AFE Meeting
Meudon, France
November 17, 2014

# Massive-star magnetospheres in the NIR

**Mary Elizabeth Oksala**
LESIA
Paris-Meudon Observatory

with J. Grunhut, ESO-Garching
and C. Neiner, LESIA

Additional work by: M. Shultz, M. Kraus,
M. Borges Fernandes, L. Cidale, M.L. Arias

# Basic properties of magnetic massive stars

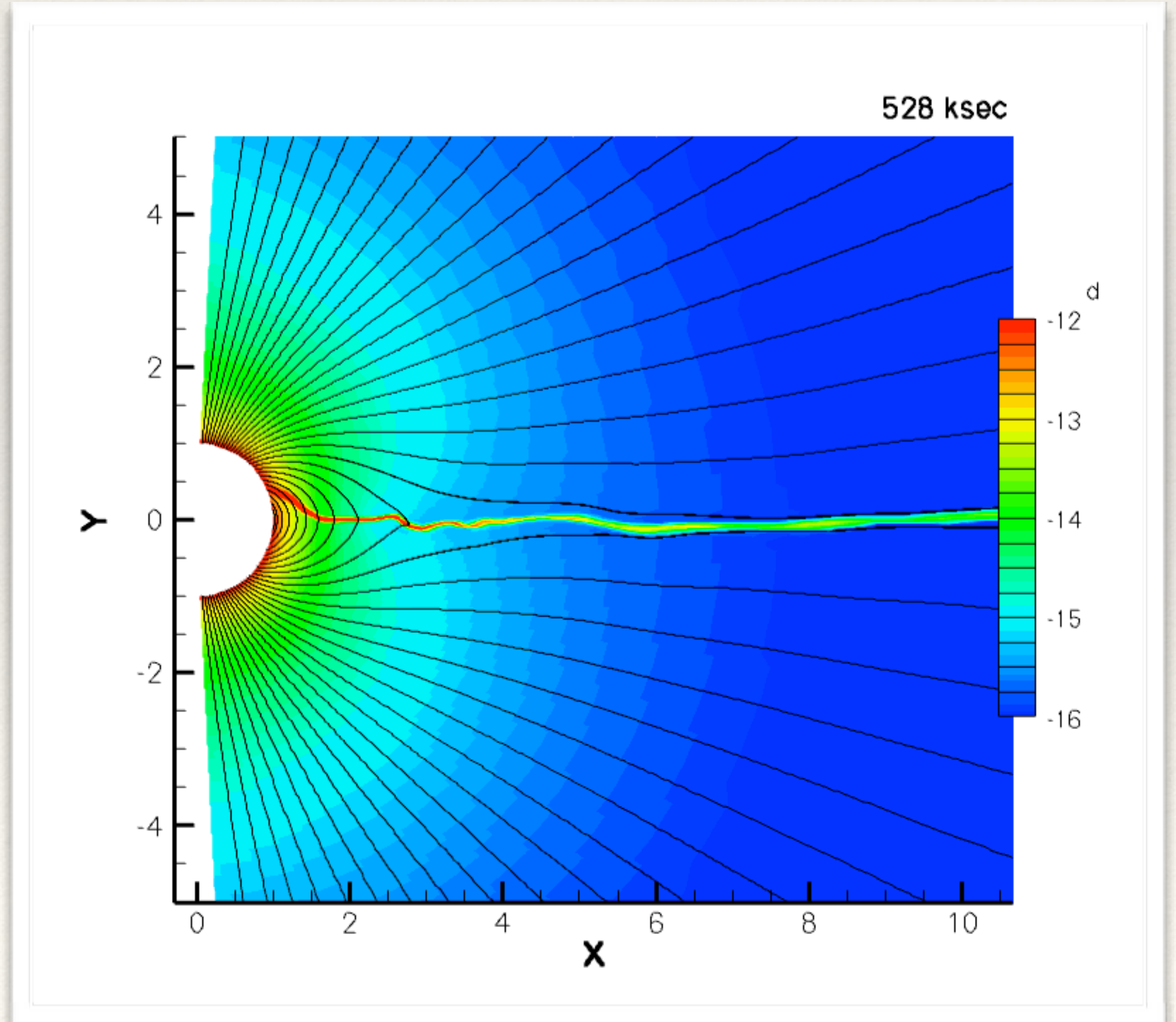
$L = 10^4 - 10^6 L_\odot$

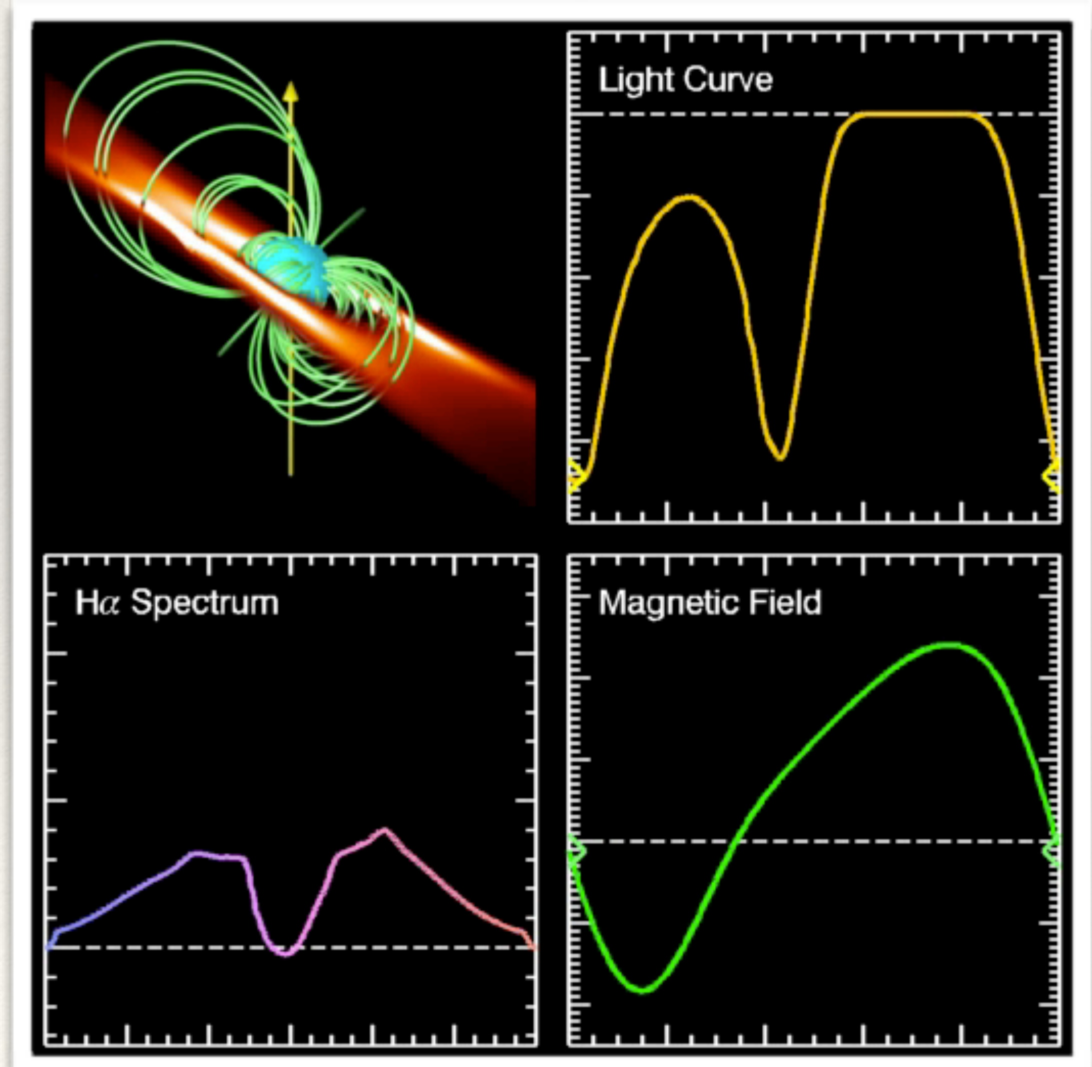
