Simultaneous Chandra and HST spectroscopy of an accreting young star

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Phases of star formation

Artist: McCaughrean
Hot gas around T Tauri stars

Günther (2013)

Brickhouse et al. (2010, 2012)

Hot wind?

The accretion model

- 1D stationary
- optically thin
- no heat conduction
- Maxwell velocity distribution (different temperature for electrons / ions)
- magnetic field does not change dynamics
- non-equilibrium ionisation calculation

Günther, AN (2011)
Fits to broad band spectra

XMM-Newton: TW Hya
Fits to He-like triplets

XMM-Newton: TW Hya

Chandra: V4046 Sgr
Günther et al., MmSAI (2007)
Problems with current models: Accretion interacts with the star

TW Hya: 500 ks Chandra observation
Problems with current models: Accretion interacts with the star

What is the temperature of the splash?
Its abundance?
How does it move?
→ We can measure velocities in the UV with HST.

TW Hya: 500 ks Chandra observation
Need for simultaneous data!
HST/COS data

- 10 orbits HST/COS, spread over one month
- Major components:
  - C IV: accretion shock
  - Continuum: shock-heated photosphere
C IV emission lines

![C IV doublet graph](image-url)
C IV emission lines
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: tubululence, $<\frac{1}{4}$ freefall velocity
How can we explain the C IV (and other hot ion line) shapes?

- Splatter: turbulent, variable bulk < 100 km/s absorption
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- Heated photosphere: 20,000 K varies with accretion
Summary

- Chandra spectra show high-densities in TW Hya due to the accretion shock.
- We observe exceptionally low f/i ratios.
- This model is tuned using kinematic information from HST/COS.
- No hot wind, but a hot splatter (a failed wind)
Optical depth

- C IV is a doublet, with an intrinsic line ratio 2:1
- If the 1448 Ang line is lower, this indicates optical depth in the emission region.