

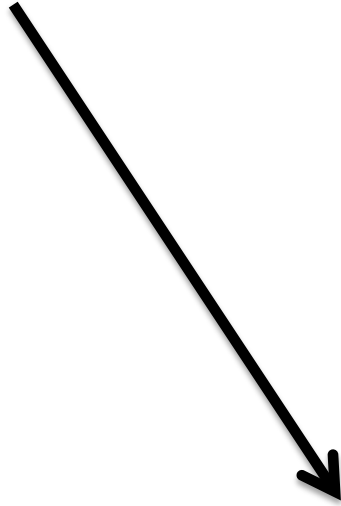
Unstuck in the middle with you: intermediate-mass stars are the missing link in star formation

Megan Reiter

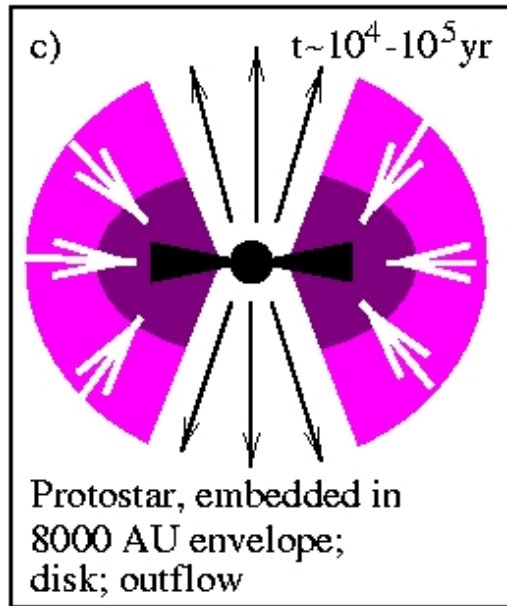
Dean B. McLaughlin Fellow
University of Michigan

with Nuria Calvet, Thanawuth Thanathibodee, Stefan Kraus, P. Wilson Cauley, John Monnier, Adam Rubinstein, Alicia Aarnio, & Tim Harries

Herbig Ae/Be stars ($\sim 2-10 M_{\text{sun}}$) sample conditions intermediate between low- and high-mass stars.



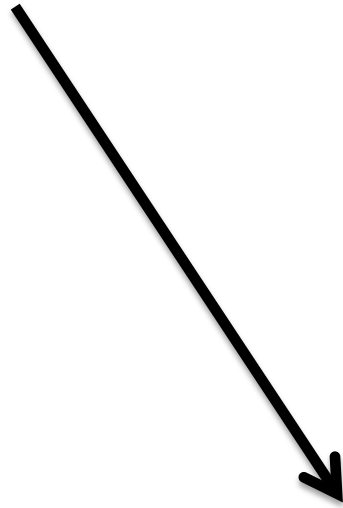
Herbig Ae/Be stars ($\sim 2-10 M_{\text{sun}}$) sample conditions intermediate between low- and high-mass stars.



Hogerheijde 1998,
after Shu et al. 1987



Herbig Ae/Be stars ($\sim 2-10 M_{\text{sun}}$) sample conditions intermediate between low- and high-mass stars.



Transition?

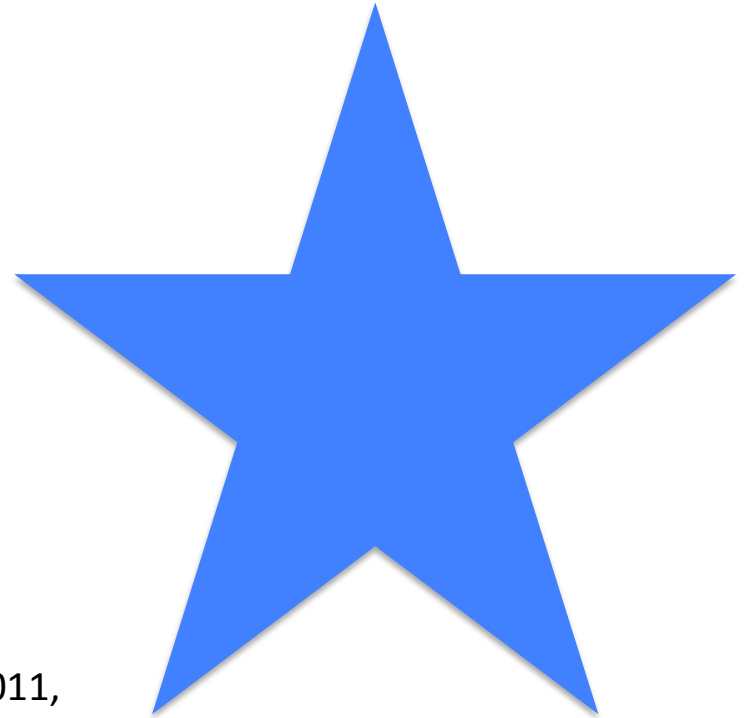
Disk geometry – Vink et al. 2002, 2005

Magnetic fields – Wade et al. 2007,

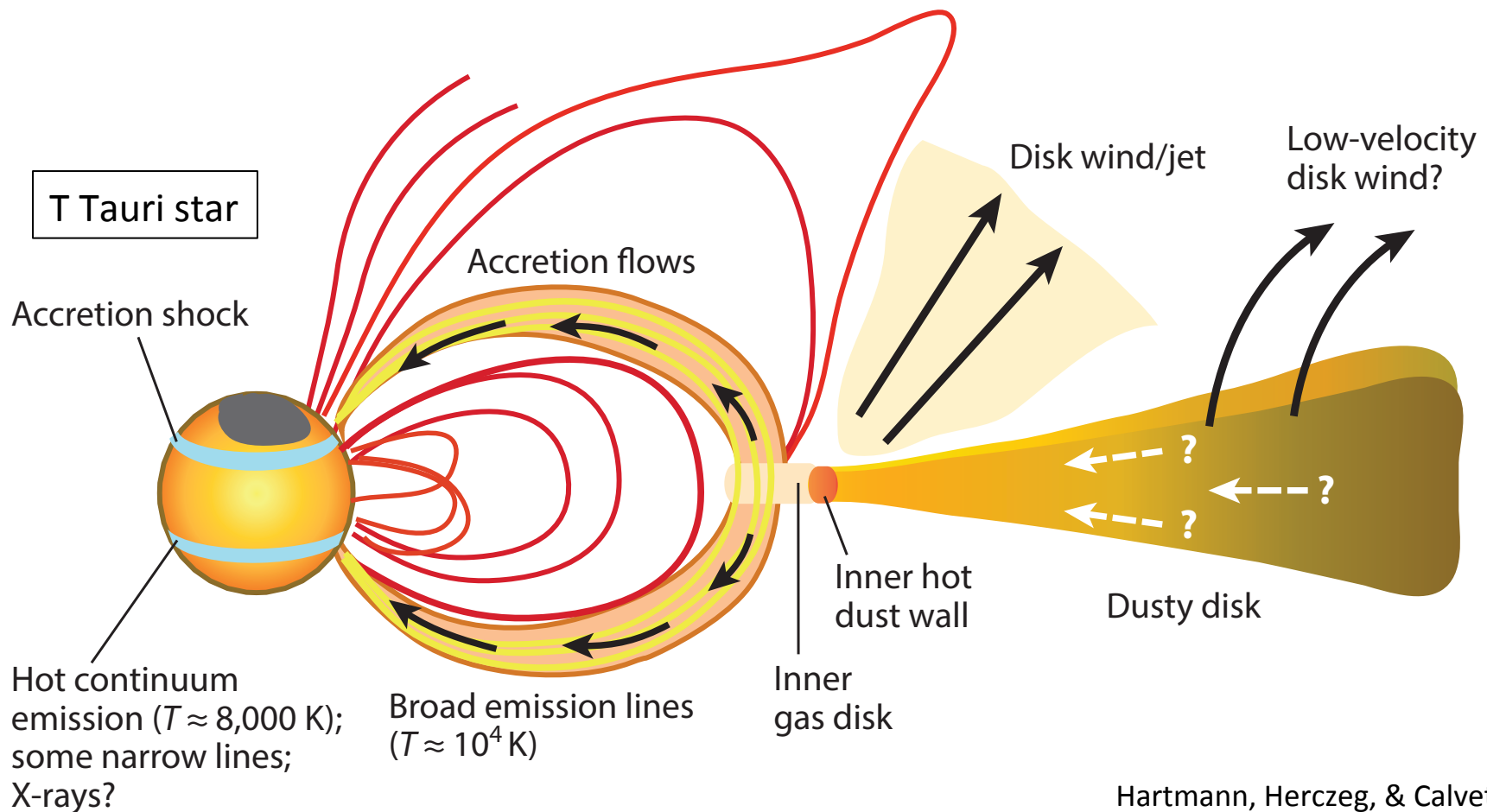
Alecian et al. 2013

Accretion physics - Donehew & Brittain 2011,

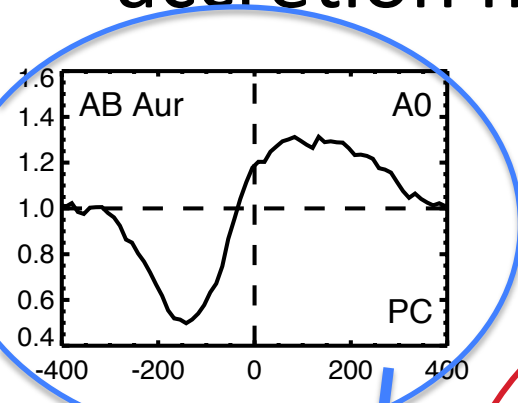
Cauley & Johns-Krull 2014



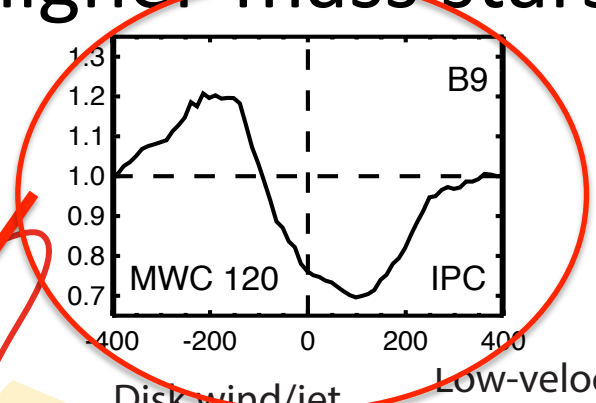
Necessary elements of magnetospheric accretion may not exist in higher-mass stars.



