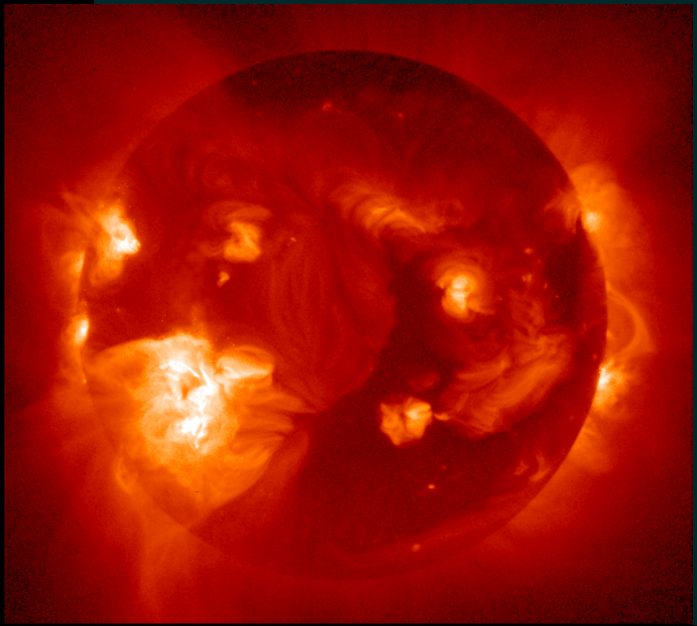
The Role of Stellar Winds in the Star-Disk Interaction



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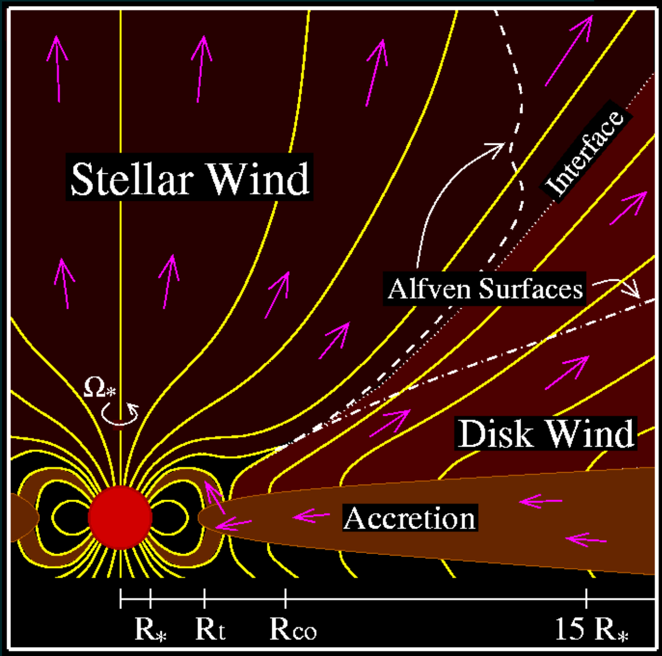


IAU Symp. 243
May 21-25, 2007

Accretion-Powered Stellar Winds may provide a solution to the angular momentum problem.

To explain accreting stars spinning at ~10% of breakup (e.g., Matt & Pudritz 2005)

$$\dot{M}_{\mathrm{w}} / \dot{M}_{\mathrm{a}} \sim 0.1$$

Typically

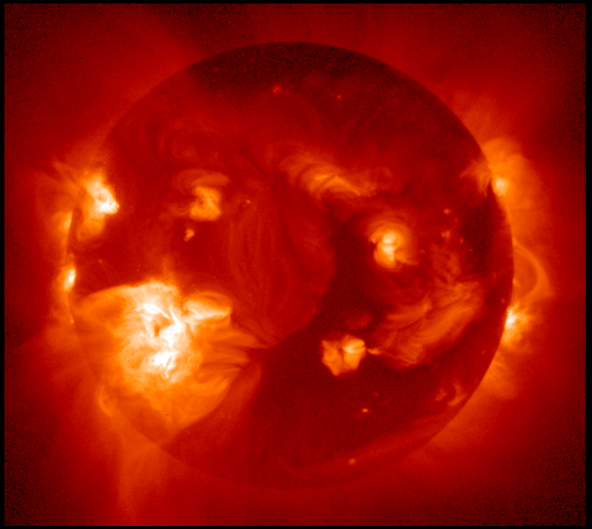
$$\dot{M}_{\mathrm{a}} \sim 10^{-8} \ M_{\odot}/\mathrm{yr}$$

--> Wind requires accretion power.

But this is based on 1-D formulation
What is the nature of these winds?
We'd like to make some predictions for people to test.


BEAL

Hypothesis:
AP Coronal Winds?



These are hot (~10^6 K), pressure-driven winds, like solar wind on steroids.

Previous work: X-rays obs. require

$$\dot{M}_w < \sim 10^{-9} \, M_\odot/\mathrm{yr}$$

Decampli (1981), Bisnovatyi-Kogan & Lamzin (1977)

We use 2D, ideal MHD simulations to get solutions for massive, coronal winds, from isolated stars.

