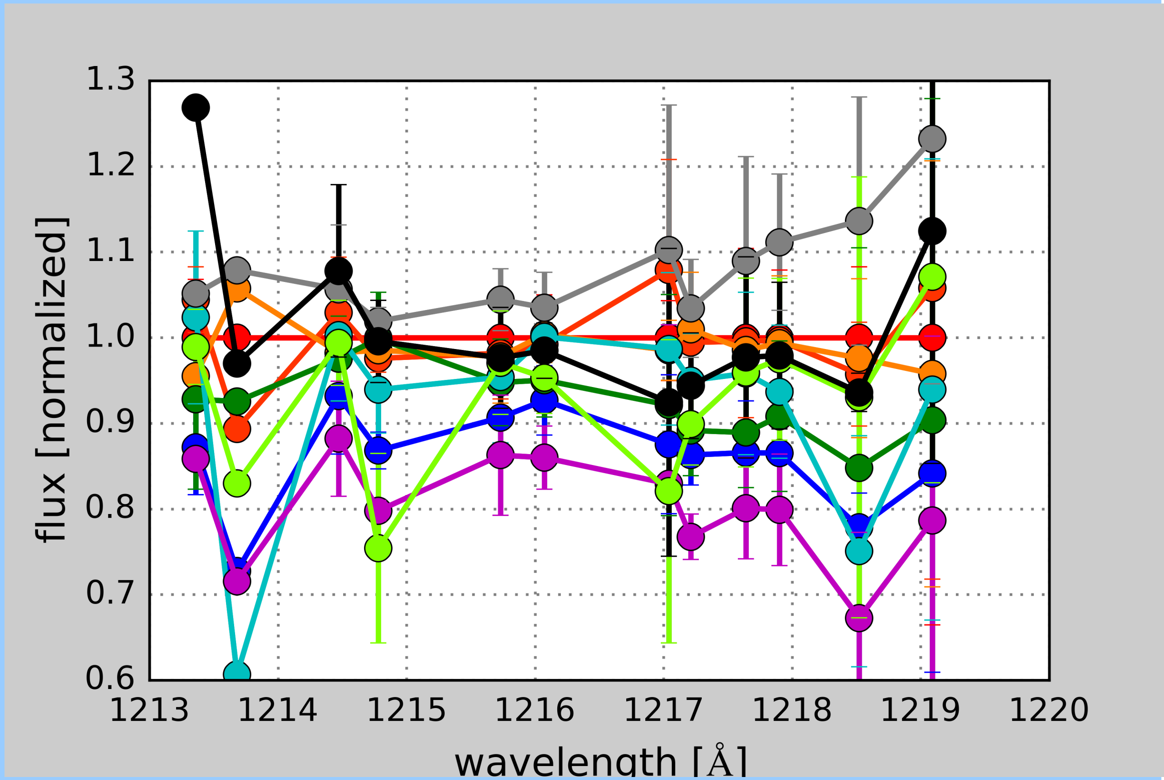


Change in Lyα



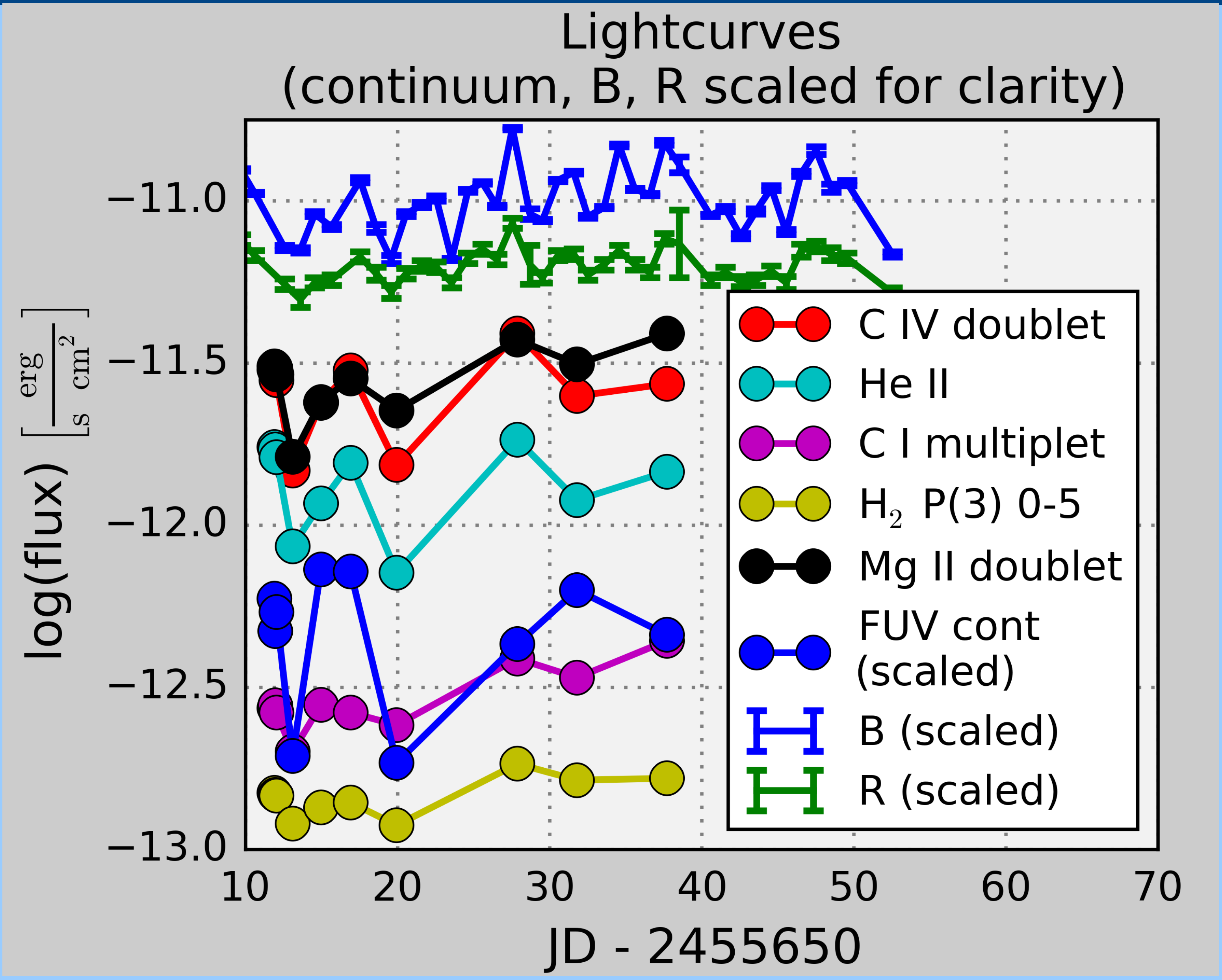
Reconstructed Lyα profile

Herczeg et al. (2004)



Change in the Lyα during our observation (as seen from the molecular hydrogen)

All tracers are correlated.