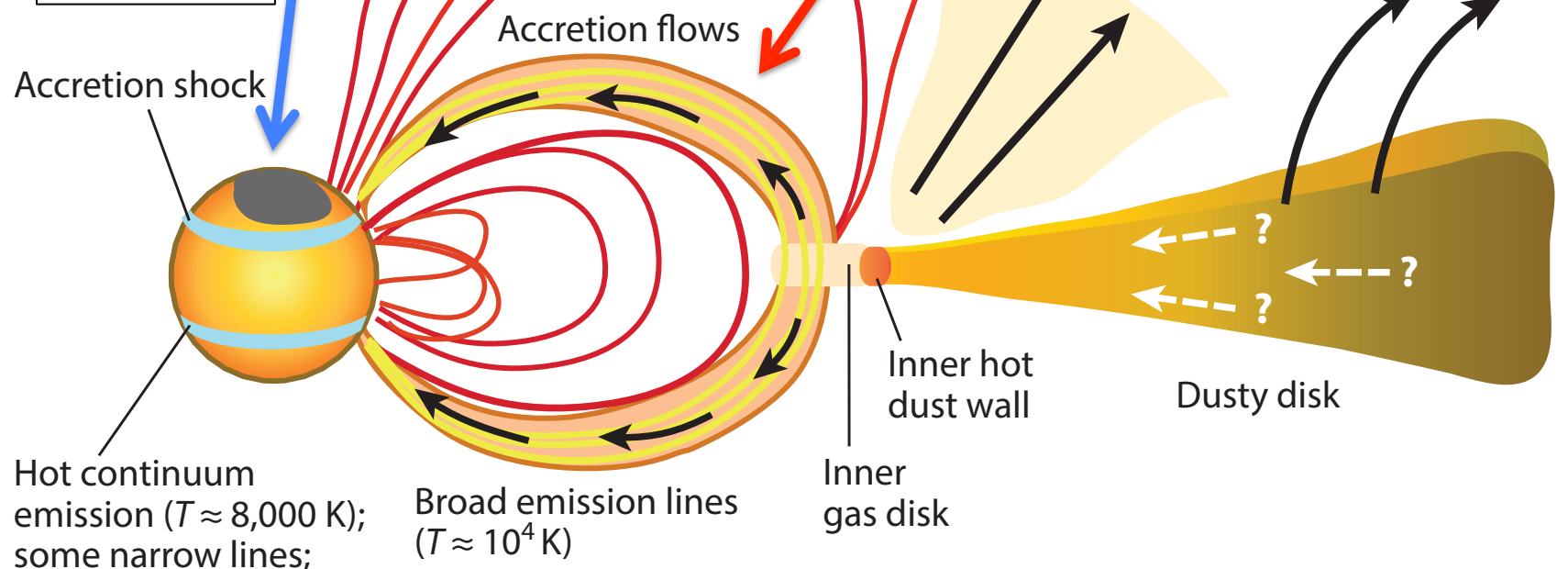
Necessary elements of magnetospheric accretion may not exist in higher mass stars.



T Tauri star

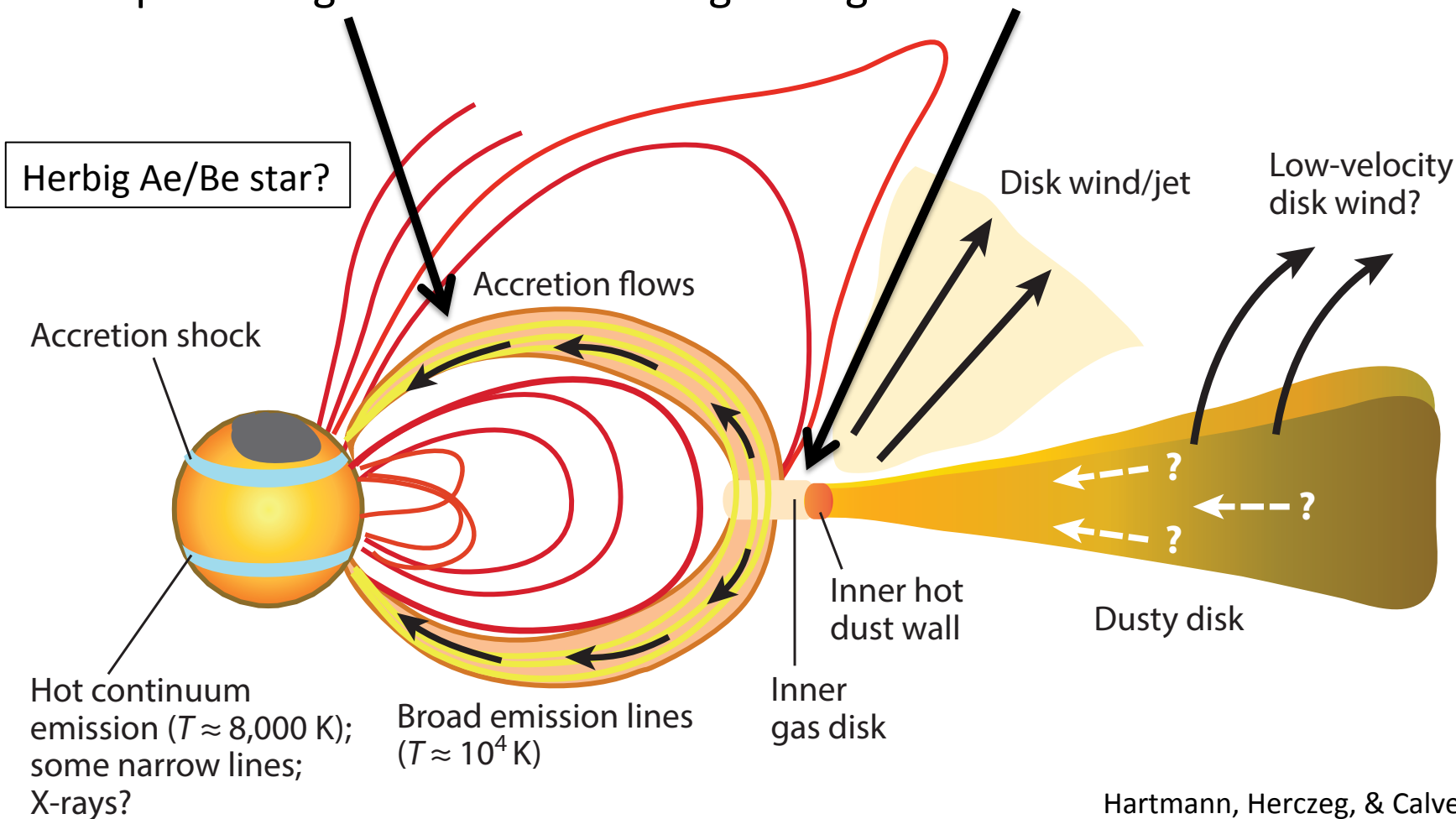


Disk wind/jet Low-velocity disk wind?