R_*	$= 2 \, R_{sun}$	spin rate	= 10% breakup
M_*	$= 0.5 \, M_{sun}$	T_{corona}	$\approx 10^6$ K
B_* (dipole)	= 200 G	$\dot{M}_w$	= 1.05 - 1.[illegible] $M_\odot/\mathrm{yr}$

Simulations for 2D Steady-State Wind Solutions

- Parameter study

- Stellar wind torques look good

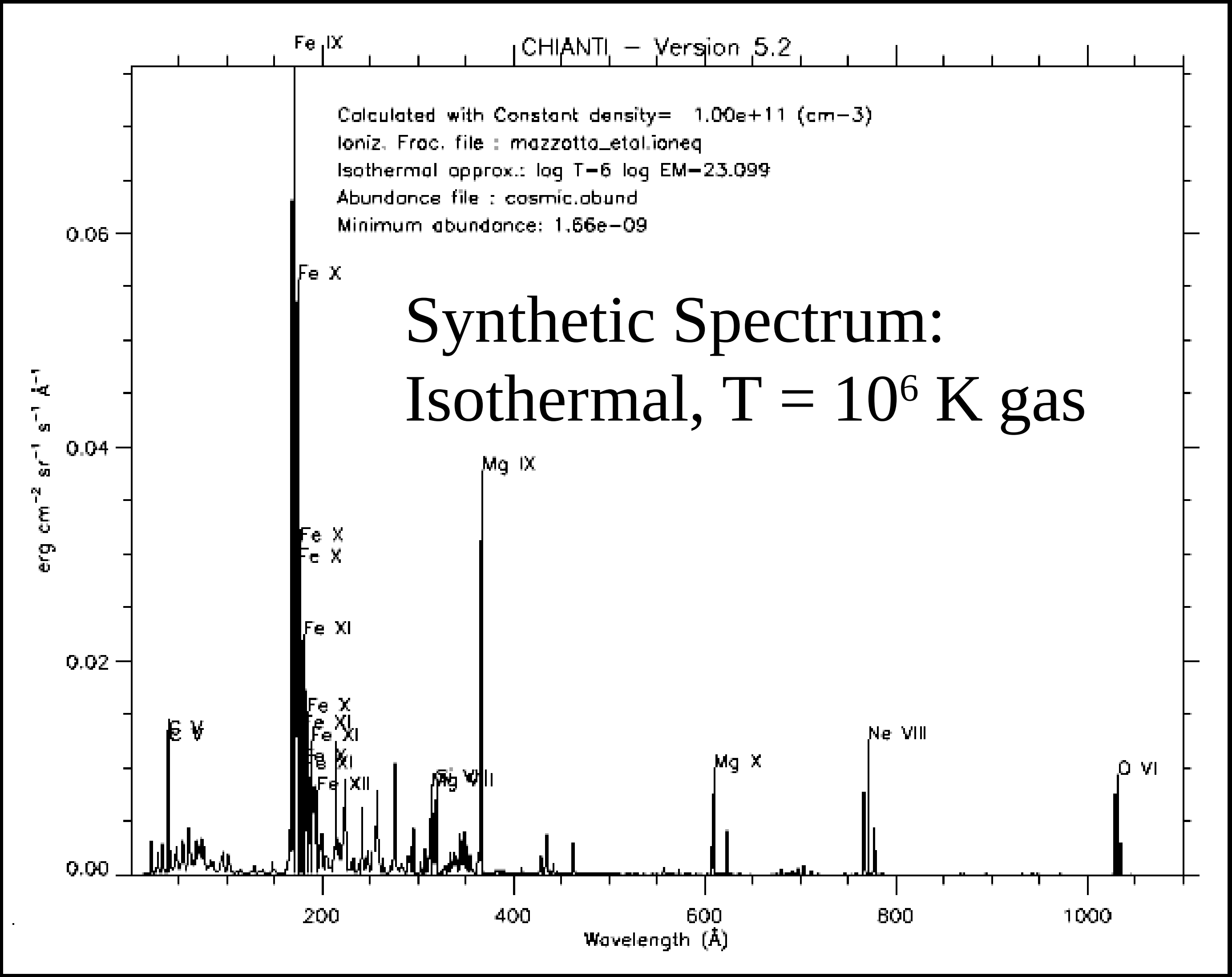
-What sort of emission do we expect?

Emission Properties from CHIANTI database

Cooling dominated by line emission

~1% of flux in soft X-rays

Mostly emits in EUV



Assumes optically thin, coronal plasma.

Total Radiative Losses (Cooling Rate)

$$L_{\rm w} \sim 10^{34}\ {\rm erg/s}\ \left(\frac{\dot{M}_{\rm w}}{10^{-9} M_\odot/{\rm yr}}\right)^2$$

This is way too large!

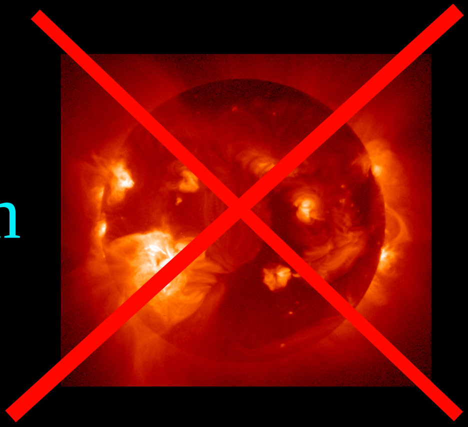
- Probably too many X-rays (Gibor B., Frank S., ... you were right!)

Accretion power: $$L_{\rm a} \sim 10^{32}\ {\rm erg/s}\ \left(\frac{\dot{M}_{\rm a}}{10^{-8} M_\odot/{\rm yr}}\right)$$

Upper Limit on Coronal Winds from CTTSs

$$\dot{M}_{\rm w} < \sim 10^{-11}\ M_\odot/{\rm yr}$$

We Rule Out Coronal (Hot) Stellar Winds for Solving the Angular Momentum Problem



- TTSs likely have coronal winds, but weak
- APSW is still a promising scenario
- APSW must be cooler (~$10^{4\text{-}5}$ K ?)

Supported by obs. of stellar winds in He I (Edwards et al. 2006) and modeling of Hα line (Kurosawa et al. 2006).

Challenge for the Theory:

How can TTSs drive massive, cool winds?

Alfven waves; episodic magnetospheric inflation; ...?