CHARACTERIZING THE UV RADIATION ENVIRONMENT OF M DWARF EXOPLANETS

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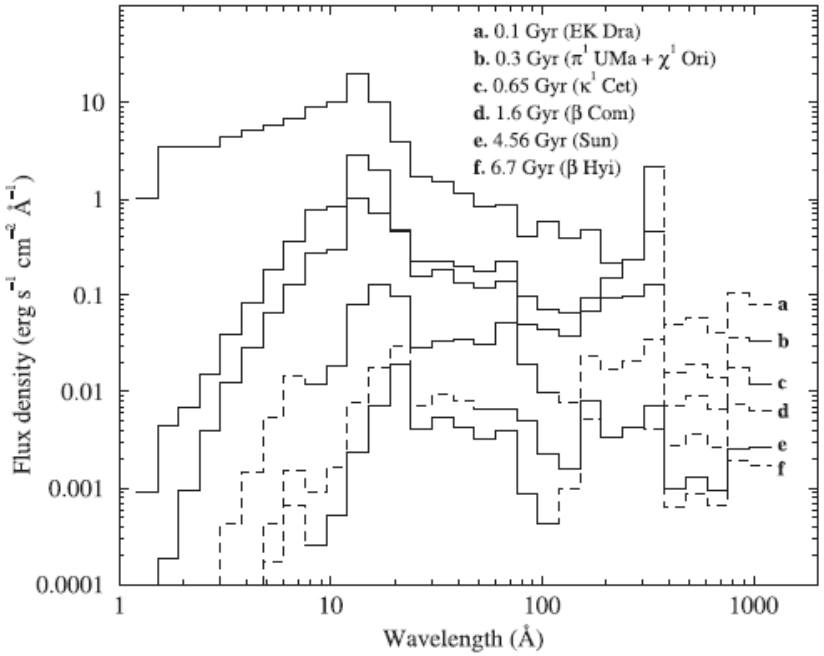
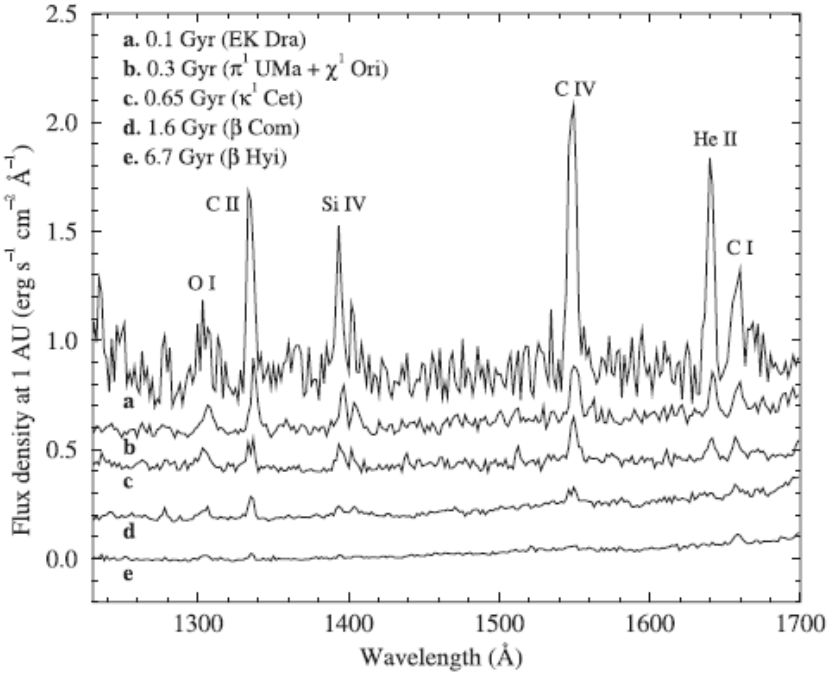
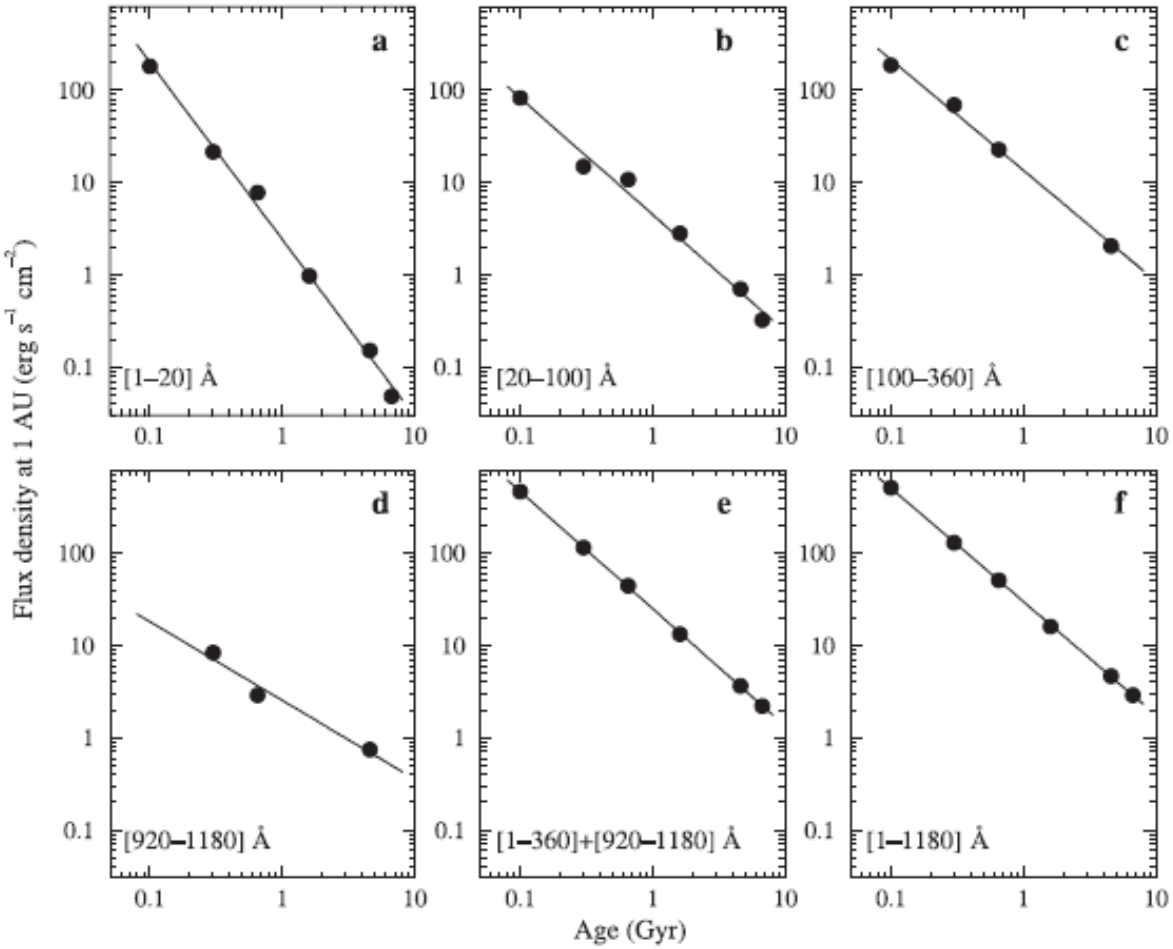
“Sun in time Project”. Fluxes at 1 AU from solar type stars as a function of age (Ribas et al. ApJ 622, 680 (2005)). Flux is very sensitive to age at shorter wavelengths.