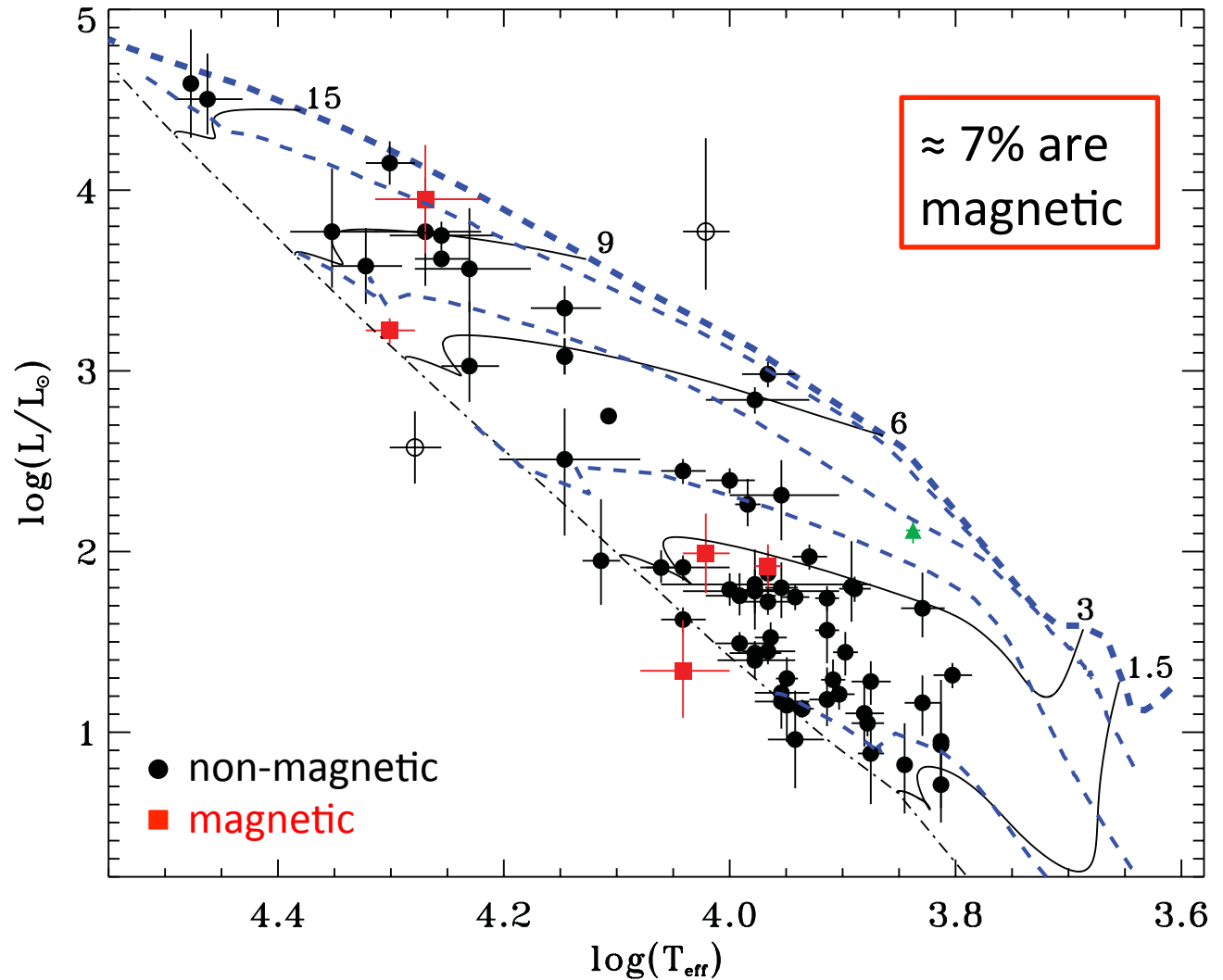


Necessary elements of magnetospheric accretion may not exist in higher-mass stars.

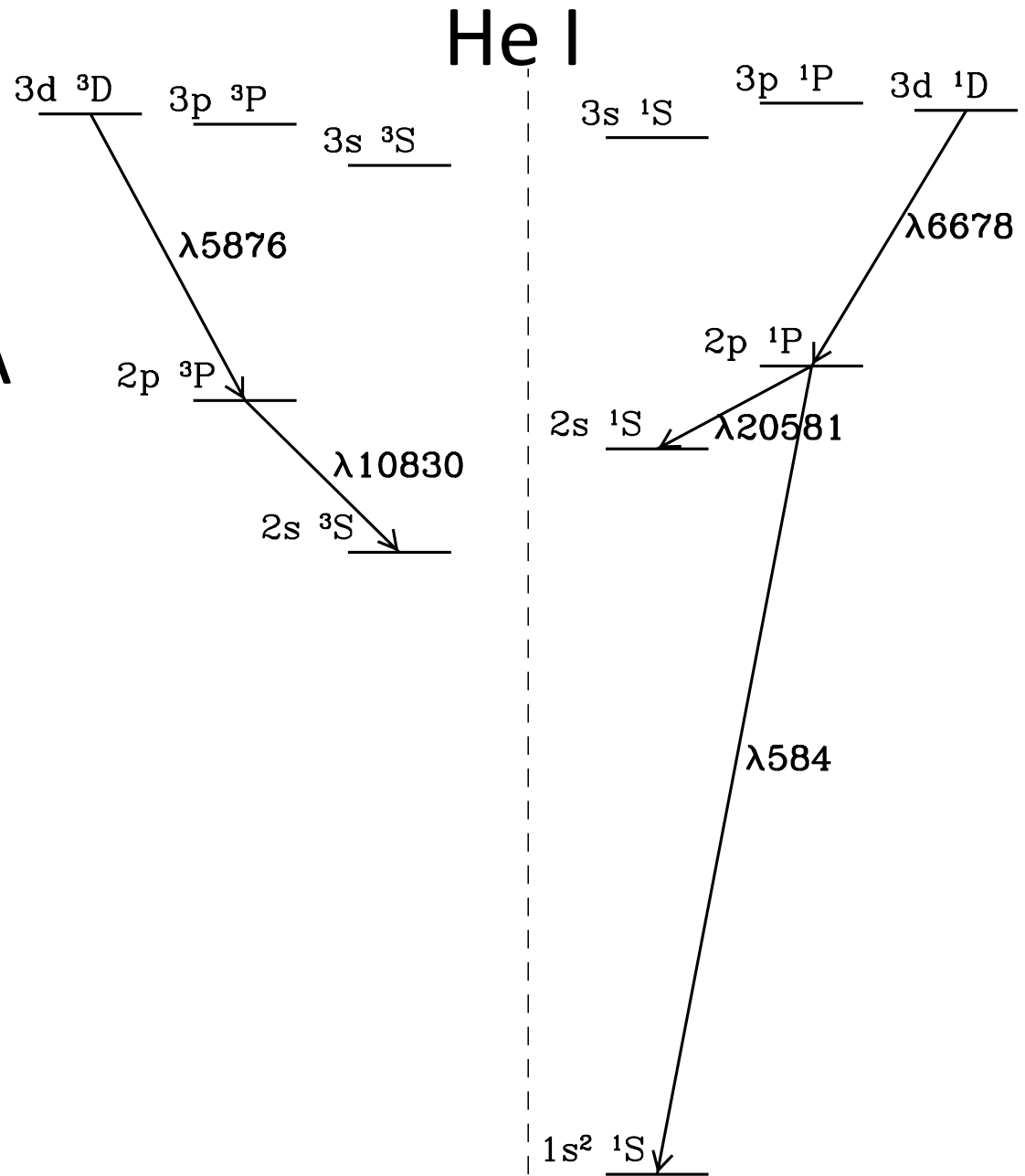
Dipolar magnetic field \rightarrow strong enough to truncate the inner disk.



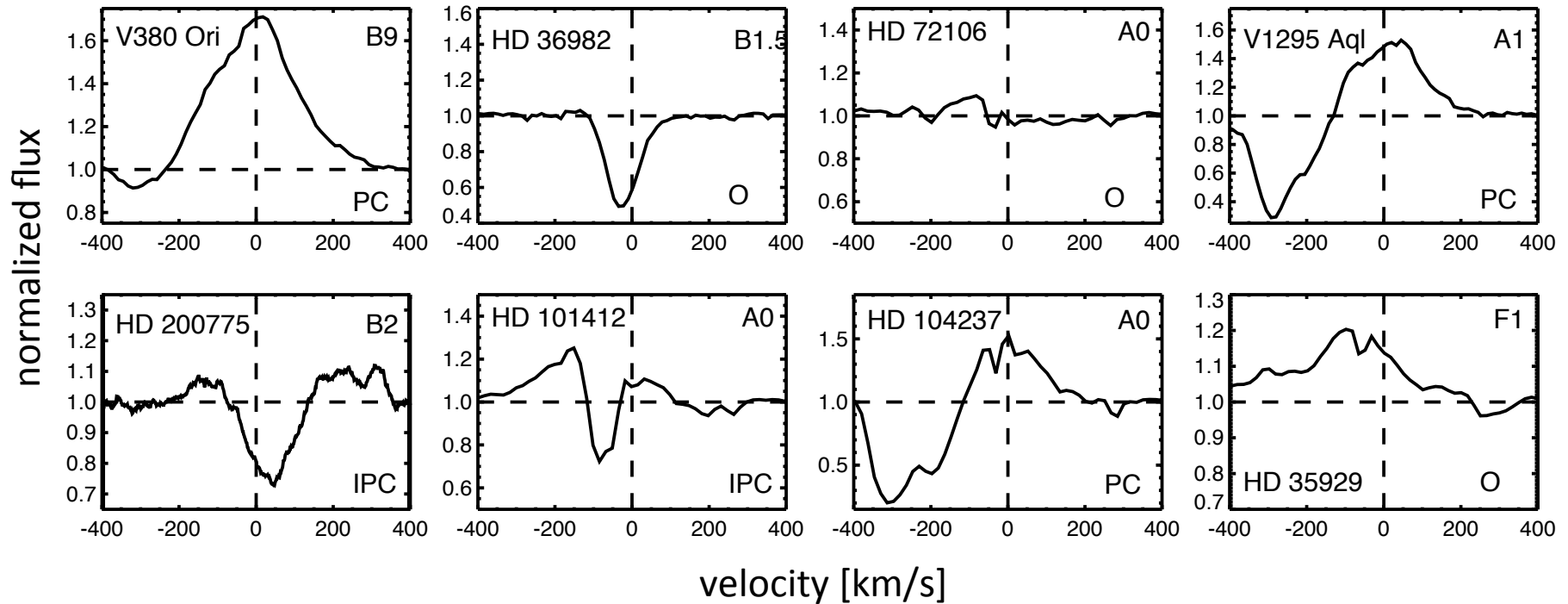
Few Herbig Ae/Be stars have detectable magnetic fields.