Strong stellar wind

+

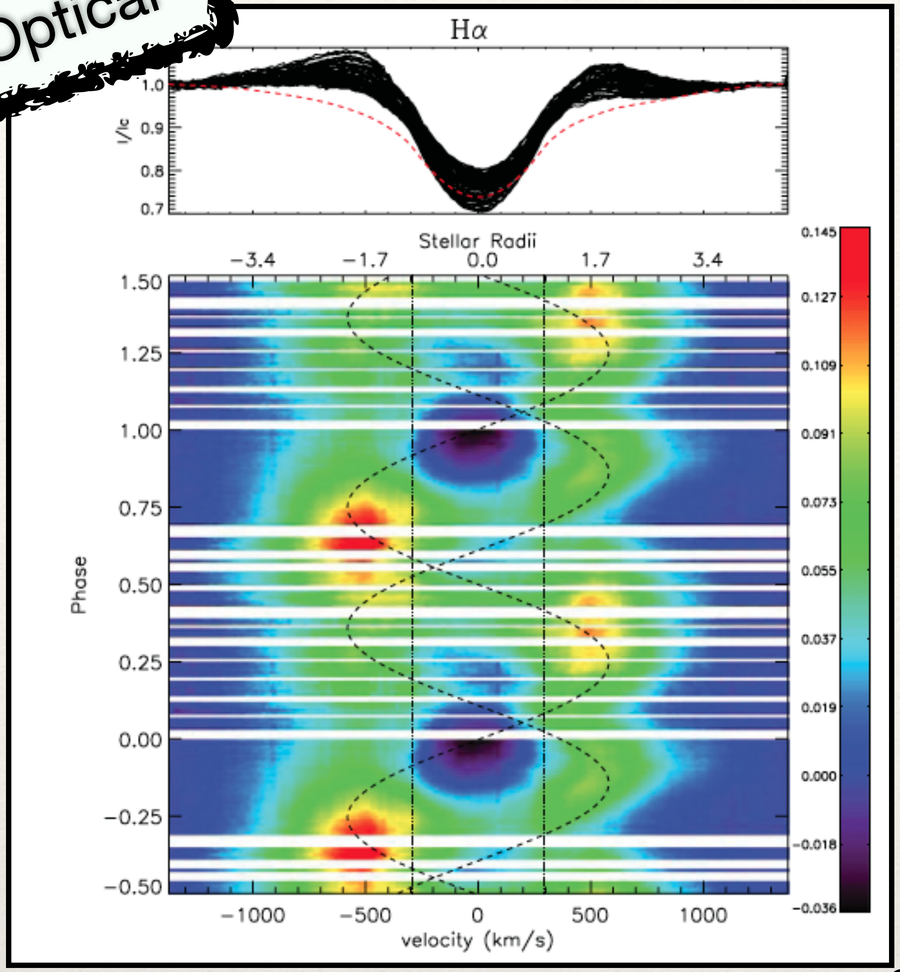
0.3 - 20 kG

Simple, Stable, Global



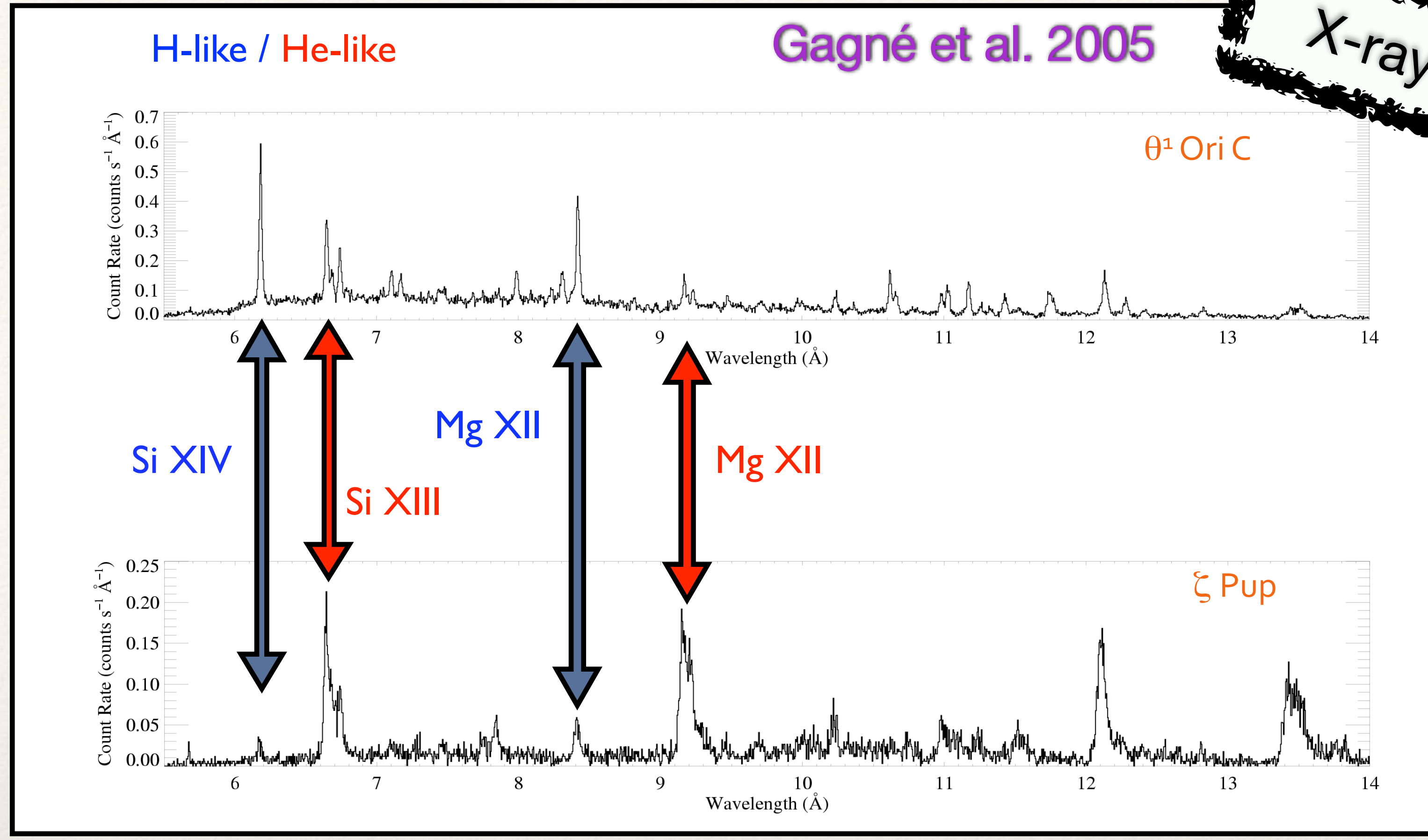



Optical



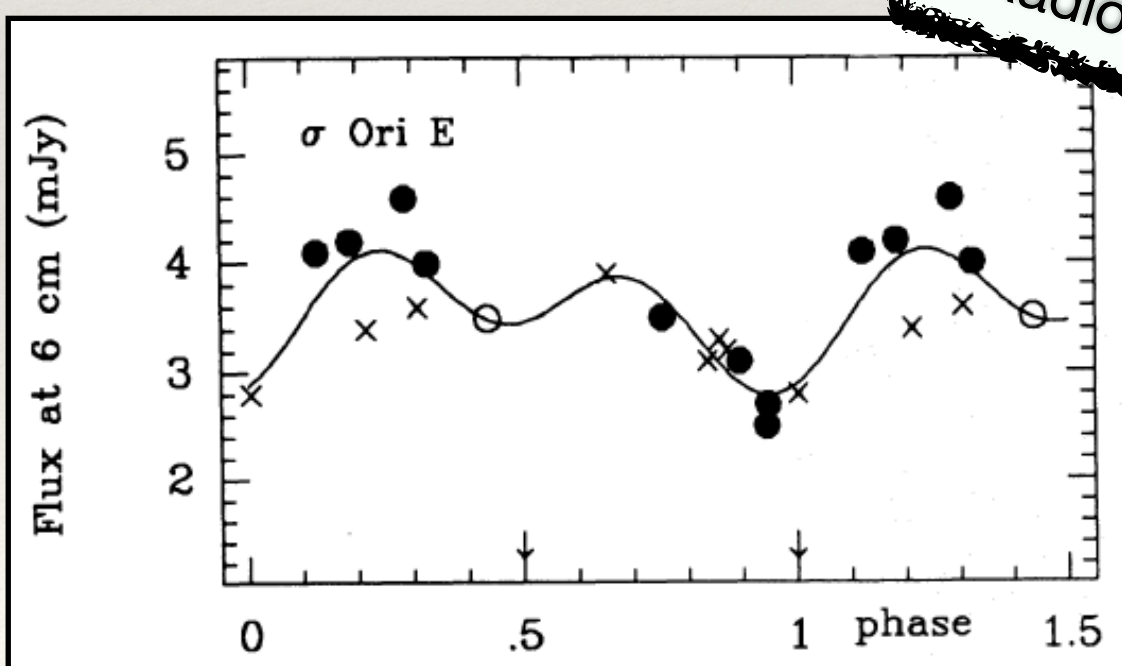