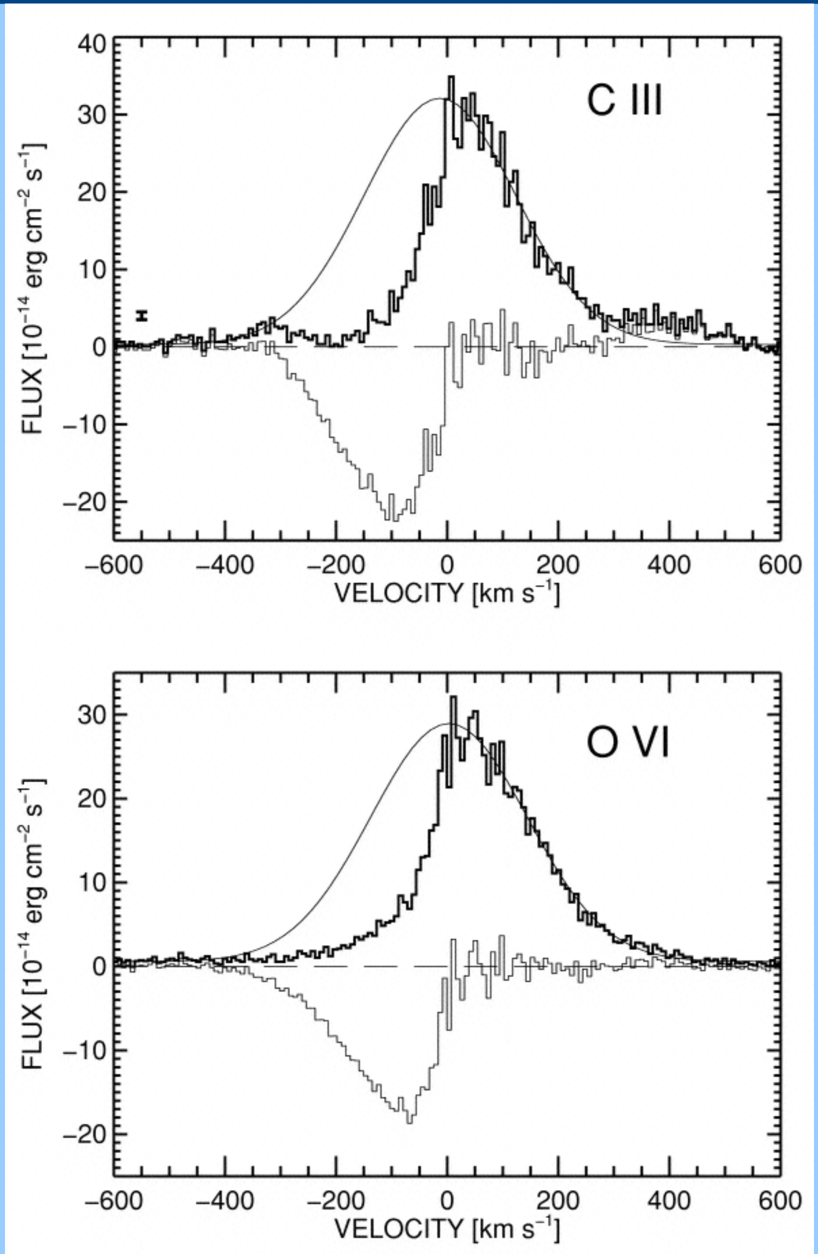
What can we learn from the new data about accretion?

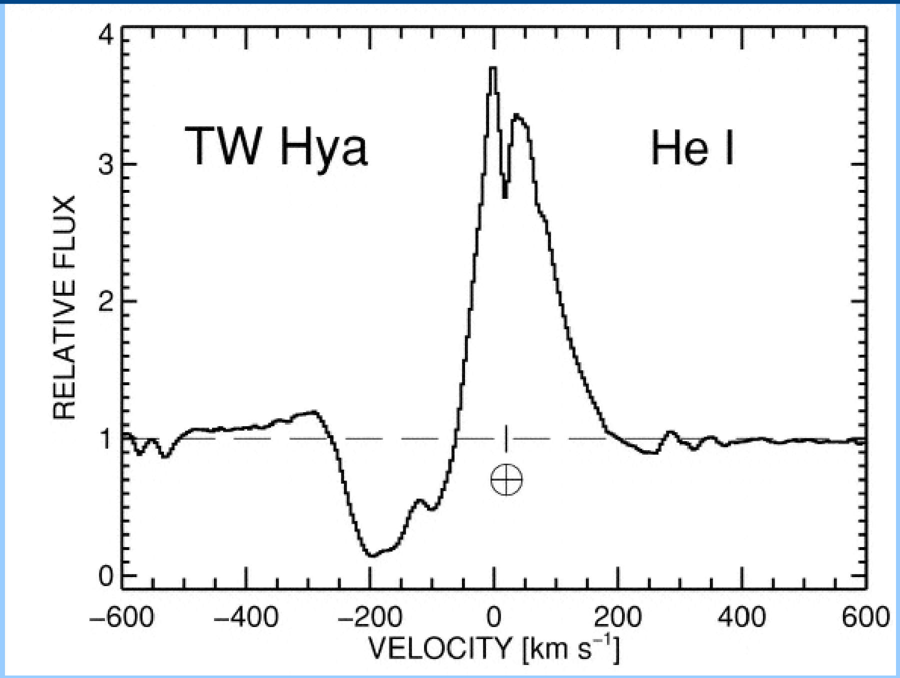
- All bands and lines are correlated (max time delay: ~hours) → All the action happens in < 0.05 AU.
- Lyα changes with a global scale factor (accretion powered).
- We might see an accretion blob moving (2 h = 5 R_*).