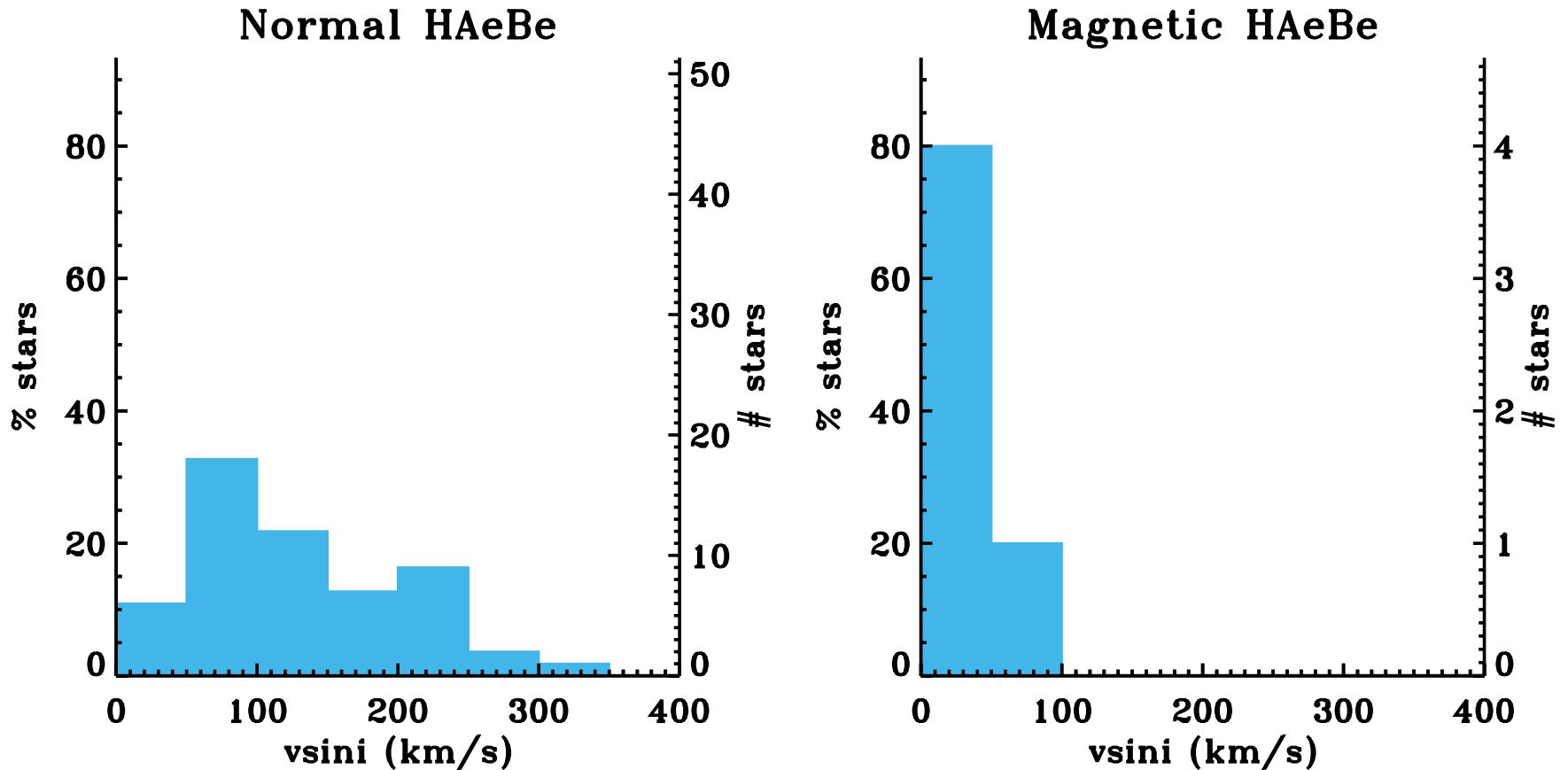
Use He I 10830 Å
line profile
morphology to
trace gas
kinematics near
the star.



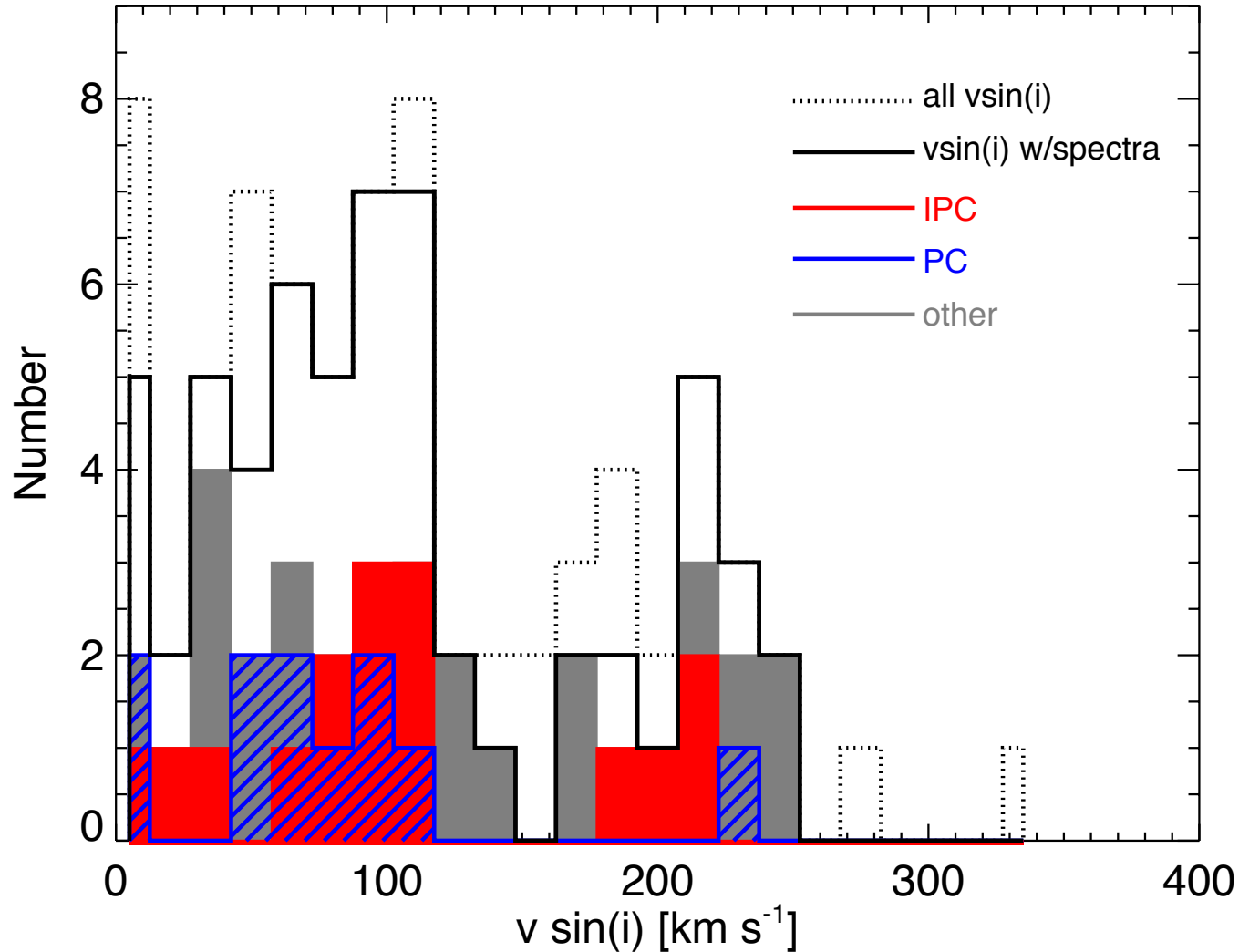
Magnetic Herbig Ae/Be stars show a mix of line profile morphologies.