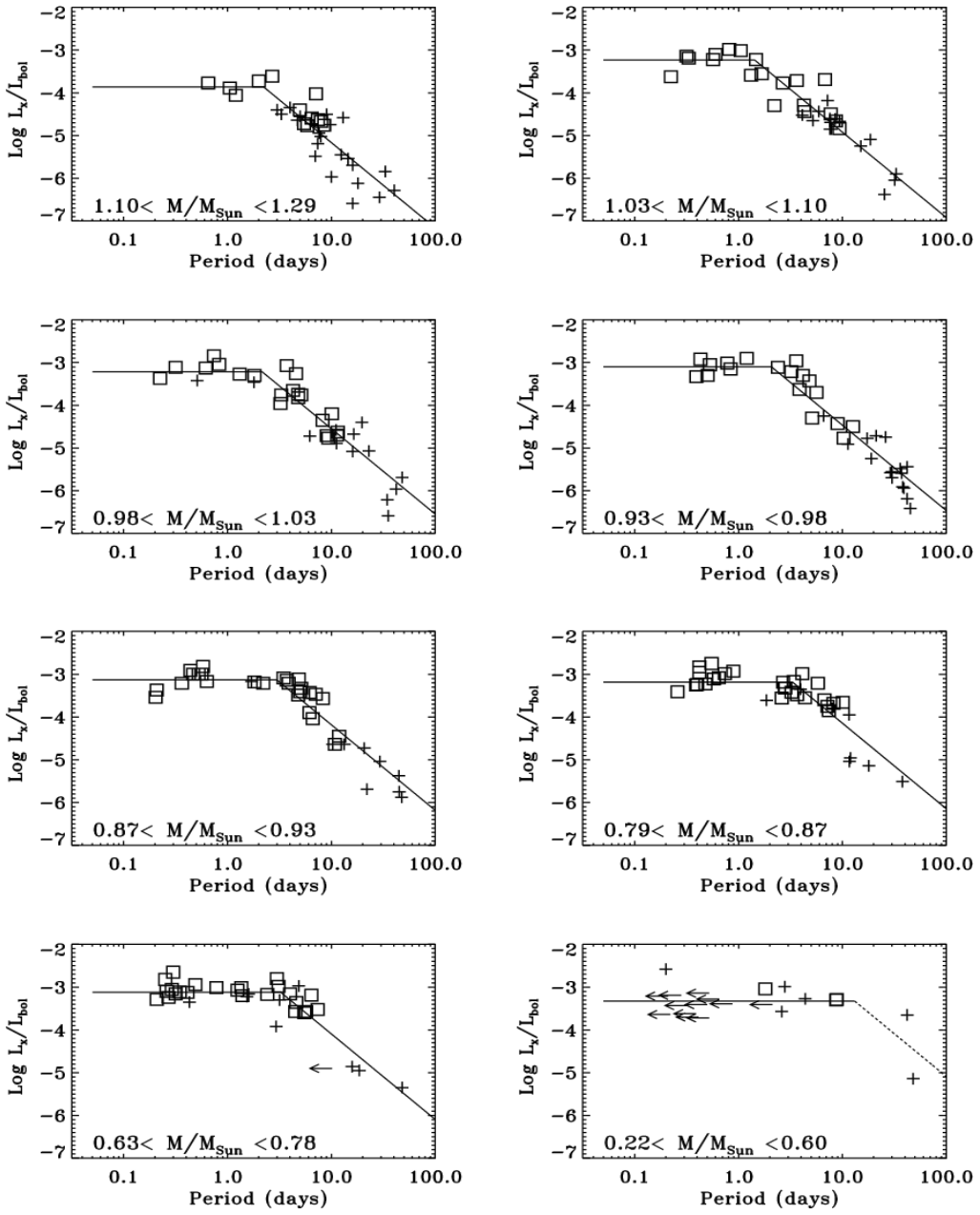




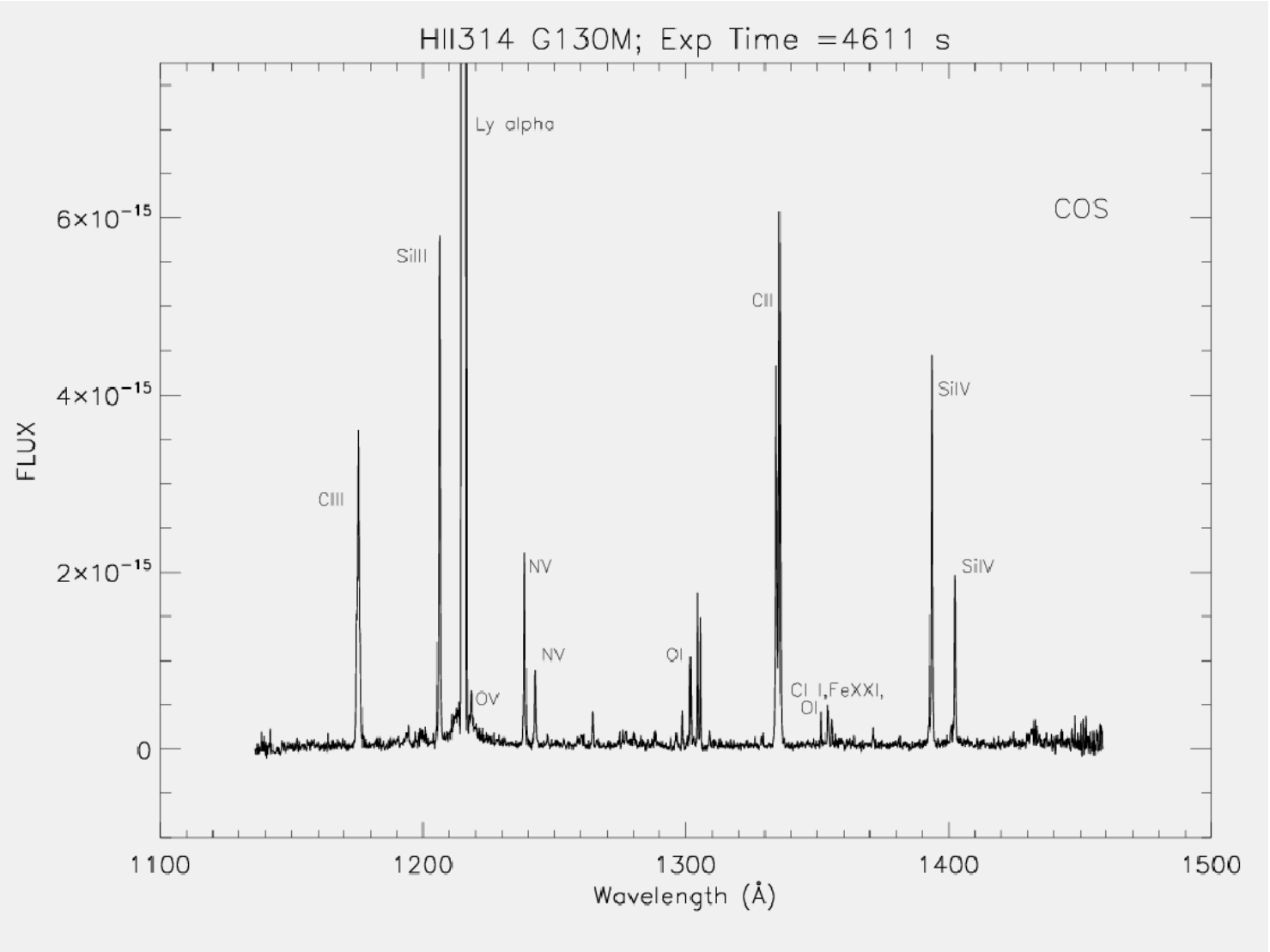
Spectral flux (for solar type stars) decreases with age most rapidly at the shortest wavelengths. Is the same true for M dwarfs?



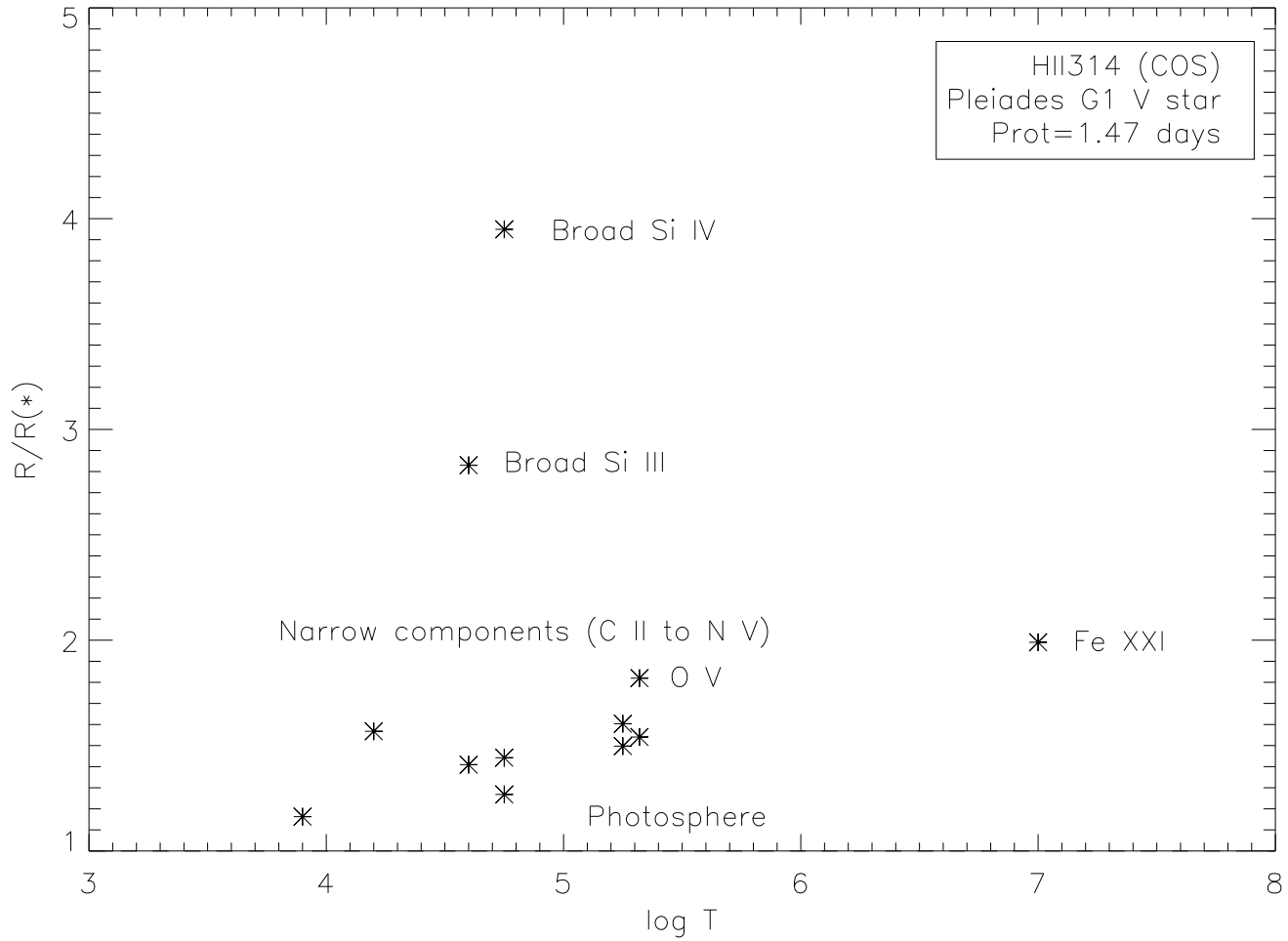
- Log L_X/L_{bol} for stars of different P_{rot} and mass (Pizzolato et al. A+A 397, 147 (2003)).
- Saturation may start at longer P_{rot} for M dwarfs.
- More data needed for M dwarfs.
- Saturation near log L_X/L_{bol}=-3