Grunhut et al. 2012

X-ray



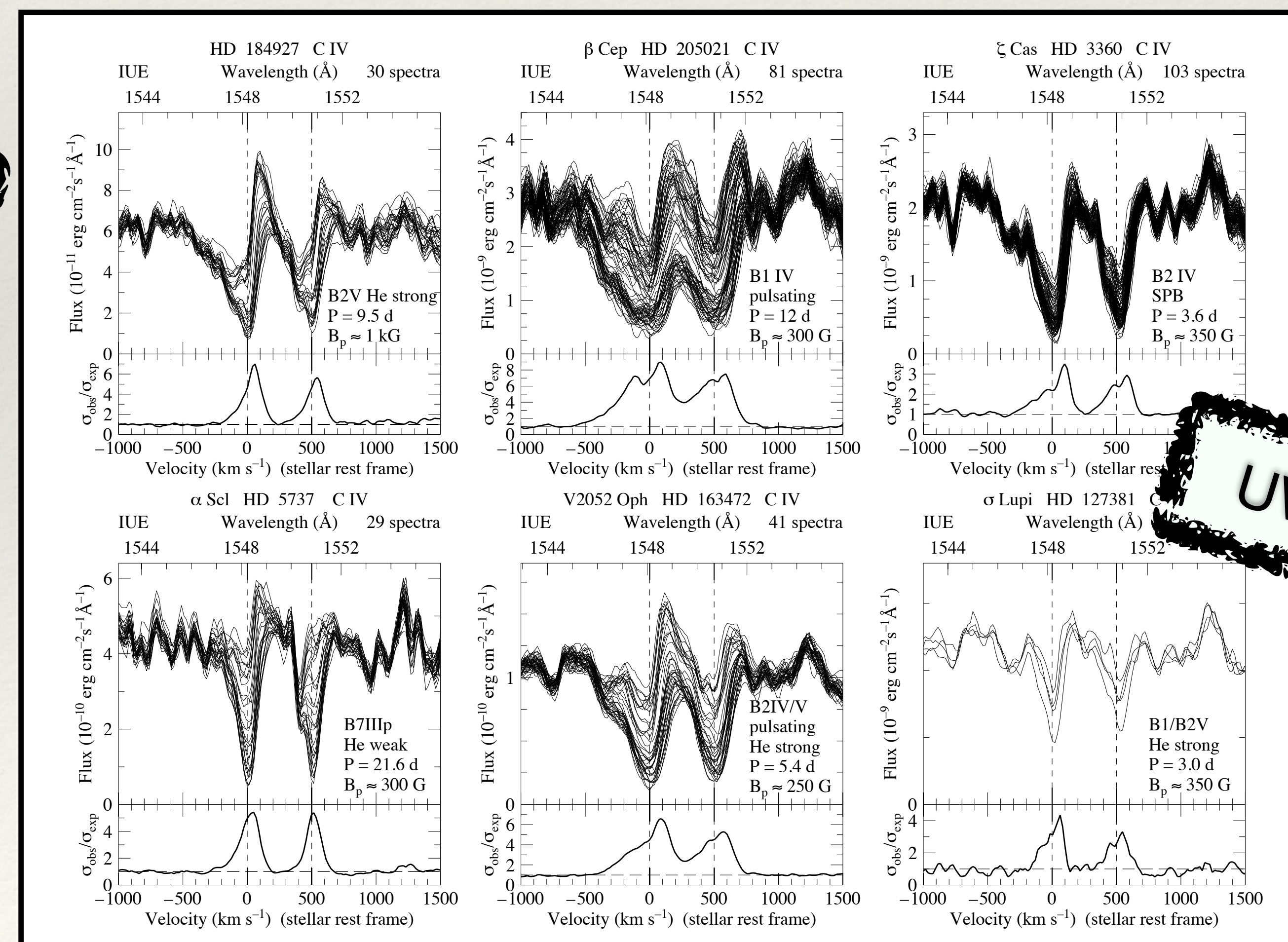

Gagné et al. 2005

Radio




Leone & Umana 1993

UV




Courtesy of H. Henrichs

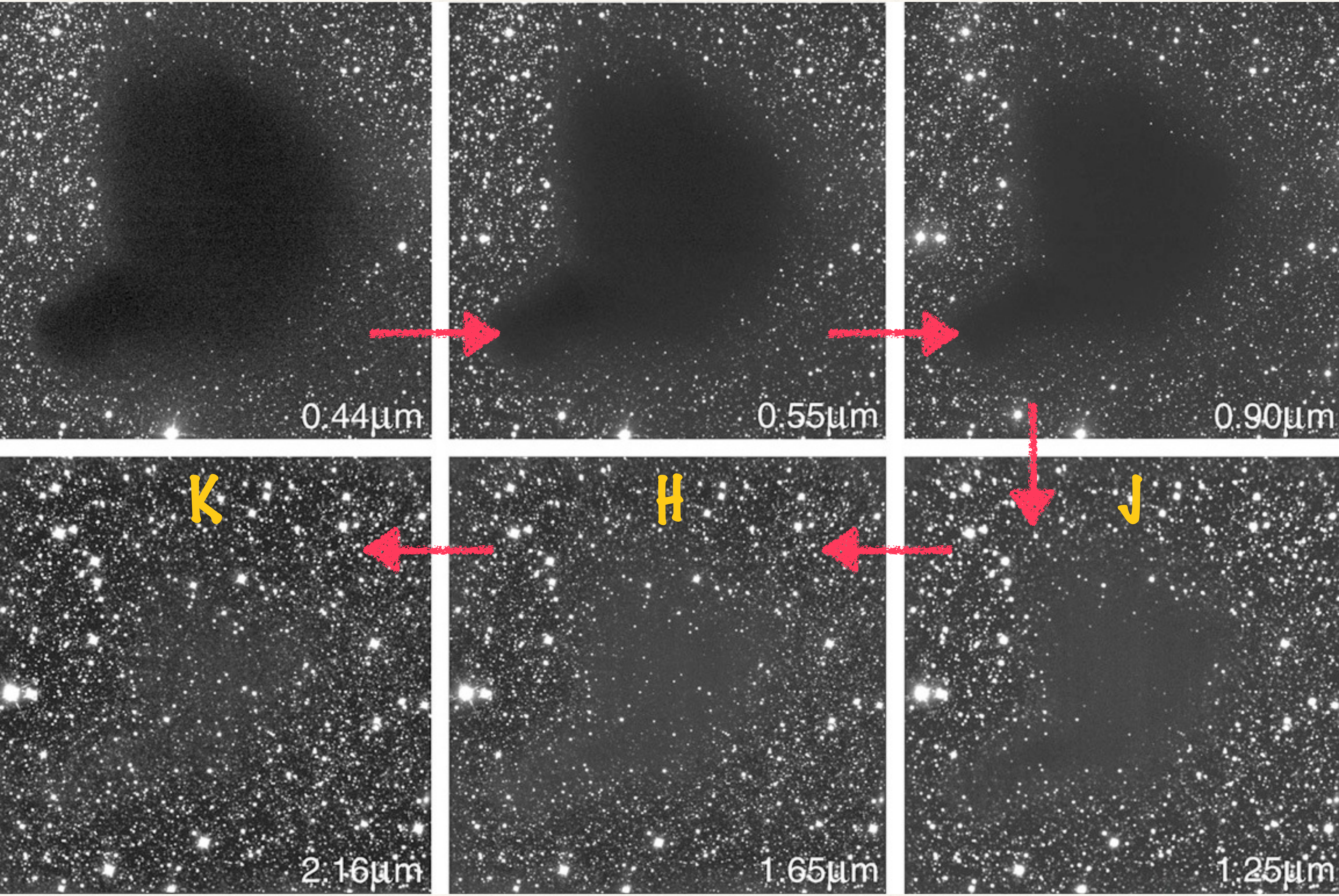
# Why IR for massive stars?