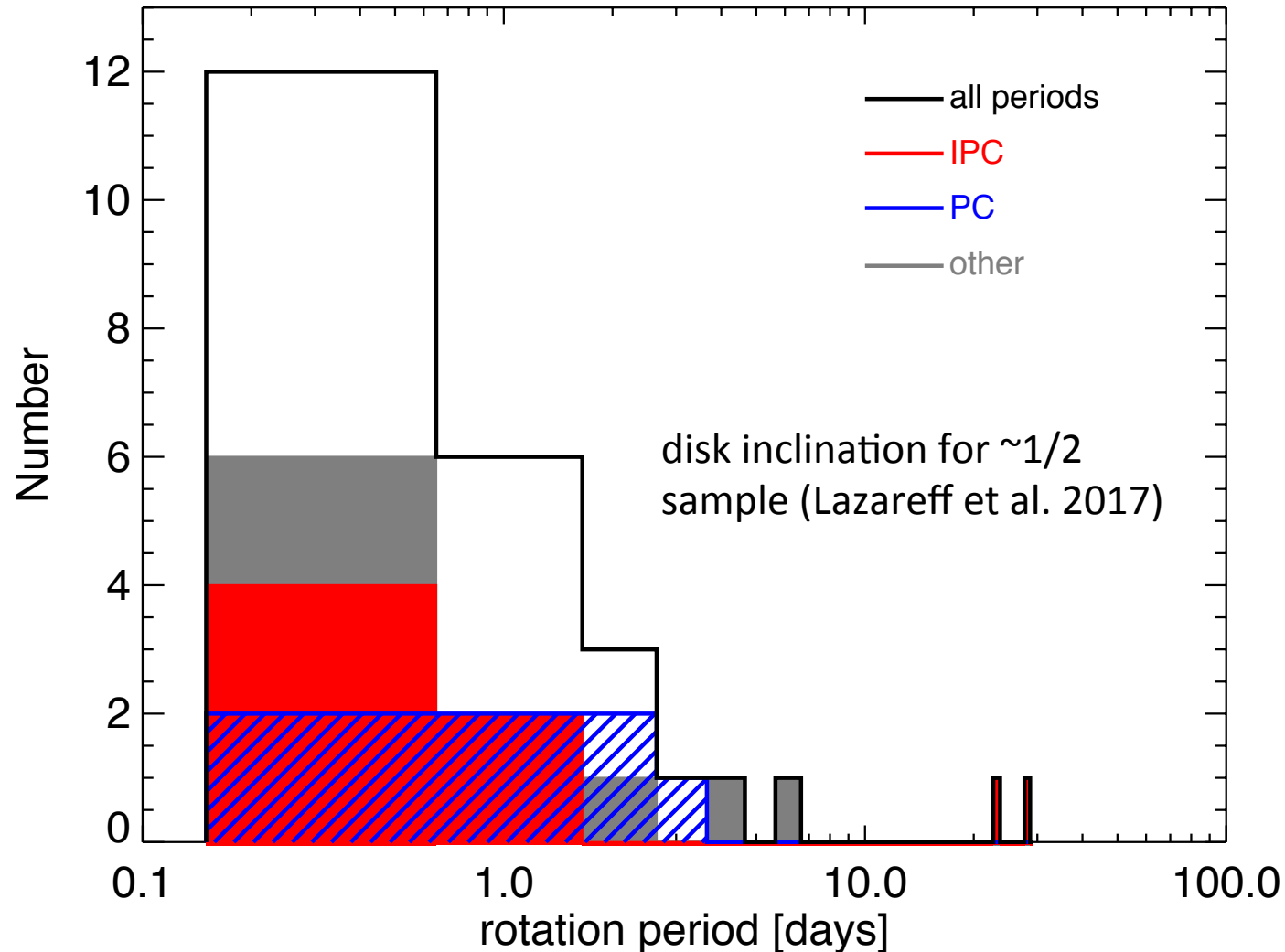
Magnetic Herbig Ae/Bes are slow rotators – do line profiles provide indirect evidence of B-field?



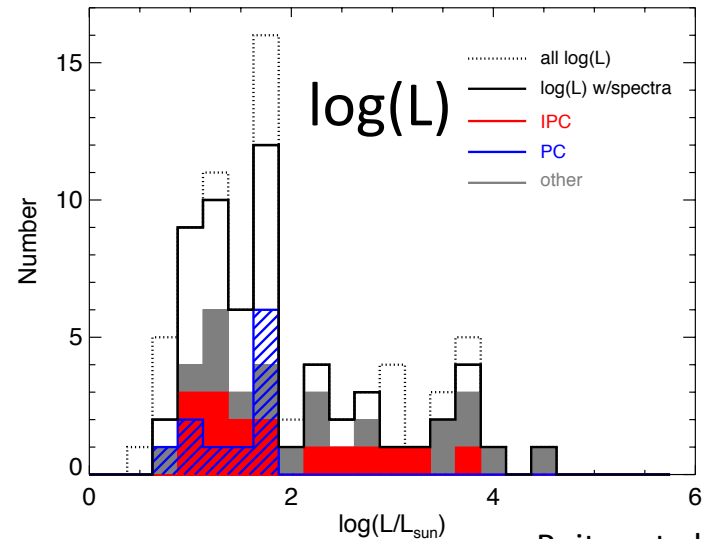
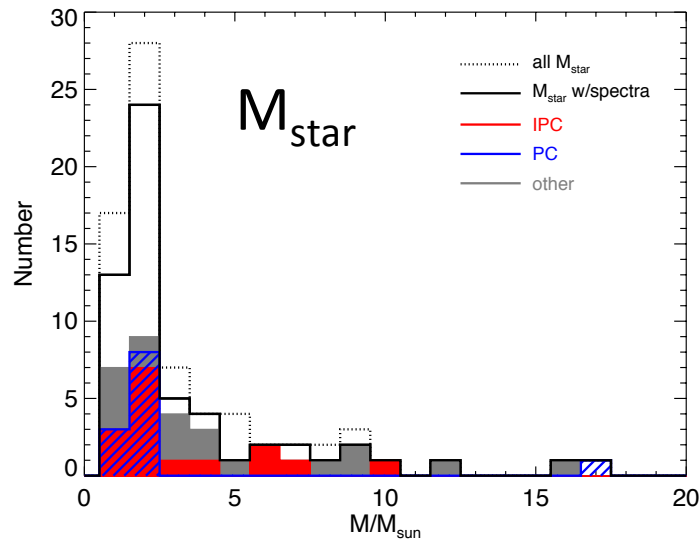
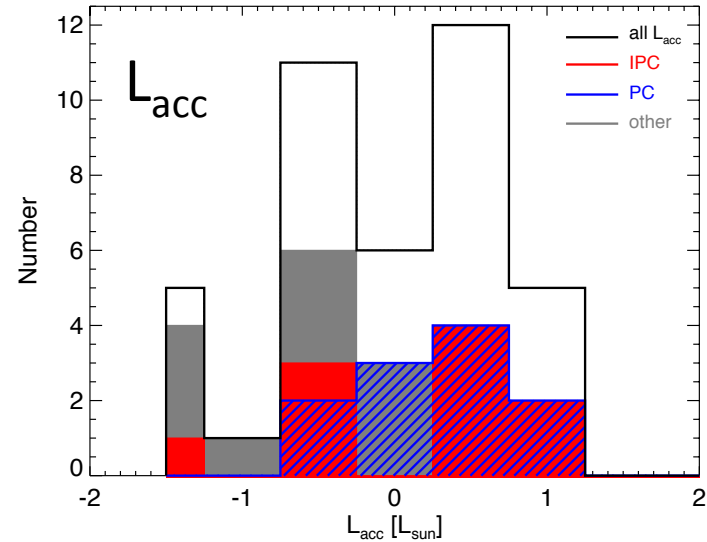
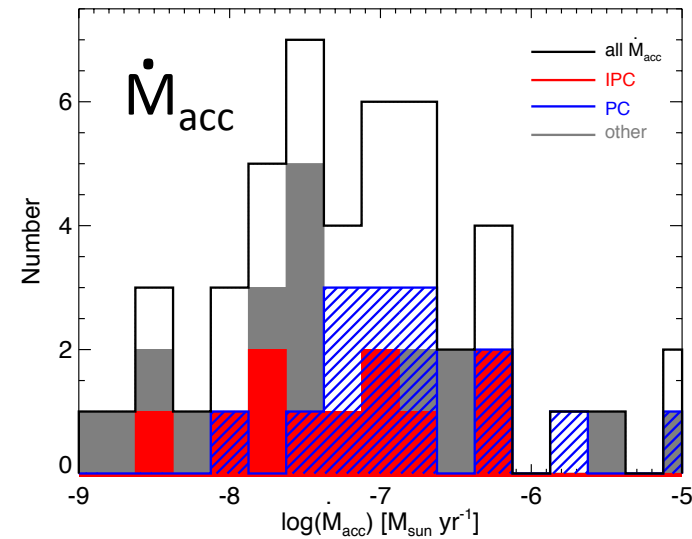
Slow rotators **not** more likely to show redshifted absorption...