Winds

Günther & Wawrzyn, in: Schäfer & Aßkamp (Ed.) (2008)

How hot is the wind from TW Hya?

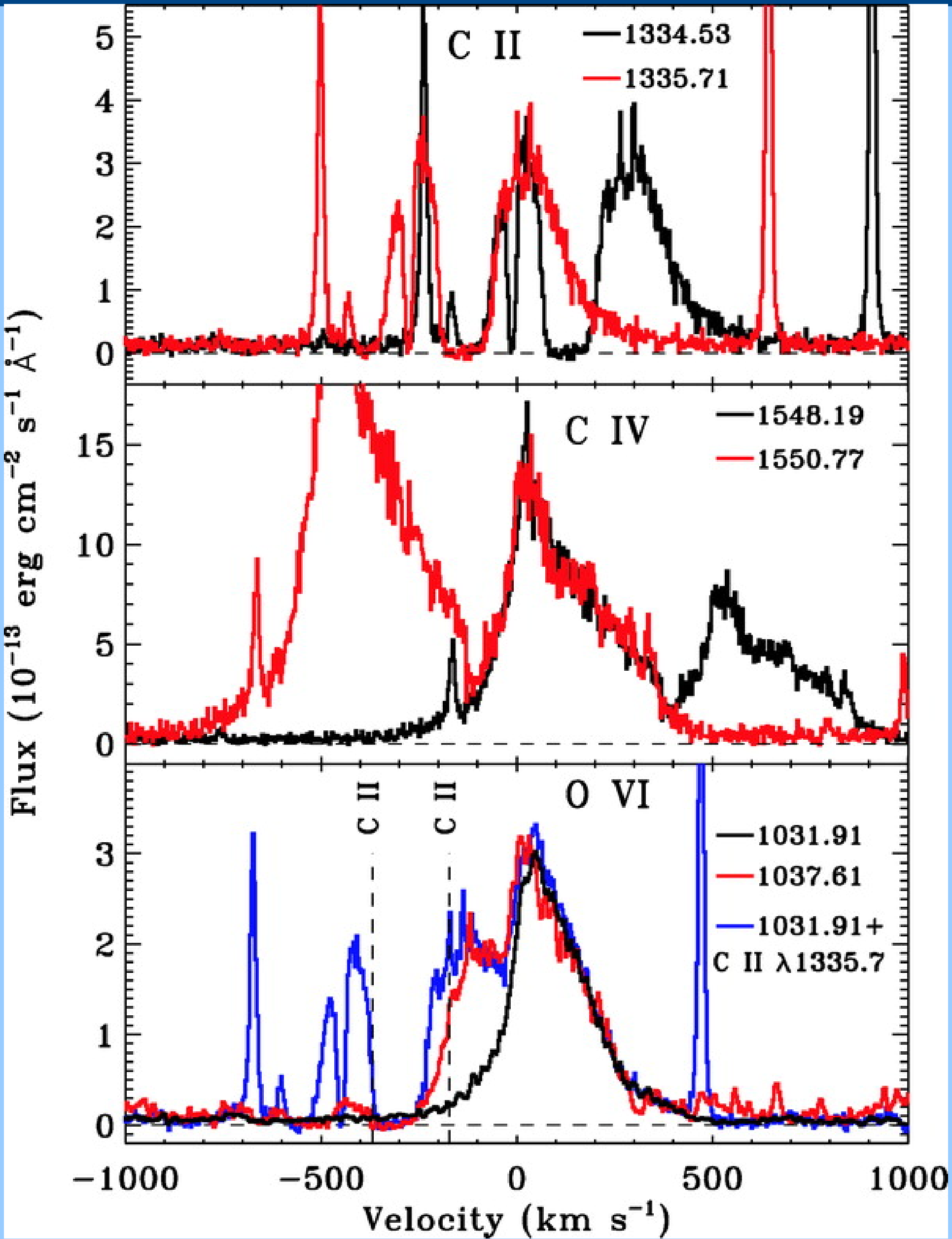




Wind as absorption signatures

Dupree et al., ApJ (2005)

How hot is the wind from TW Hya?