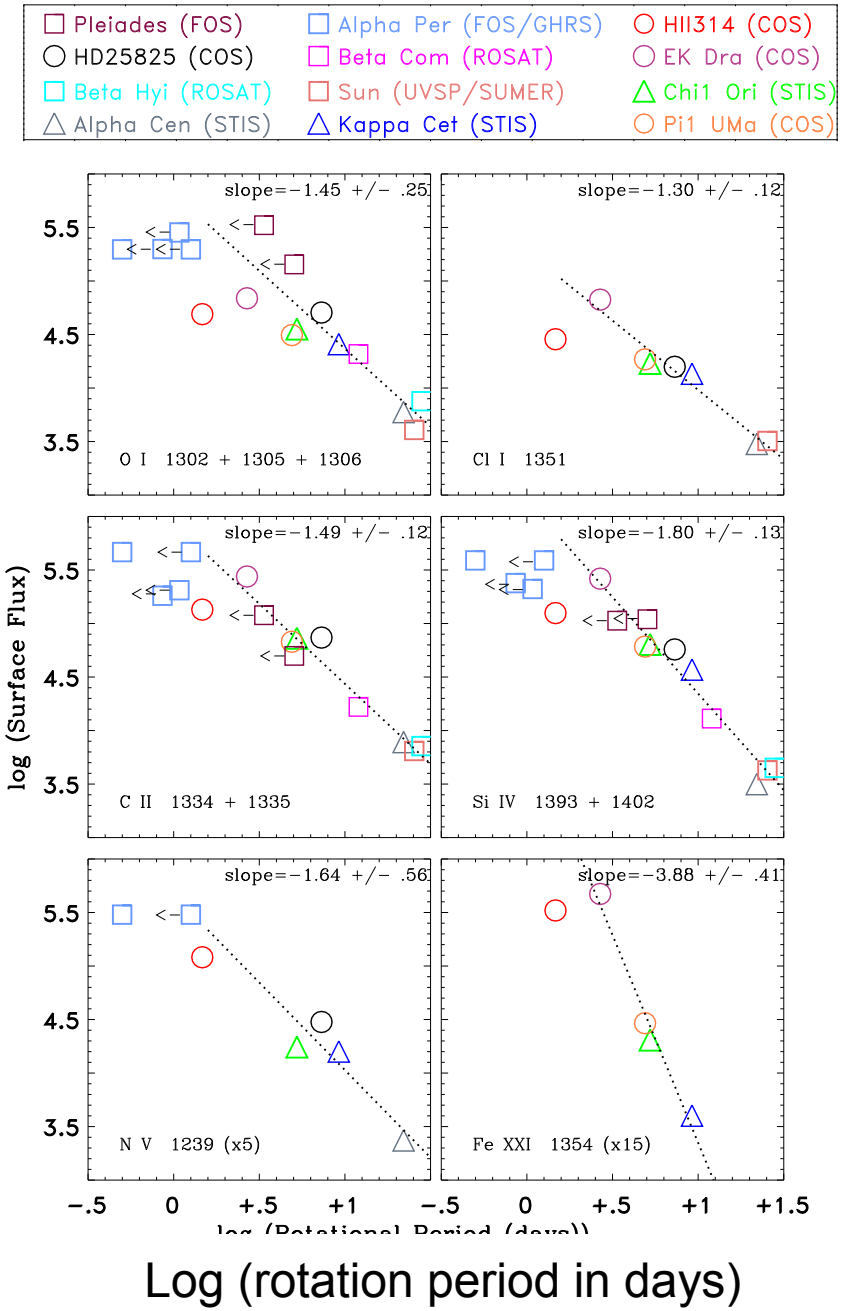
COS medium resolution (17 km/s) spectrum of HII314 (Pleiades age G1 V star). Lyman-α is geocoronal.



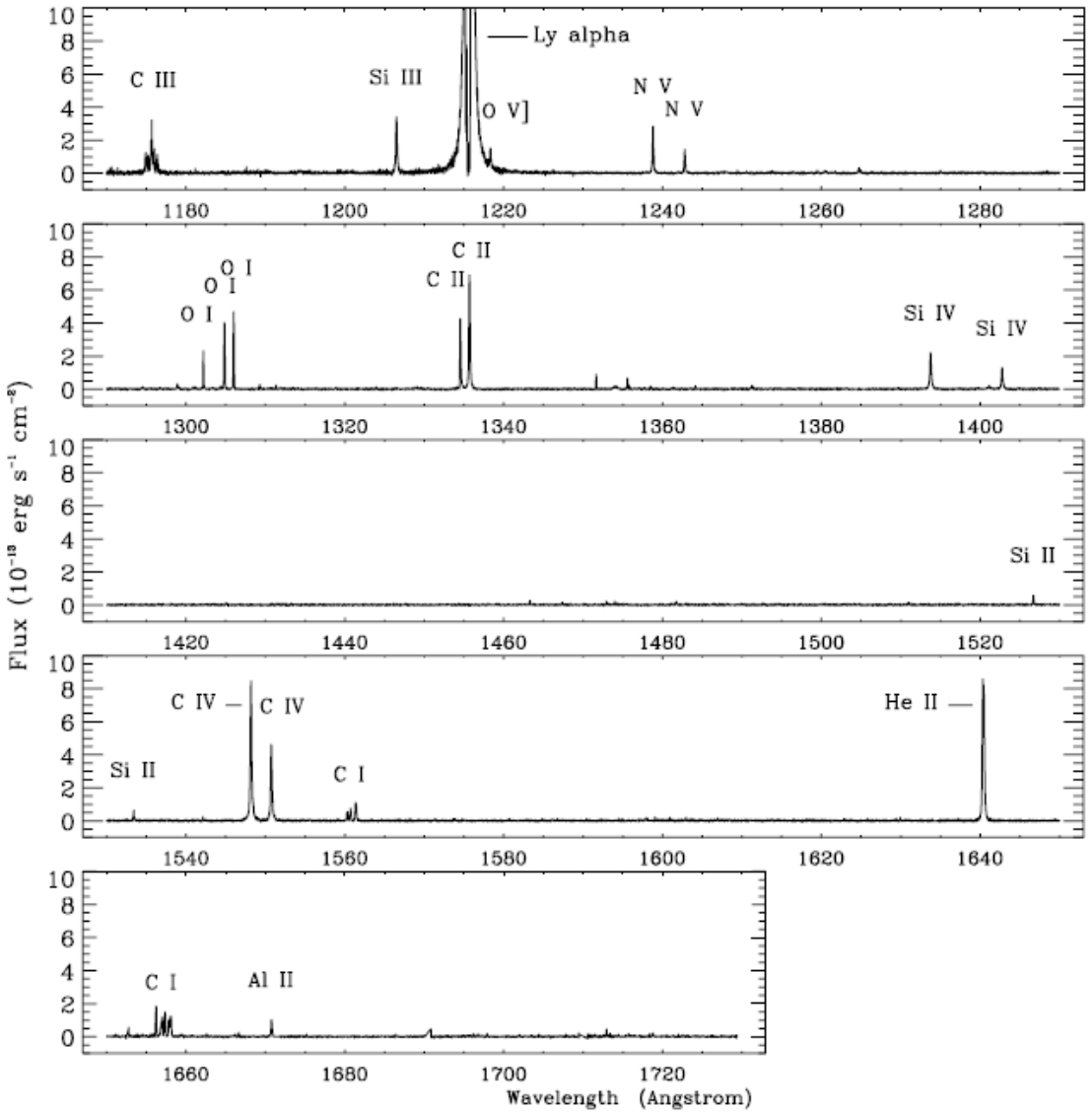
For rapidly rotating stars like HII314, broad components of emission lines could be produced by plasma in extended corotating loops.