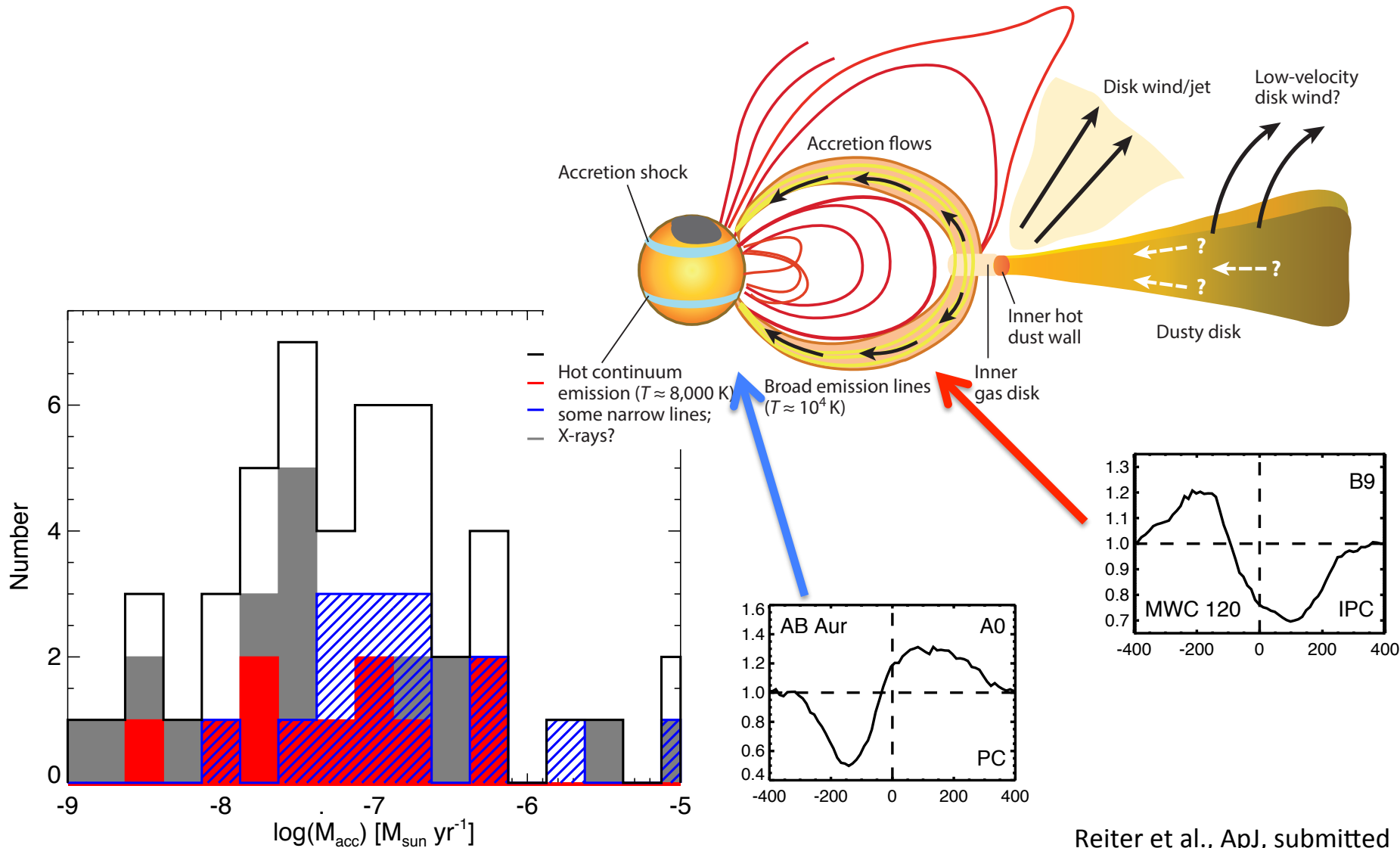
Slow rotators **not** more likely to show redshifted absorption... even when corrected for inclination.



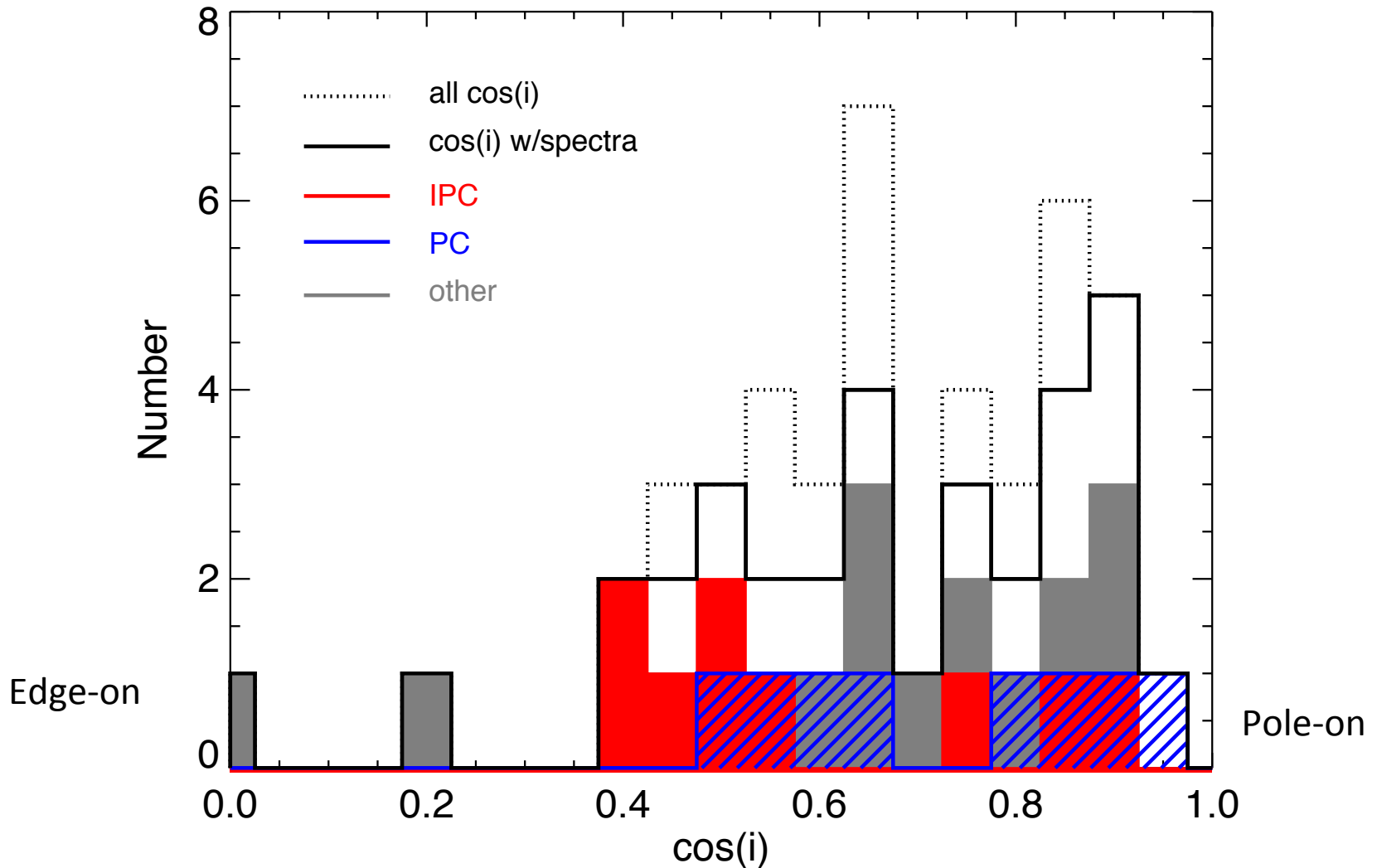
Line profile morphology does not correlate with any stellar parameter.



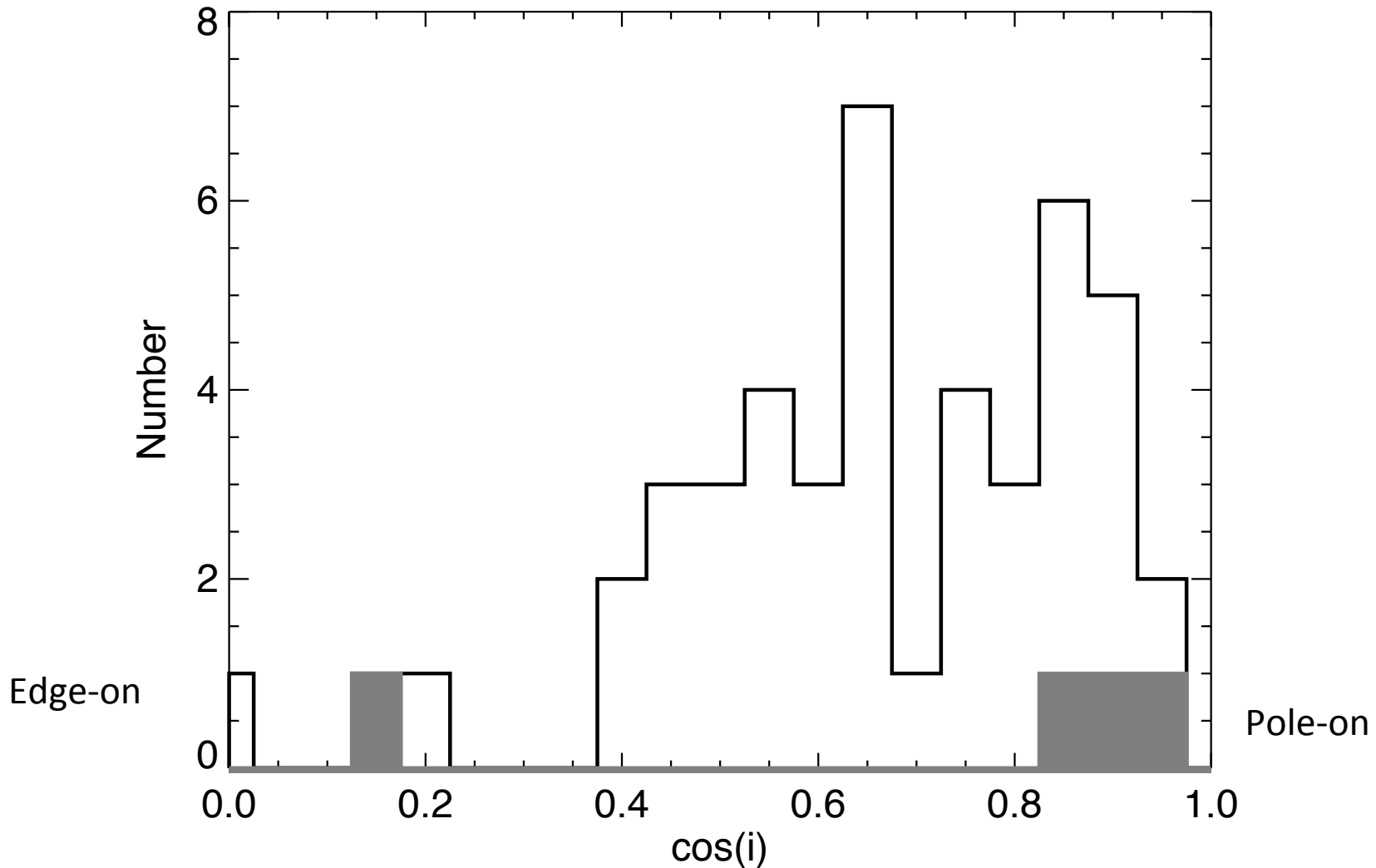
For magnetospheric accretion, redshifted absorption is only visible from some inclinations.