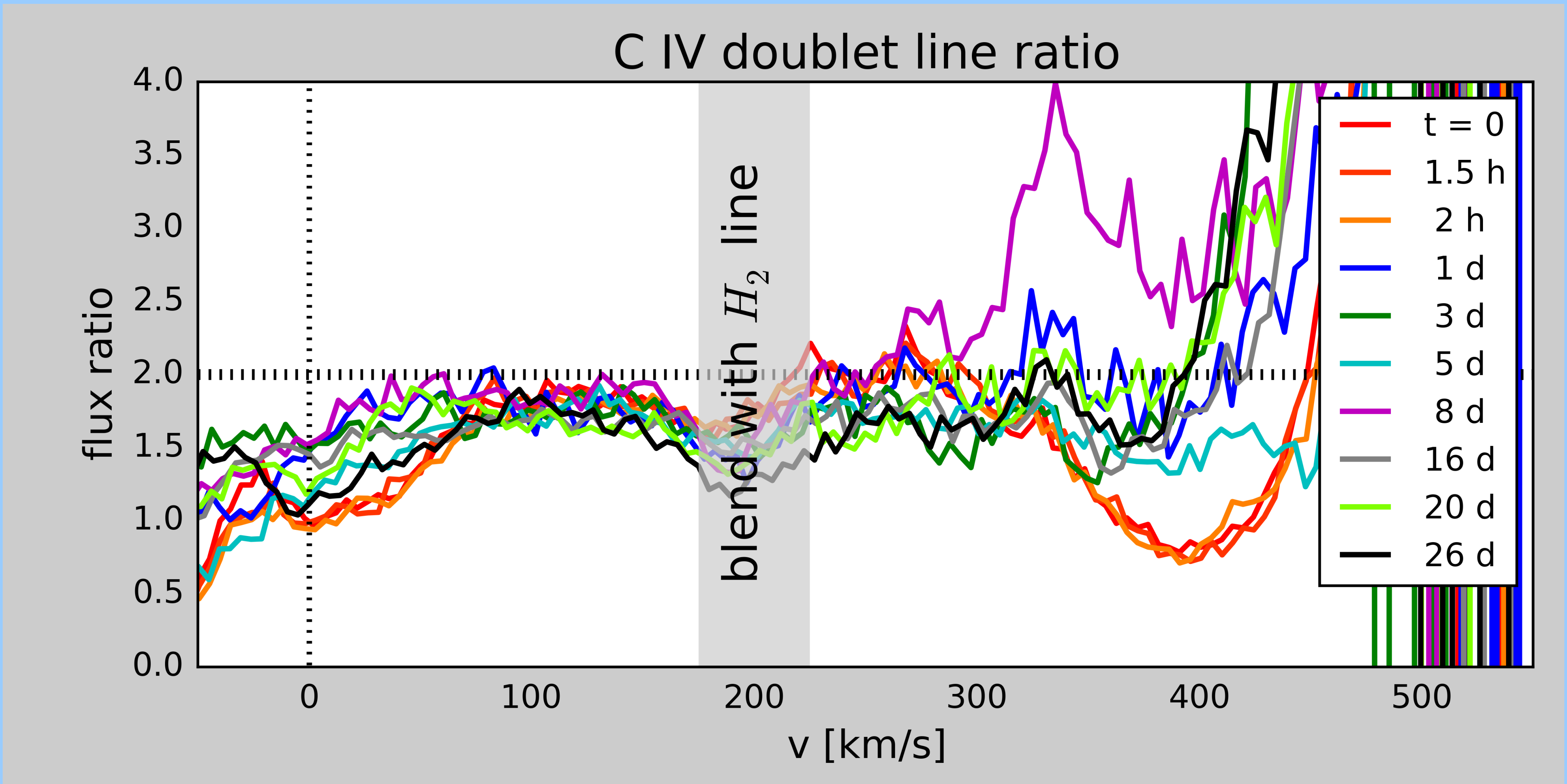


Three arguments against a hot wind