Infrared is an effective tool to “see” through dust and other optical barriers.

With E(B-V) > 1.67 (or 5 magnitudes of extinction), the stellar flux at 2 microns > flux at 4500 A.

Many massive stars, especially within the Galaxy, are hidden in star forming regions and other areas highly-obscured from optical and UV observations

# Barnard 68



# Why IR for massive stars?

Infrared is an effective tool to “see” through dust and other optical barriers.

With E(B-V) > 1.67 (or 5 magnitudes of extinction), the stellar flux at 2 microns > flux at 4500 A.

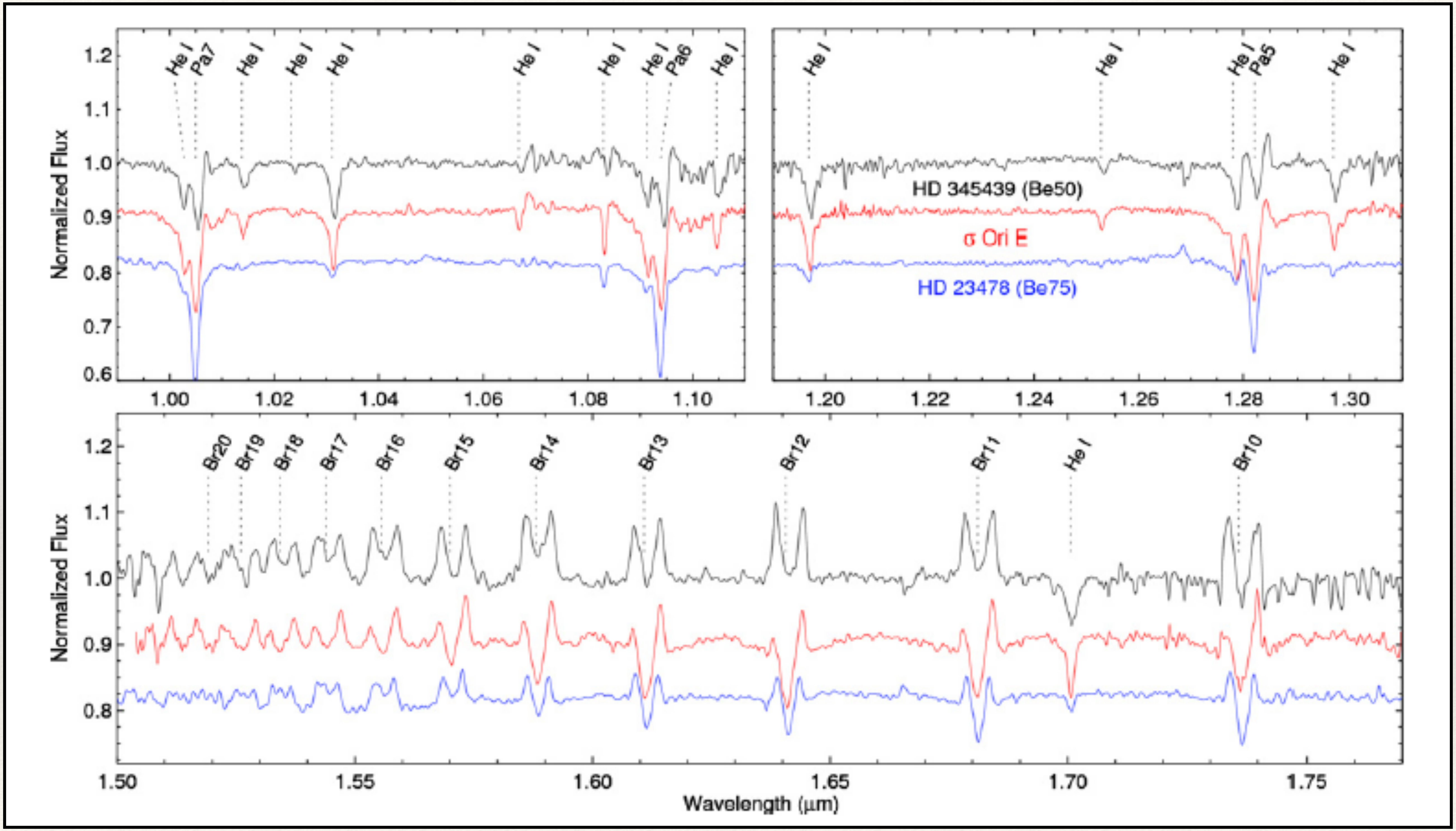
Many massive stars, especially within the Galaxy, are hidden in star forming regions and other areas highly-obscured from optical and UV observations

For stars with circumstellar material:

Emission is stronger in IR, less stellar contribution — more spectral features

Najarro et al. (2011): Hydrogen lines in the IR are **more sensitive to low mass-loss rates, detecting rates 10x lower than measurable by Hα**, making them ideal to study of low density environments.