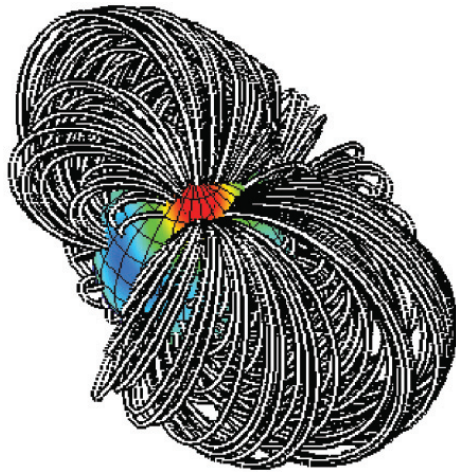
No clear dependence of line profile morphology on inclination (although small numbers).



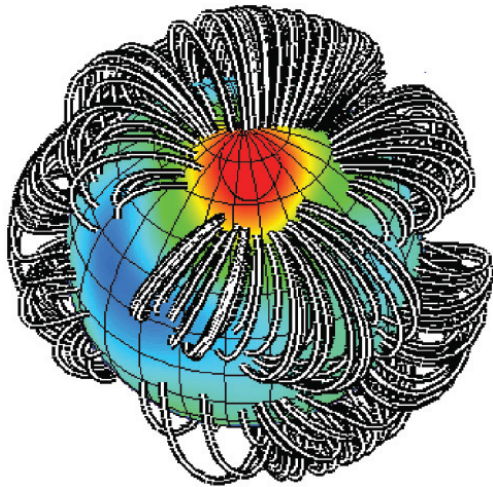
Magnetic fields preferentially detected in sources seen closer to pole-on.



Magnetic fields only detected from some viewing angles.



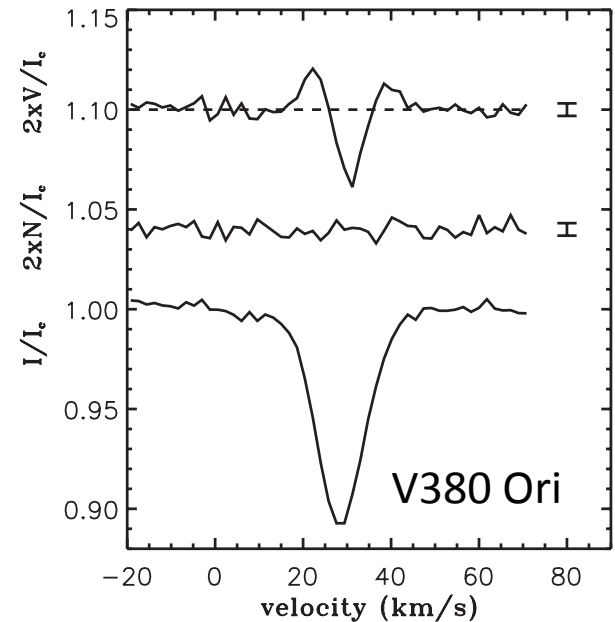
dominant dipole



higher-order field

Circular polarization

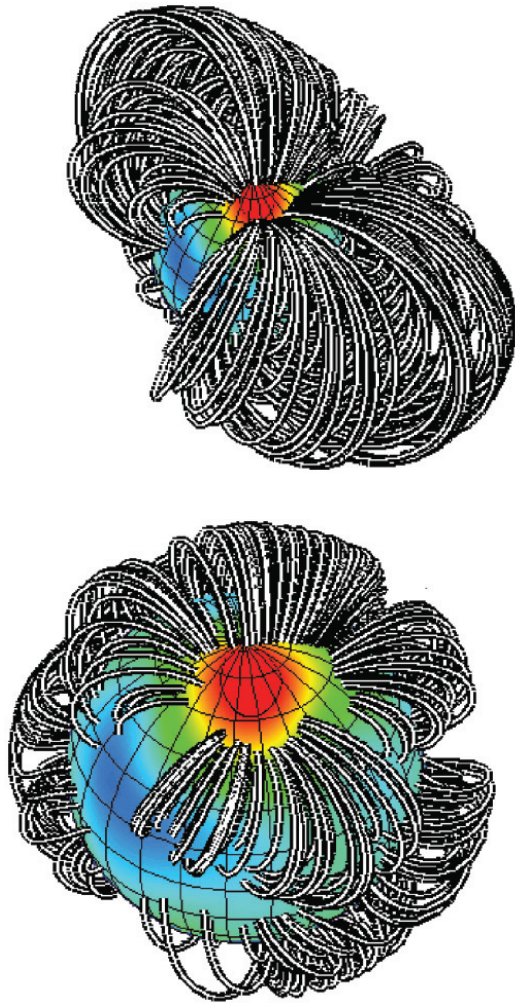
→ indicates ordered field



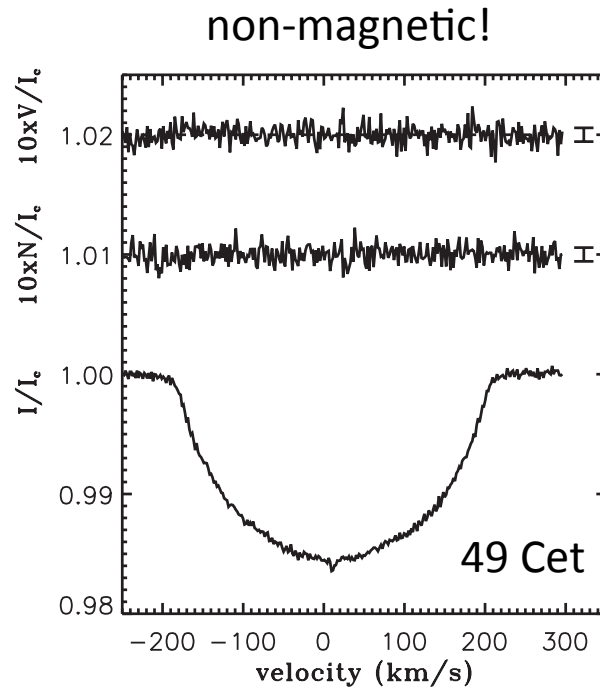
Zeeman broadening

→ field strength

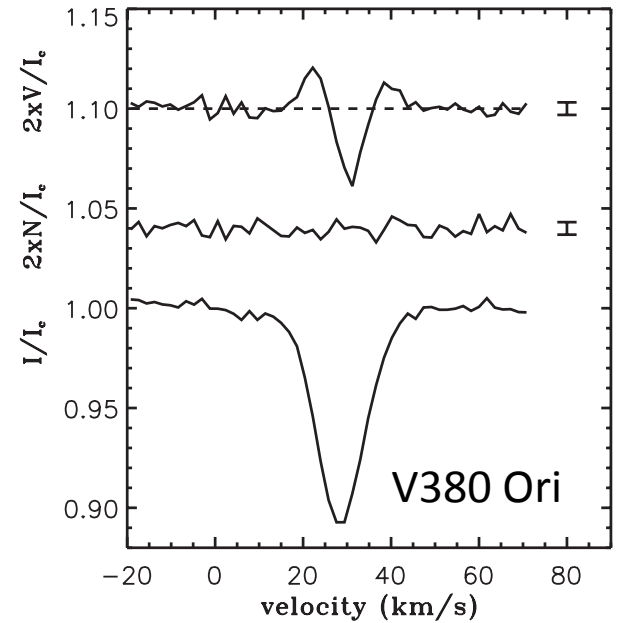
Magnetic fields only detected from some viewing angles.