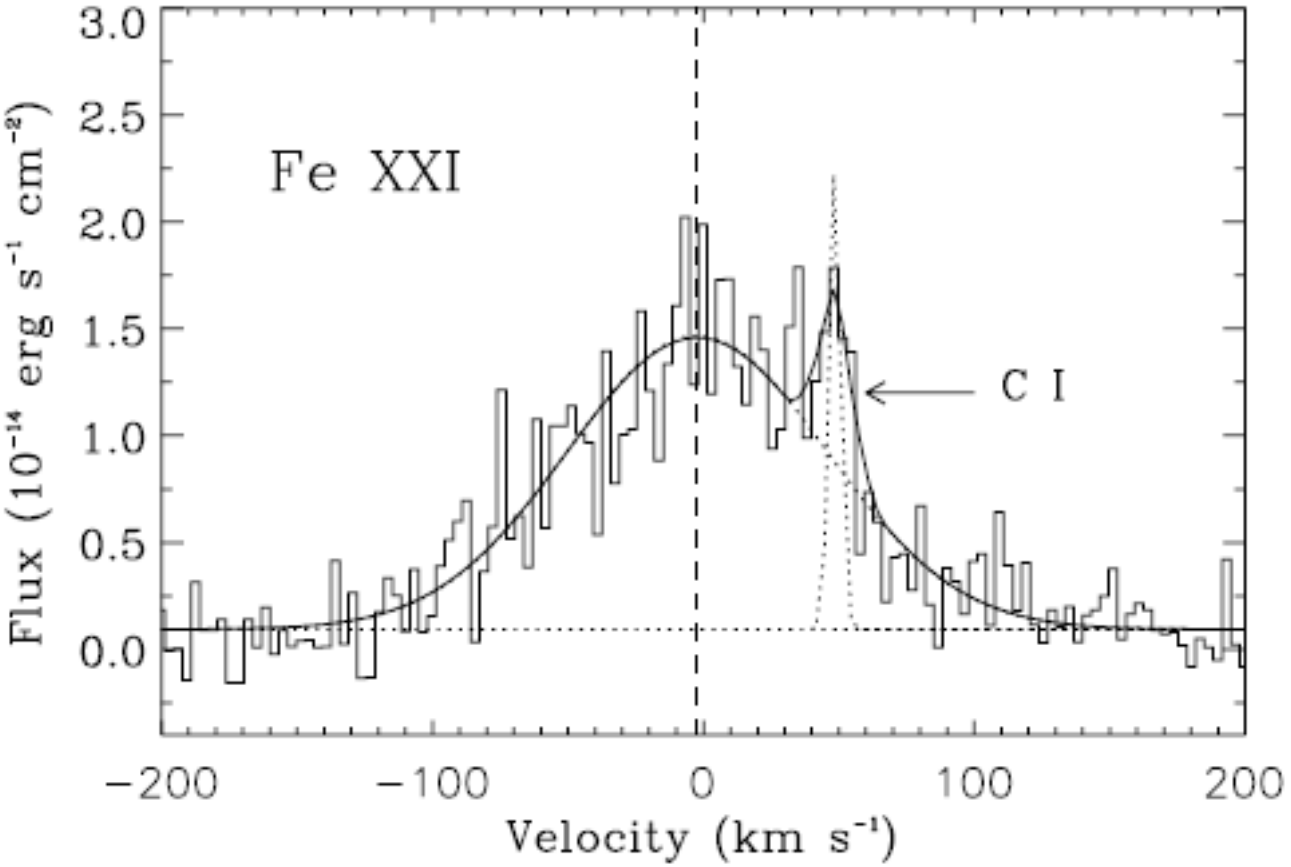
- Saturation diagrams for solar mass stars with a range of P_{rot} and ages.
- Ages range from 10^8 yr (α Per Cluster and Pleiades) to $5x10^9$ yr (Sun and α Cen).
- Saturation important for P_{rot}<2 days (HII314).



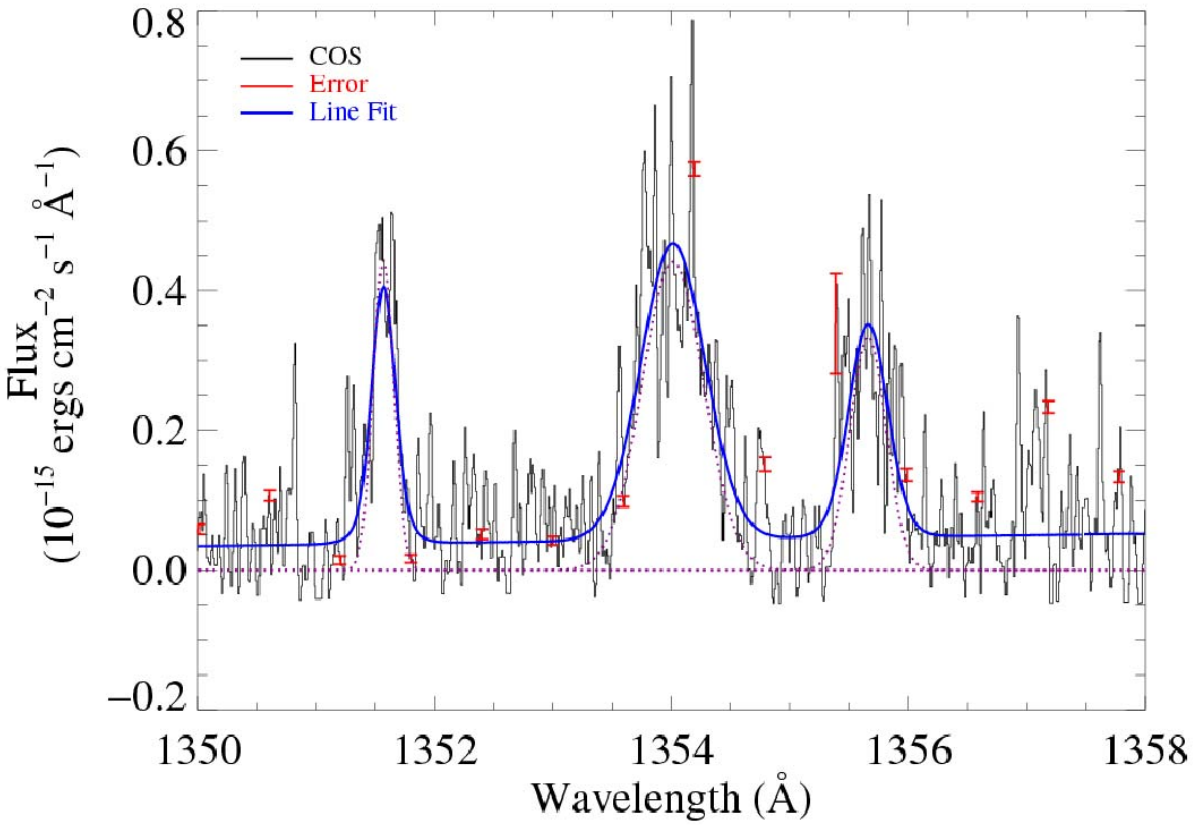
HST/STIS spectrum of AU Mic (M1 V) (Pagano et al. ApJ 532, 497 (2000). What line emits most of the UV flux?



Fe XXI 1354A line in AU Mic (Pagano et al. 2000). Line width is thermal at 10^7 K)