# Eikenberry et al. 2014



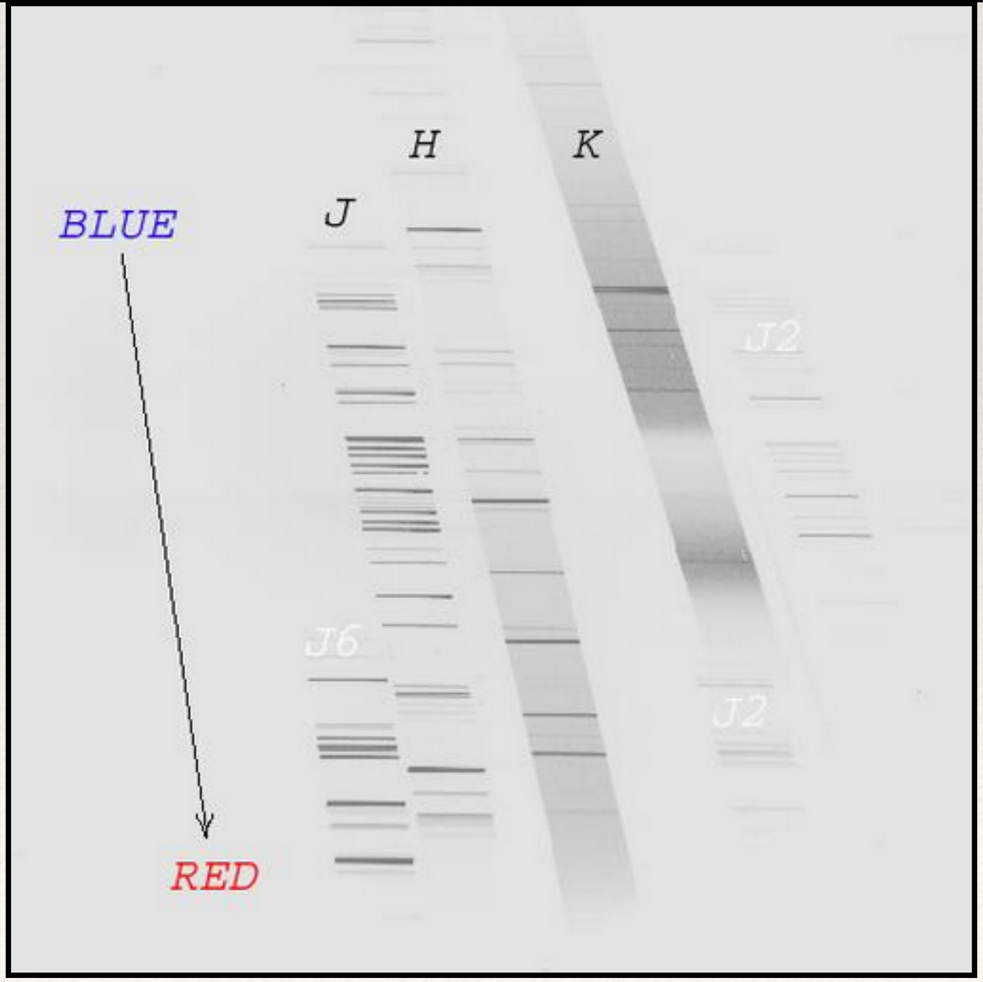
# OSIRIS NIR Spectrograph

- Operates on the 4.1-m SOAR telescope @ Cerro Pachon

- For cross-dispersed spectra (JHK), R ~1200

- J-band:  1.26 - 1.56 microns
- H-band:  1.45 - 1.98 microns
- K-band:  1.80 - 2.30 microns

- Because of the shape of the filter continuum only a few lines utilized — Br 10, 11, 12, Br ɣ