BP Tau from Gregory et al. (2008)



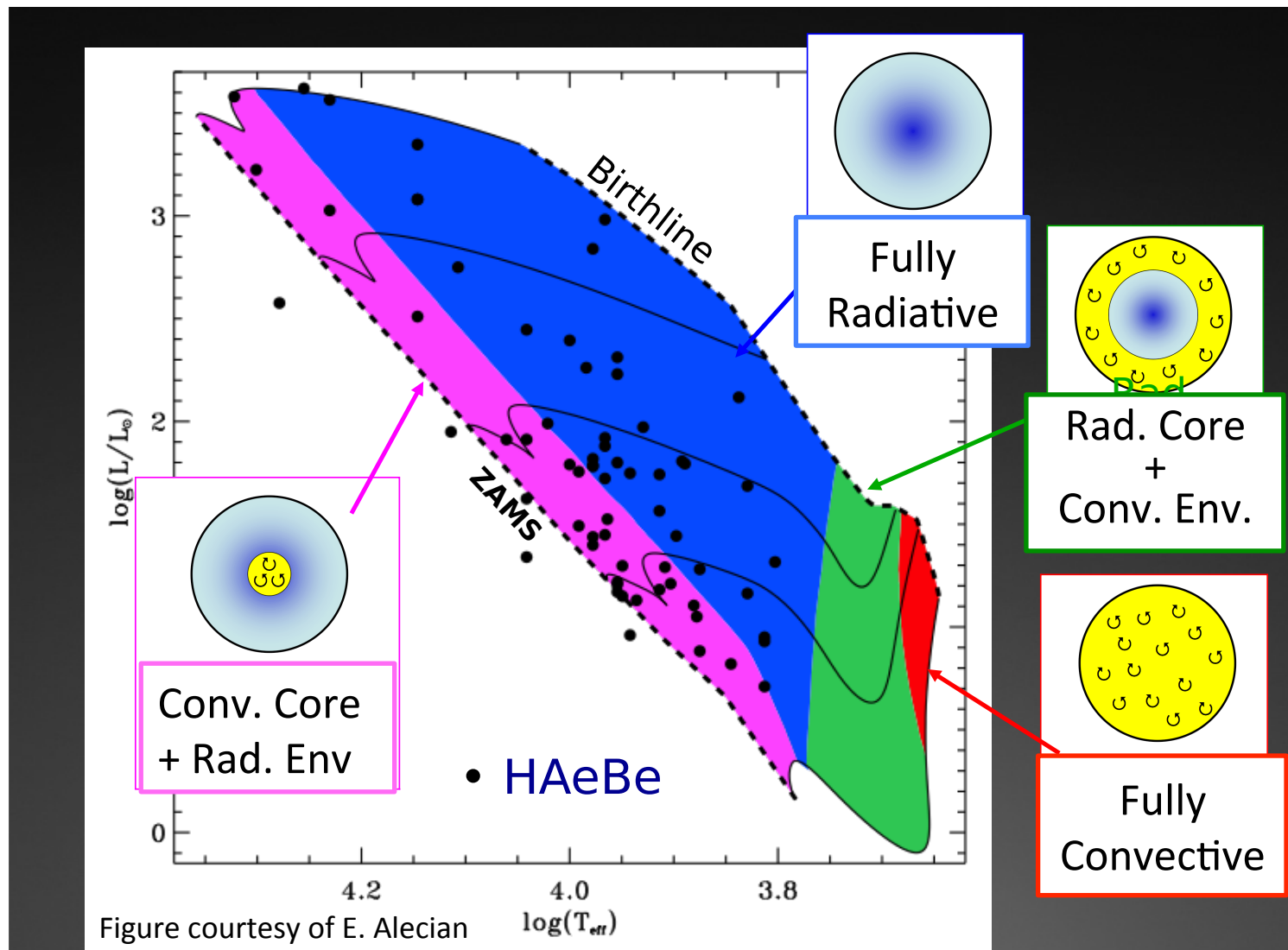
Circular polarization
→ indicates ordered field



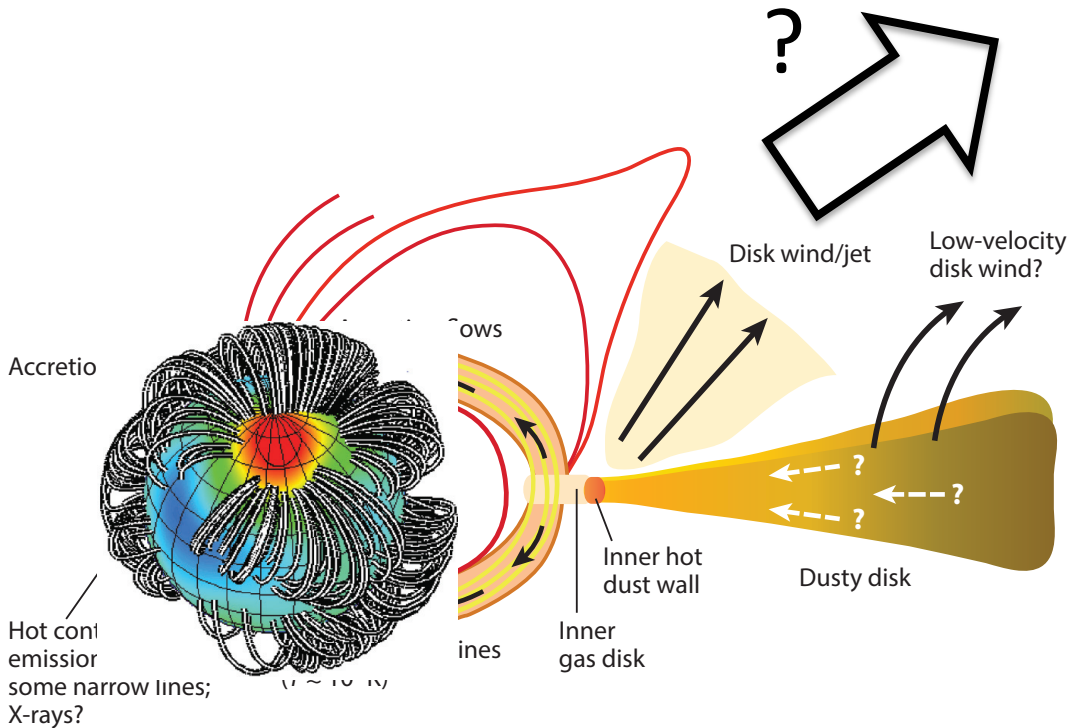
Zeeman broadening
→ field strength

Alecian et al. (2013b)

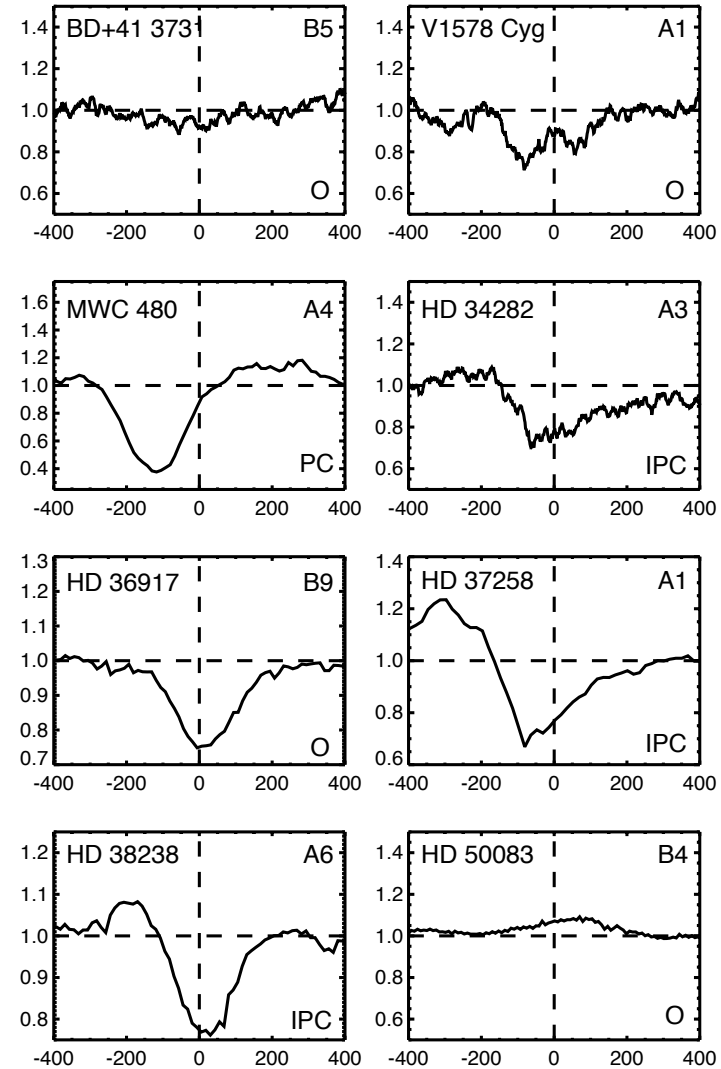
Magnetic field strength and topology evolve as star moves in HR diagram.



Models needed to test magnetospheric accretion via weaker, higher-order field components.



BP Tau from Gregory et al. (2008)
cartoon from Hartmann et al. (2016)



Line profiles unaffected by the magnetic field.

- Line profiles not different between magnetic and non-magnetic Herbig Ae/Be stars.
- No correlation between stellar parameters and line profiles.
- Possible selection bias – magnetic fields only detected in sources view pole-on?