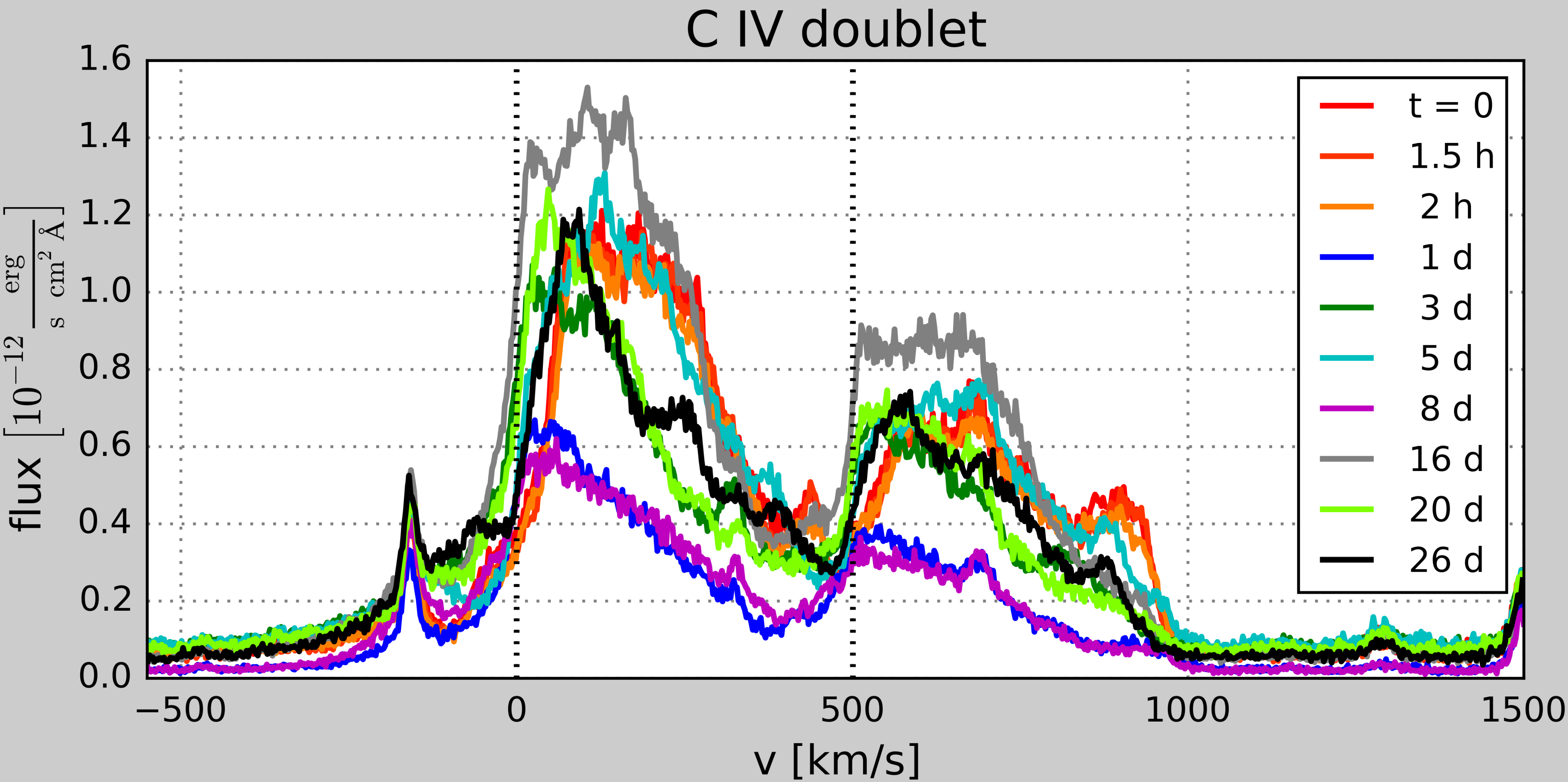
- Continuum
- Molecular hydrogen
- doublets