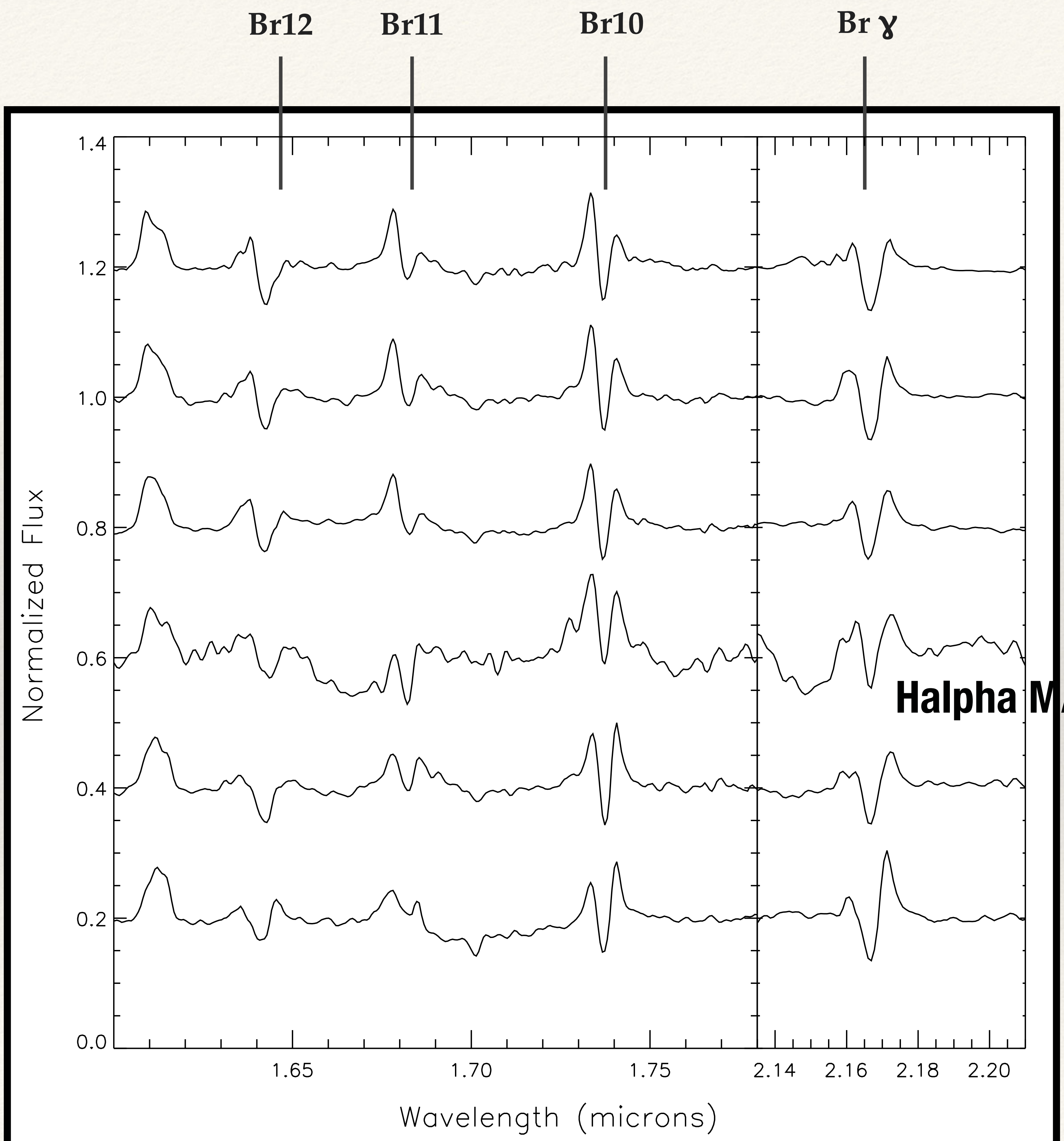


# Time series — HR 5907

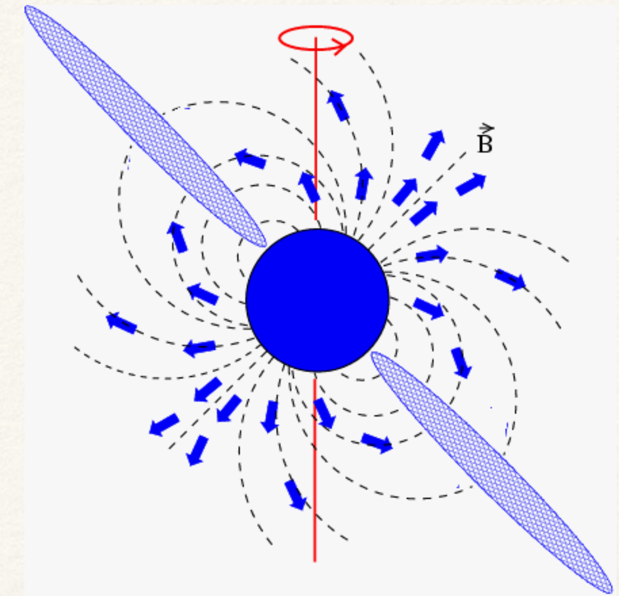
0.6

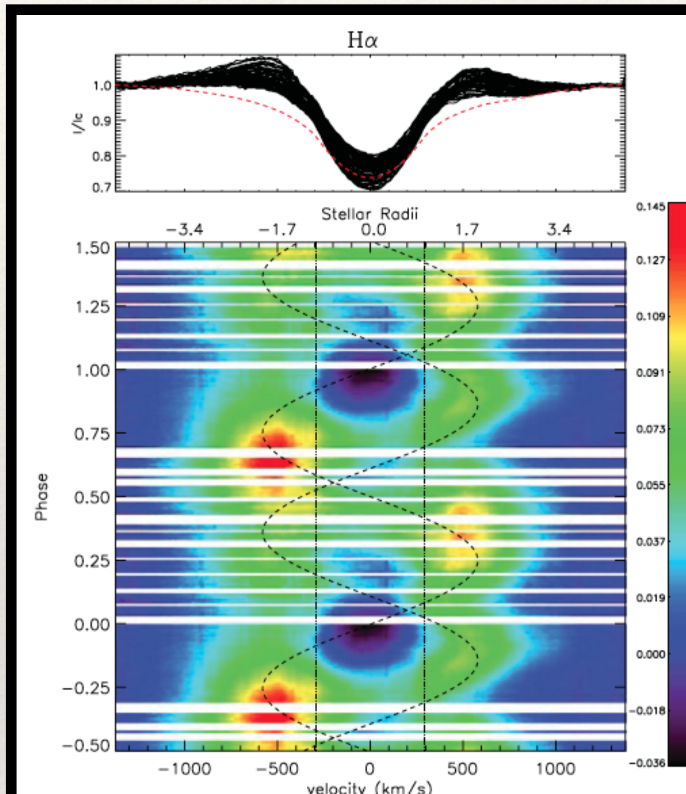
Phase

0.4




**Halpha MAX**





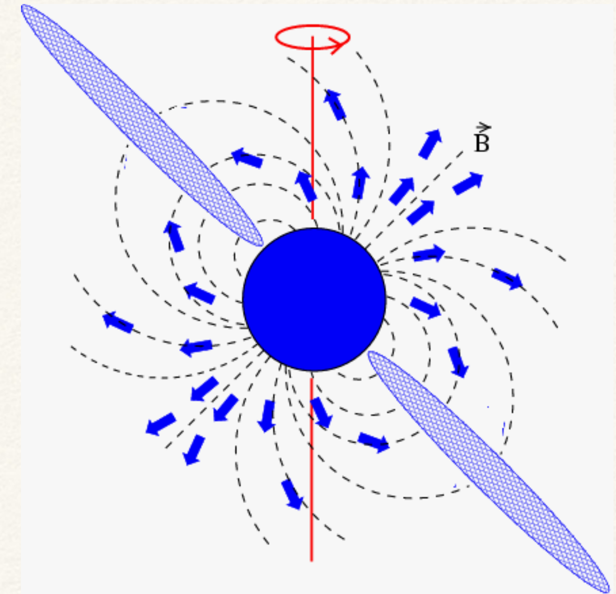

vsini = 290 ± 10 km $s^{-1}$

$P_{rot}$ = 0.508276 d

$B_{dipole}$ = -10.4 kG

**Grunhut et al. 2012**

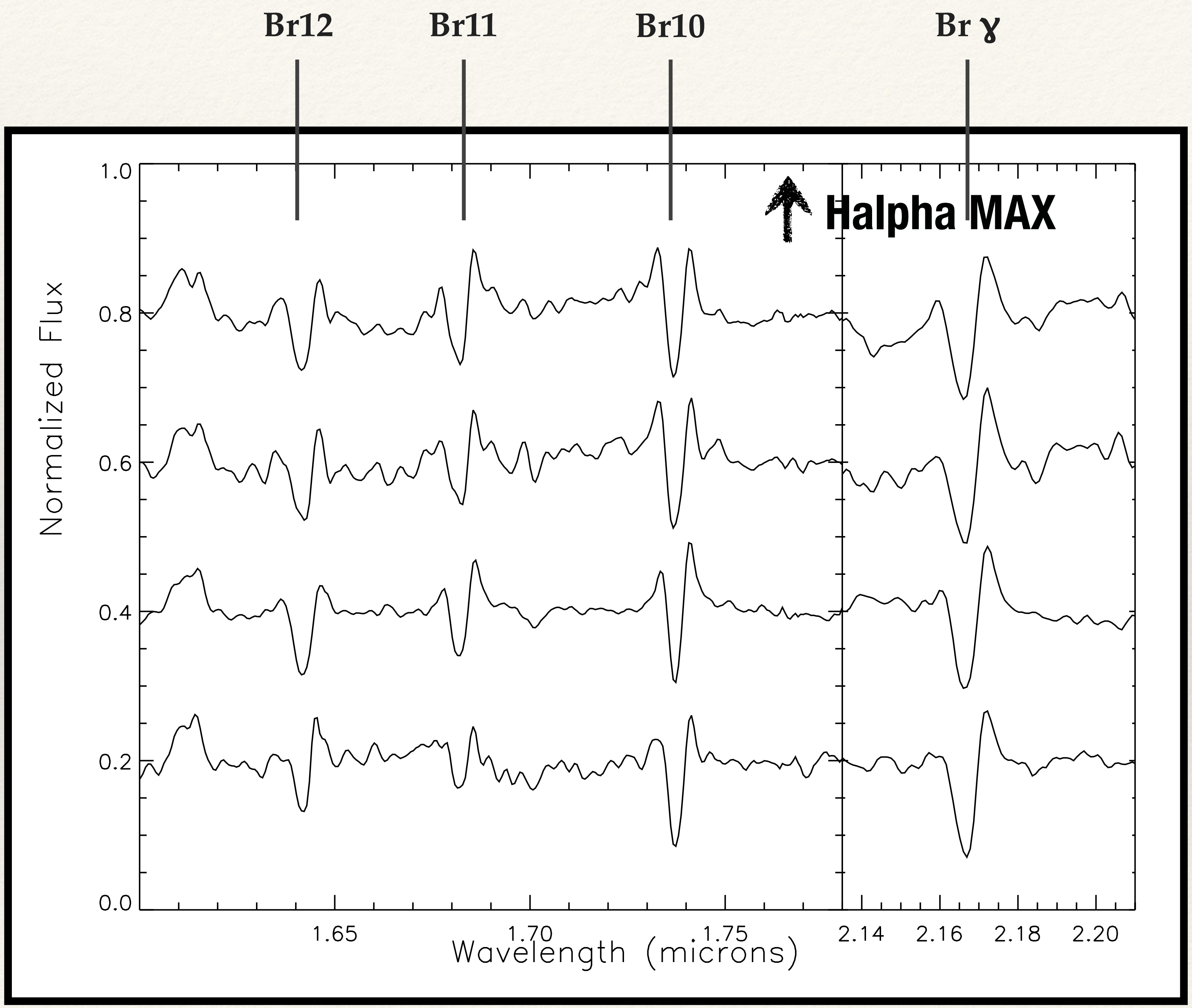
# Time series — HR 7355

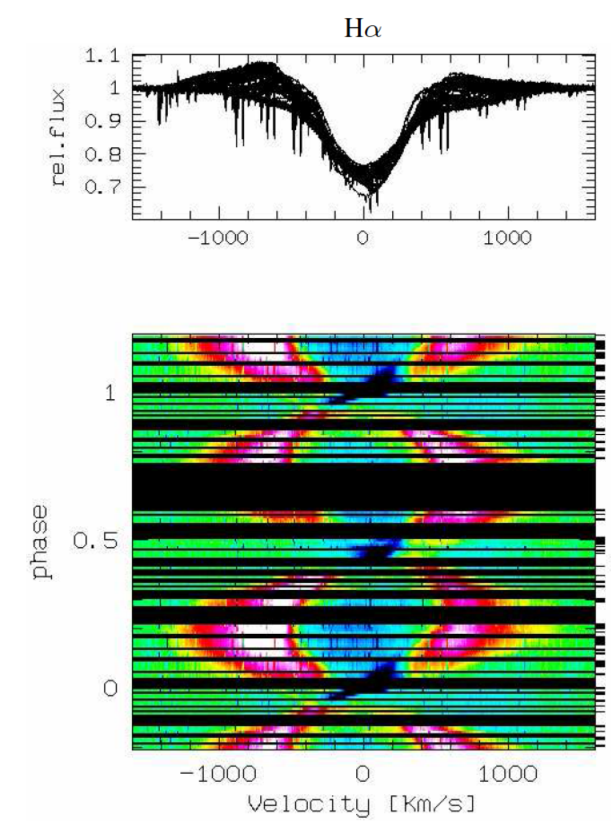



0.74

Phase

0.62




$v\sin i = 310 \pm 5$ km s$^{-1}$

$P_{rot} = 0.5214404$ d

$B_{dipole} = 11.6$ kG

**Rivinius et al. 2012**

# Summary

- ★ **NIR spectra**, particularly the H-band Brackett series, are **ideal to study massive-star magnetospheres**, given the lower contribution of stellar flux at these wavelengths

- ★ Even with low resolution spectra, we can detect this material and its variability.

- ★ **NIR spectroscopy is necessary to detect and study lower-density environments around magnetic stars.**

- ★ **IR is a tool to detect magnetic candidates in the Galactic center and star forming regions.** The NIR is needed to study young PMS OB stars and to increase the number of known magnetic stars to determine basic formation properties.

- ★ We will continue to obtain more data from medium and high (?) resolution spectrographs (with higher S/N), with emphasis on **preparation for SPIRou and other infrared spectropolarimeters.**