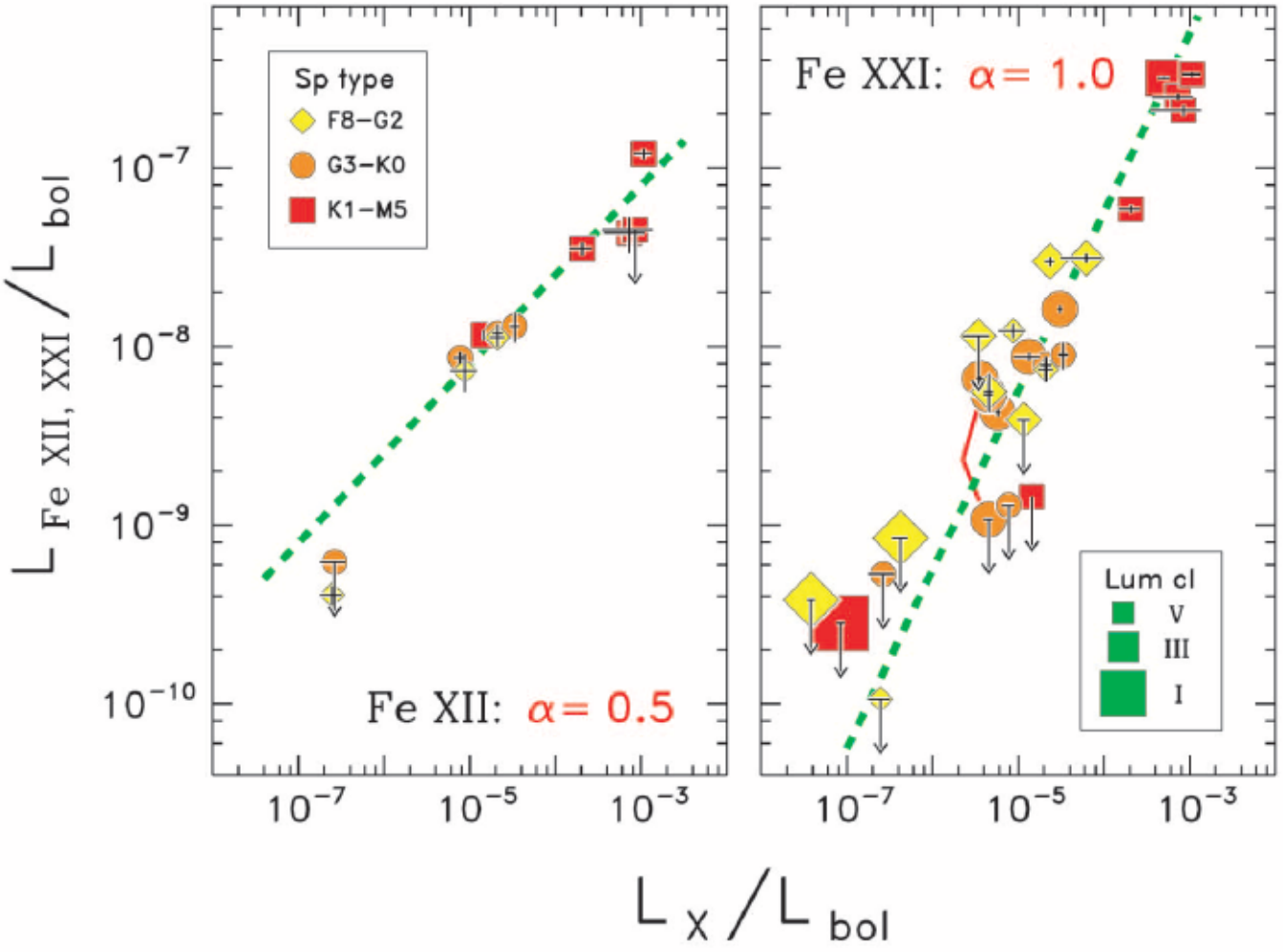


Fe XXI 1354Å line in HII314 (Pleiades age G1 V star P_{rot}=1.47 days)

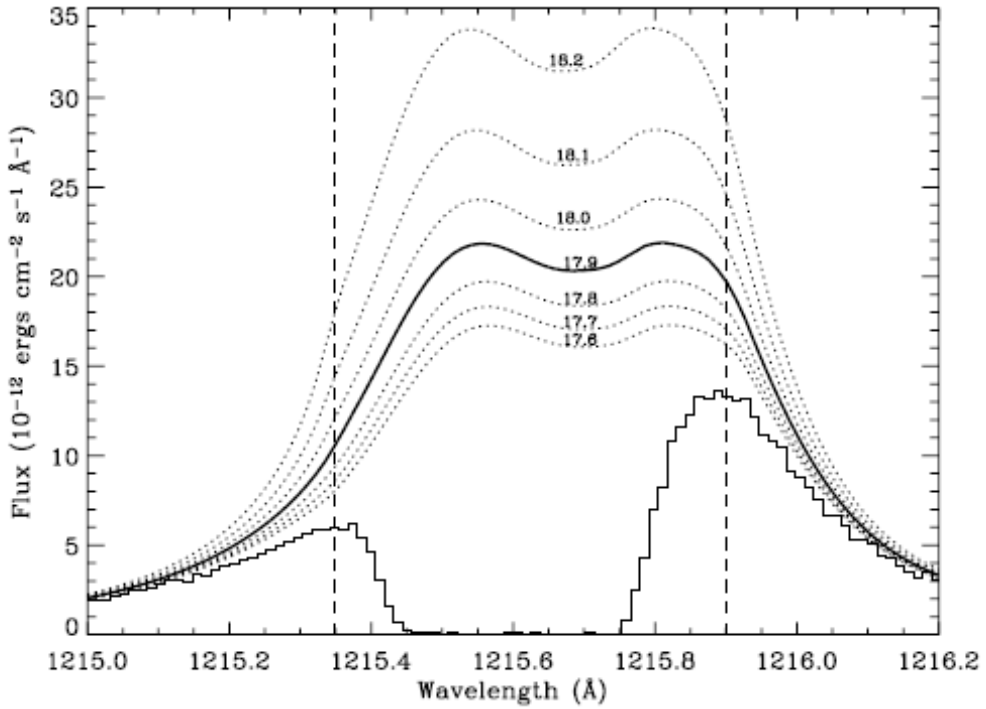


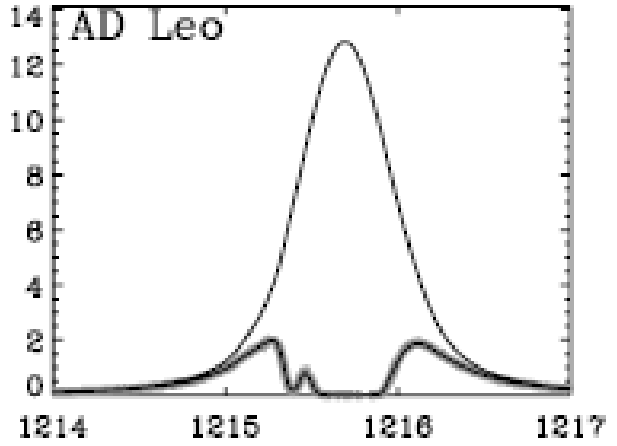
Log [T(Fe XXI)] = 7.0

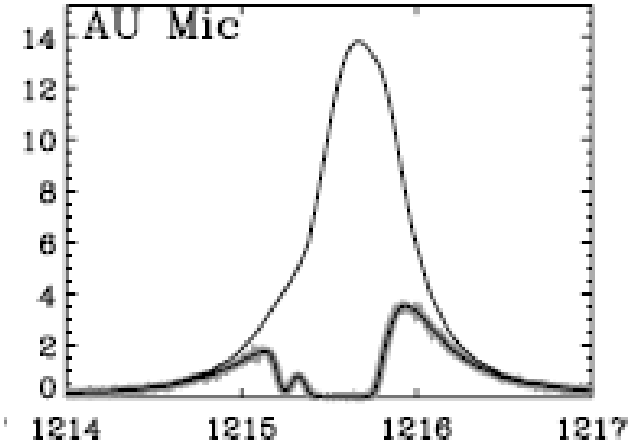
Correlation of Fe XXI 1354A and X-ray Luminosities (Ayres et al. ApJ 583, 963 (2003)). Note: very few M dwarfs.



Reconstructing Lyman-α Line Profiles Using Information on the Local ISM (Wood et al. ApJS 159, 118 (2005).