Johns-Krull & Herczeg, ApJ (2005)

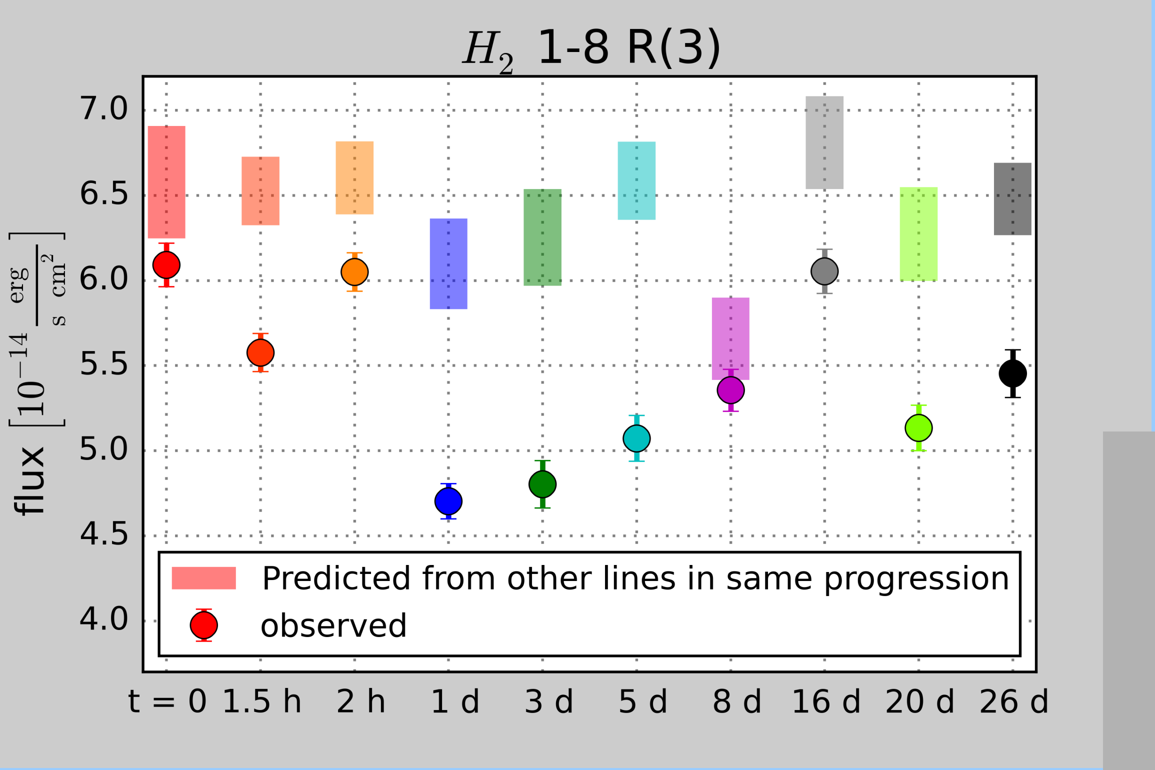
The doublet is not always 2:1.