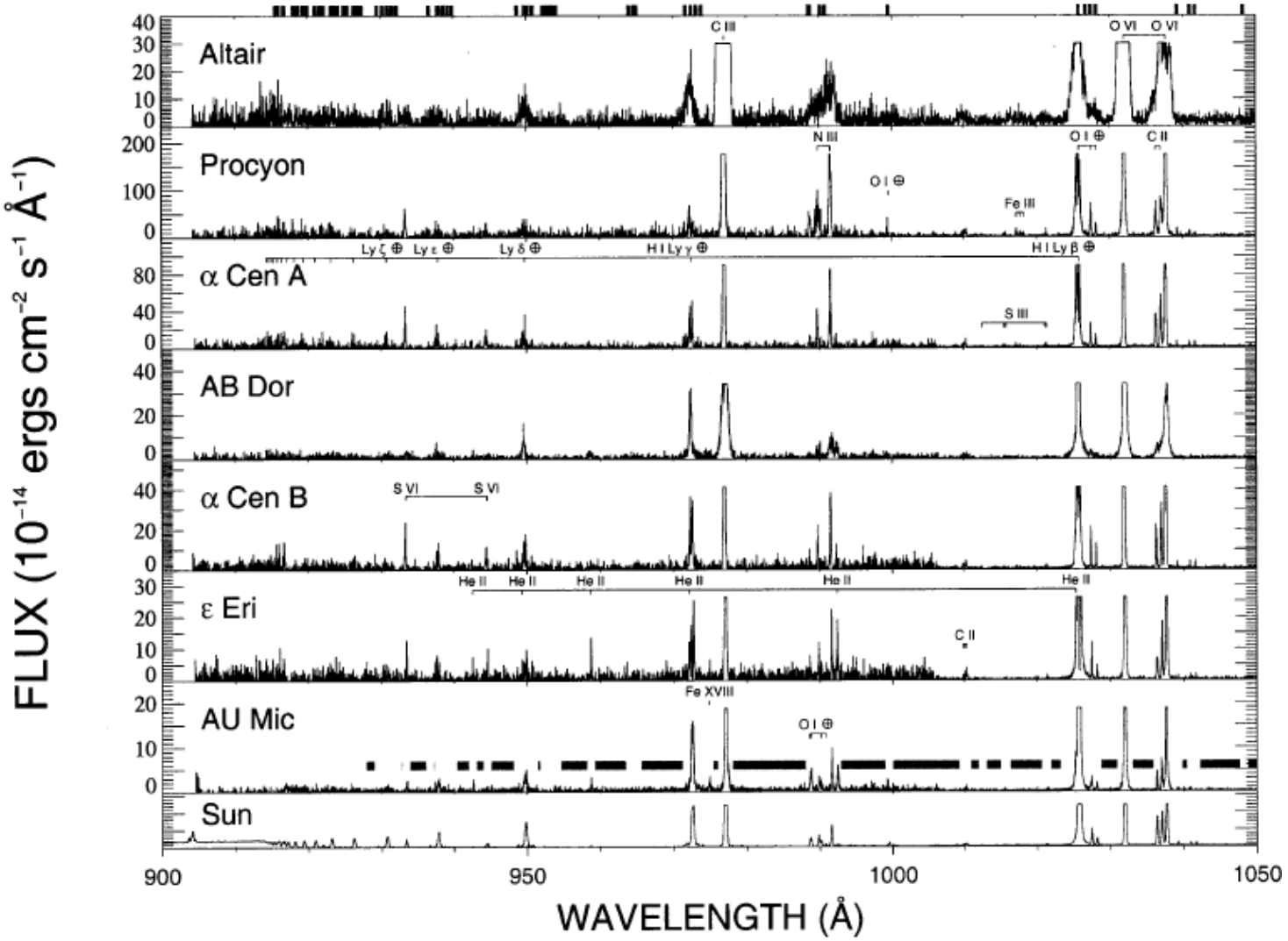






Left: ξ Boo A (G8 V). Right: AD Leo (M3.5 V) and AU Mic (M0 V).

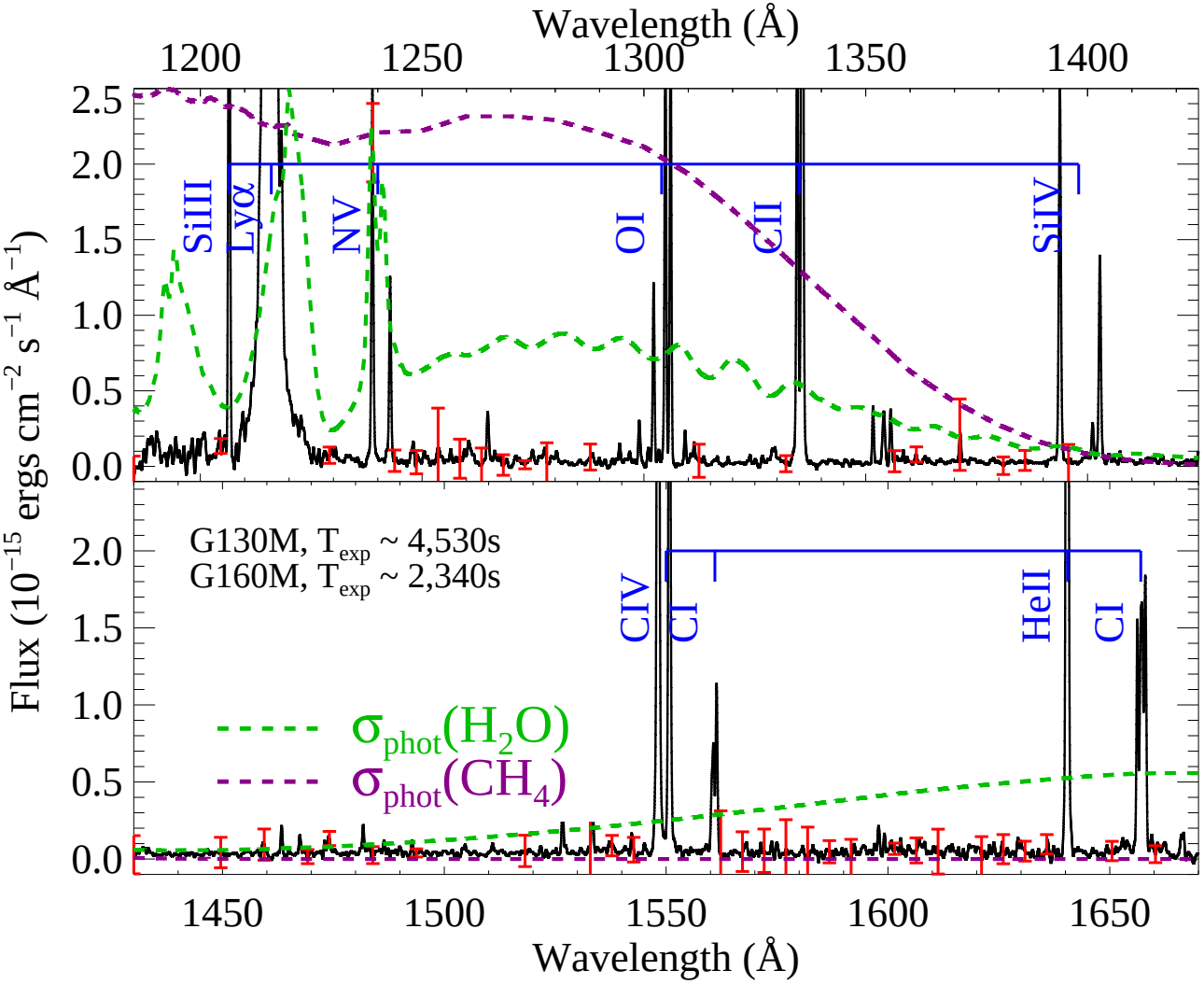
A portion of FUSE spectra of late-type stars showing C III and O VI emission (Redfield et al. ApJ 581, 626 (2002))



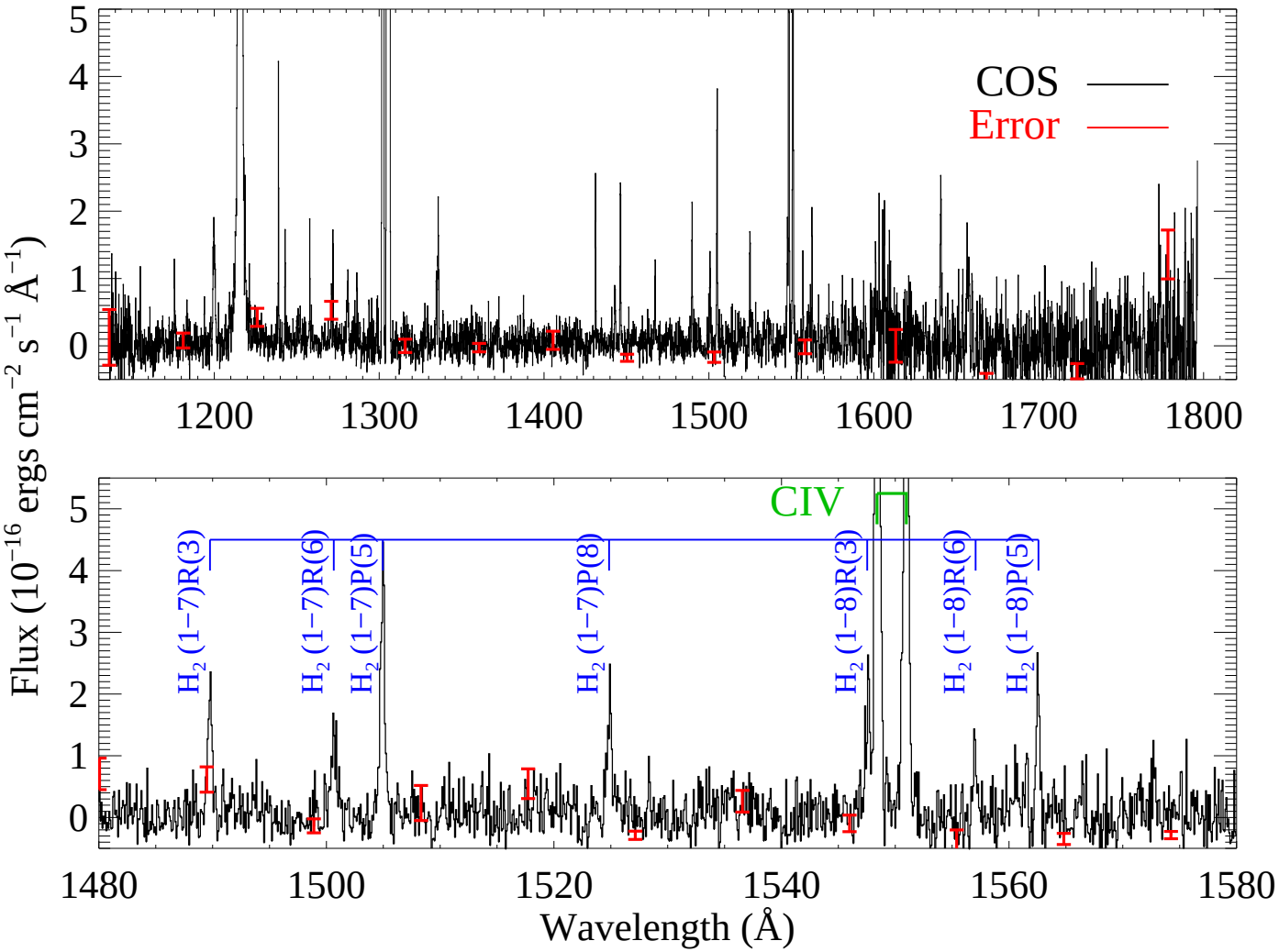
UV and X-ray flux emitted by AU Mic (M1 V)

Spectral Region	Obs. flux (10^{-12} erg/cm^2/s)	Reference
Lyman-α (1216Å)	10.3 (Reconstructed)	Wood et al. (2005)
1175-1700Å except Lyman-α	1.6 (HST/STIS)	Pagano et al. (2000)
933-1176Å	0.75 (FUSE)	Redfield et al. (2002)
X-ray	36.1 (ROSAT)	Wood et al. (2005)

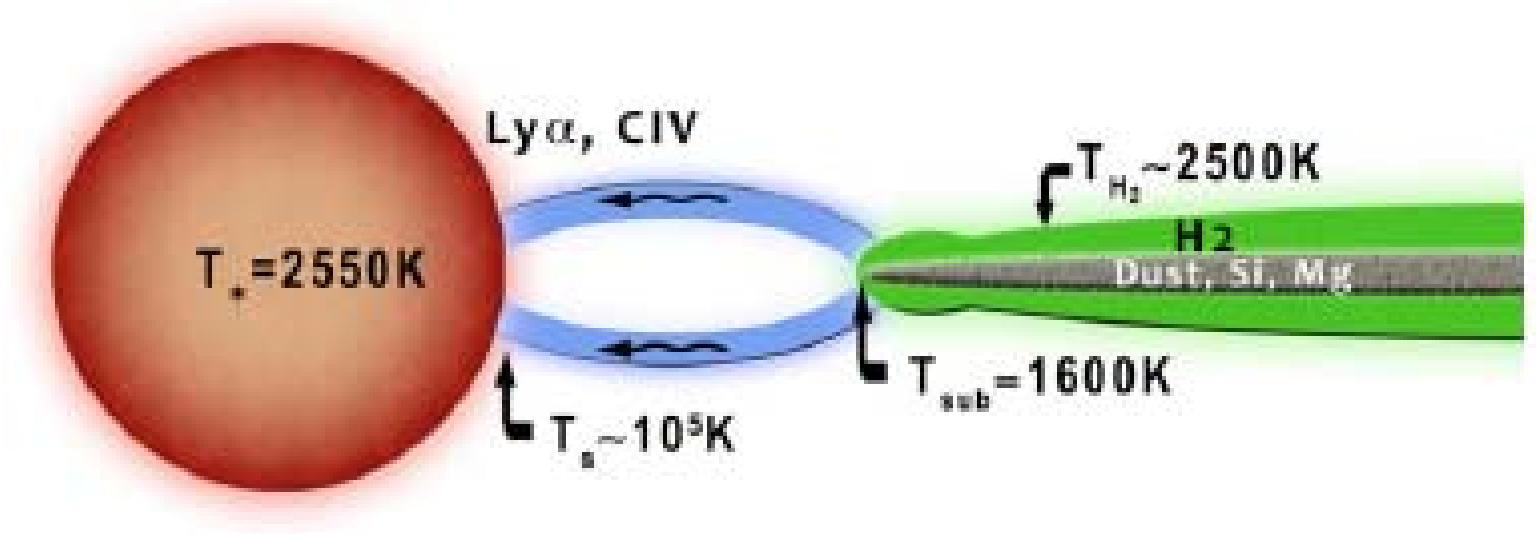
Simulated spectrum of GJ 436 (M2.5 V with a 0.073M_J exoplanet). Note emission lines and photo-absorption cross-sections of H_2O and CH_4



COS spectrum of 2M1207 a young M8 brown dwarf with a CS disk (H_2) and accretion (C IV) but no Si III-IV or Mg II emission lines (France et al. ApJ 715, 596 (2010))



A cartoon representation of the inner disk region of 2M1207



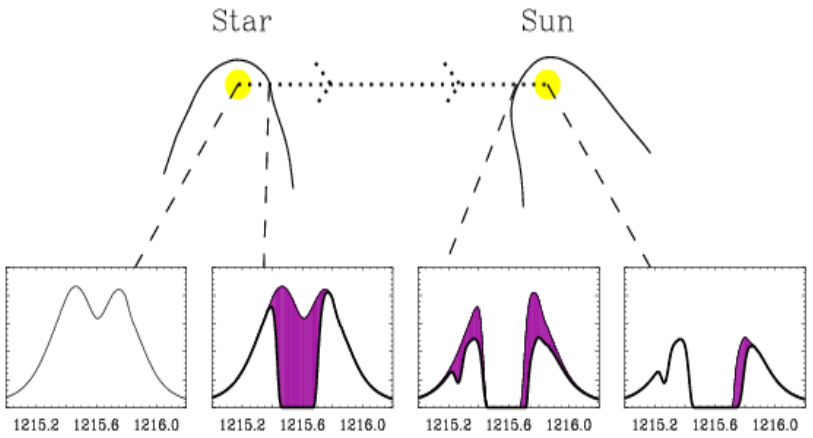
2M1207b is a $6M_J$ exoplanet at a radial distance of ~40 AU.

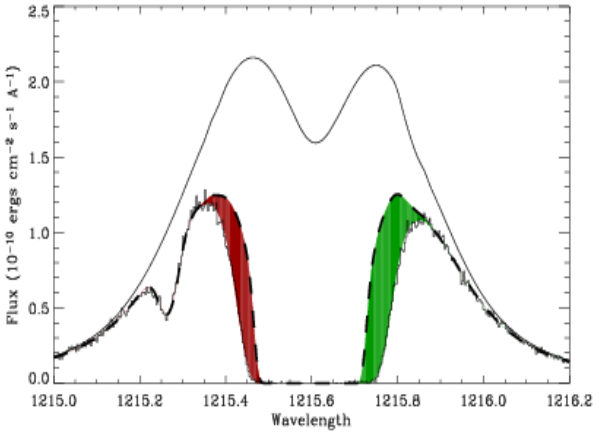
Proposed HST GO19 Observing Program (PI: K. France)

Star	d(pc)	Sp Type	Exoplanets
GJ 674	4.5	M2.5	1
GJ 876	4.7	M4	4
GJ 832	4.9	M1.5	1
GJ 436	10.3	M2.5	1
GJ 1214	13.0	M6	1

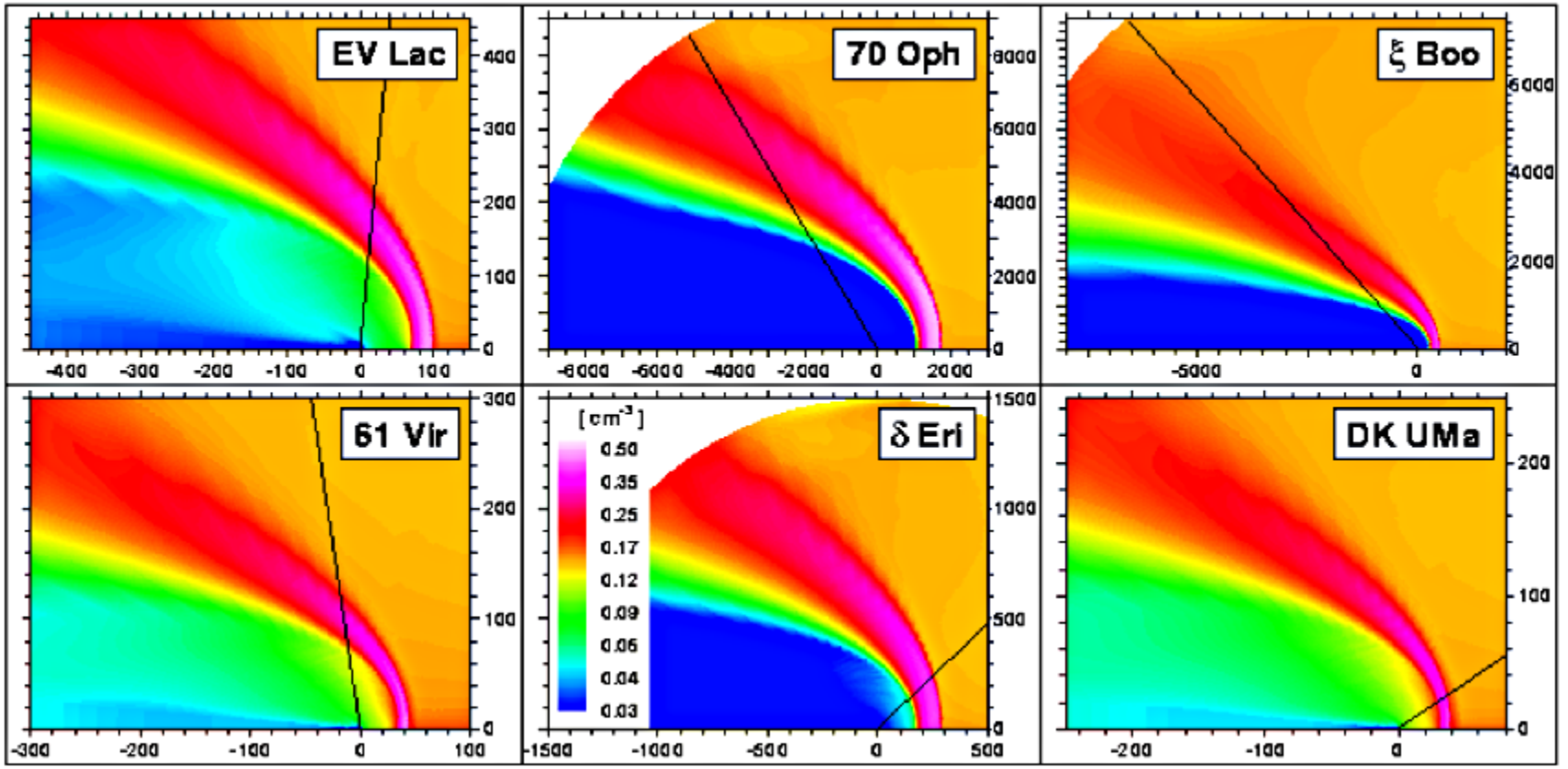
Interstellar, astrospheric, and heliospheric Lyman-α absorption