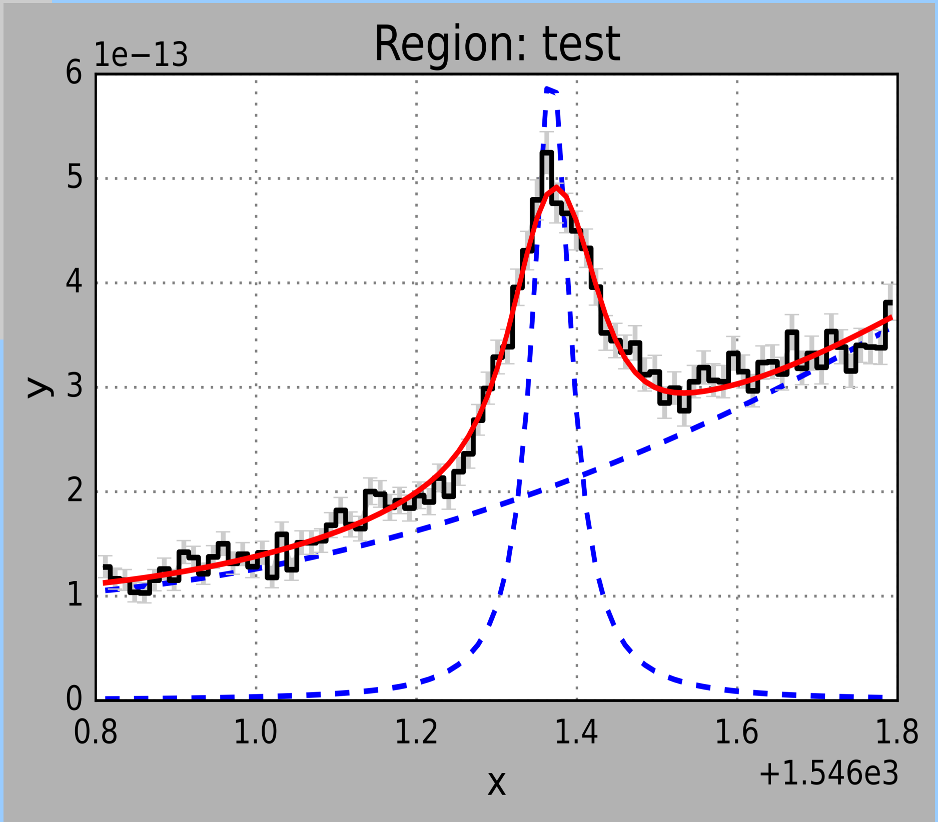


There is no continuum absorption.



Molecular hydrogen is absorbed.





1-8 R(3) is close to C IV doublet and could be absorbed by red wing.

Systematics remain, but I believe that they are too small to explain the difference.

What can we learn from the new data about winds?

- C IV emission is optically thick → the geometry of the flow is important.
- The wind above the accretion spot has (most likely) no C IV.
- The wind above the H_2 emitting disk sometimes has C IV.

Conclusion

- The more we observe, the more complexity we find.
- Accretion and outflows are dynamic systems (and stationary / equilibrium models are insufficient).
- Tracers are well correlated → small scales.
- Wind is variable is hot and cold phases → multiple components.