- Interstellar gas flow from above.
- Line of sight passes through astrosphere, ISM, and then heliosphere
- Astrospheric absorption is blue compared to ISM because H slows down in the astropause as seen by the star.
- Heliospheric absorption is red compared to ISM because H slows down in the heliopause.
- Astrospheric absorption proportional to stellar mass loss rate.



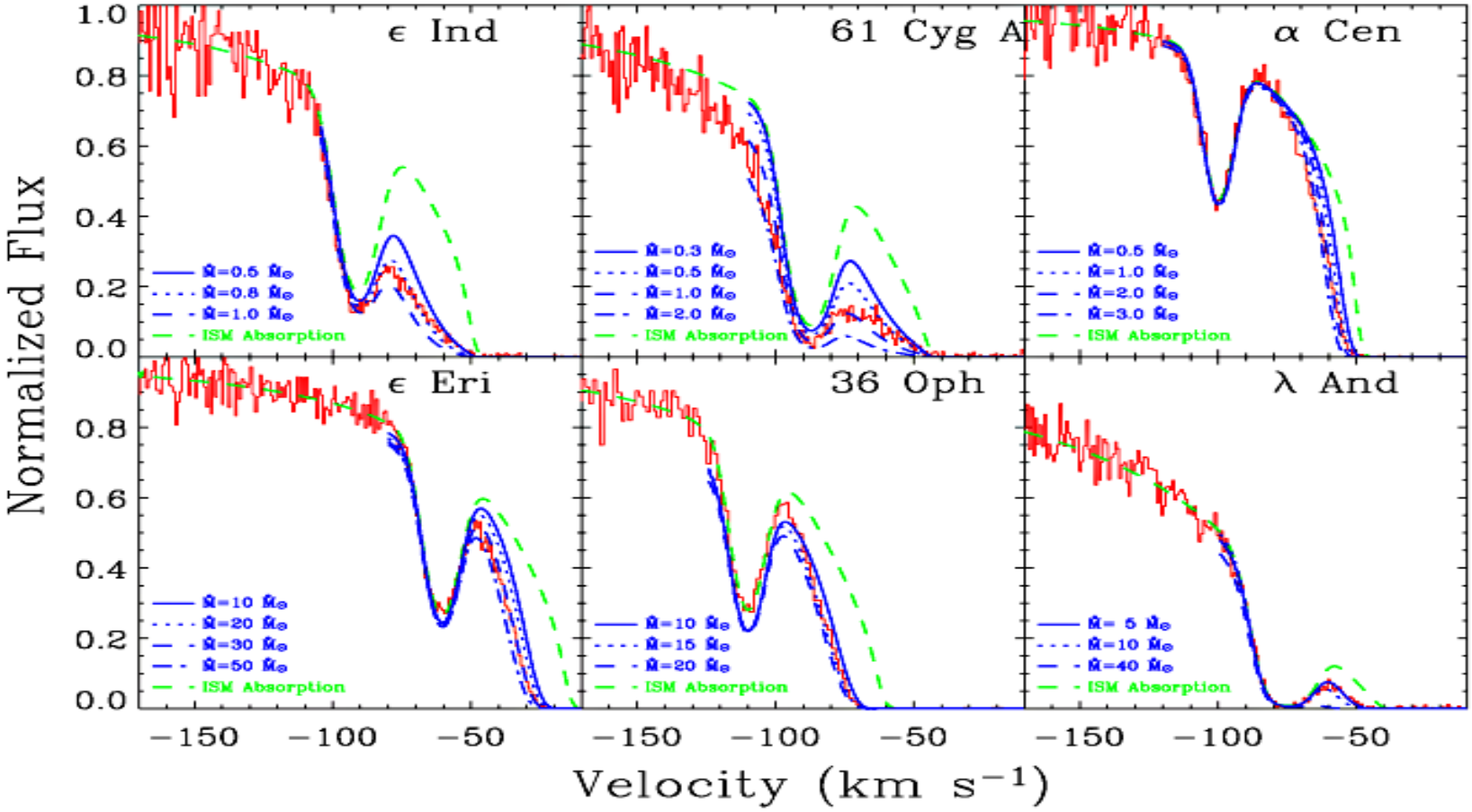


Maps of n(HI) computed in hydrodynamic models of stellar atmospheres (Wood et al 2005). Scales are in AU. Solid line indicates LOS to the observer.



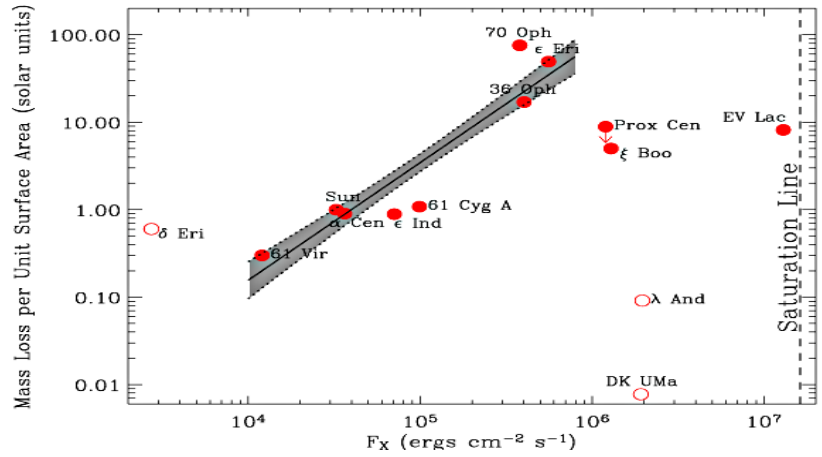
61 Vir has 3 exoplanets located inside of its hydrogen wall.

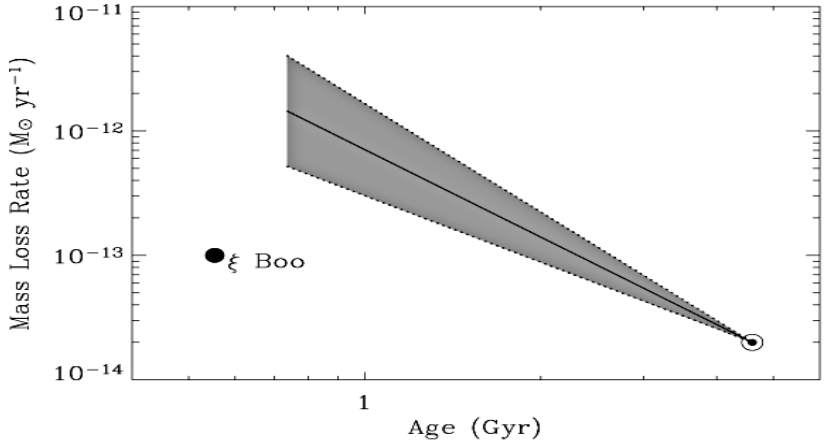
Measuring stellar mass loss rates from the astrospheric absorption feature on the blue side of interstellar Lyman-α absorption



Mass loss rate vs activity (X-ray surface flux) and stellar age

- Solid dots indicate dwarf stars (Prox Cen and EV Lac are only M dwarfs).
- Near $F_x=10^6$ there is a break suggesting a change in magnetic field structure.
- More measurements are needed (HST GO-19 proposal).
- $\dot{M} \sim F_X^{1.34\pm0.18} \sim t^{2.33\pm0.55}$





Conclusions: 2 important points and a message

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We know how to measure its flux.