

Spectropolarimetry of WR + O binaries with SALT

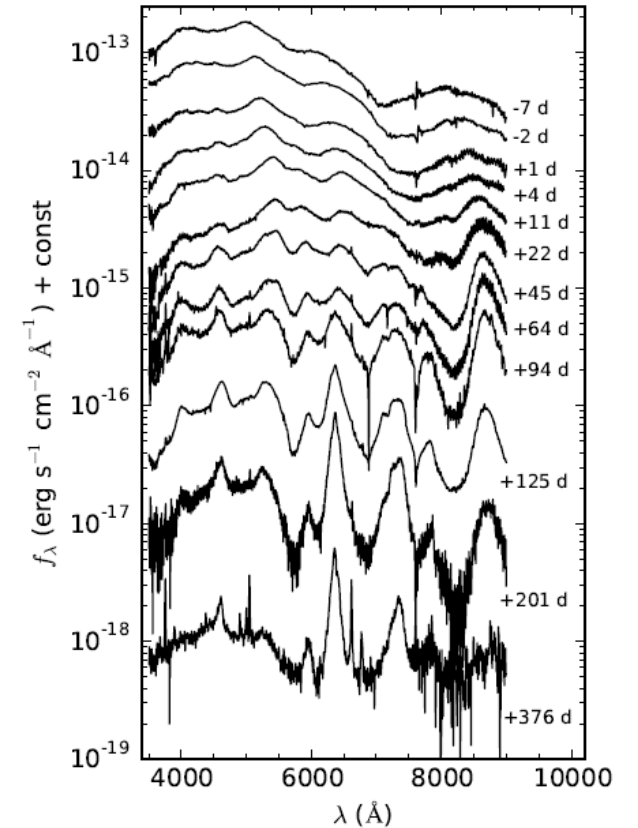
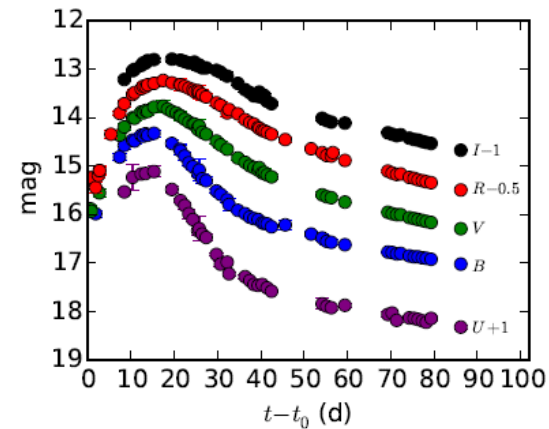
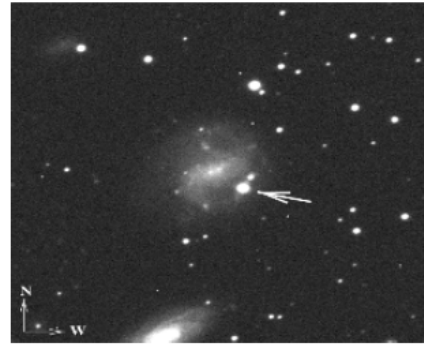
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Long duration gamma ray bursts

- Originate from massive stars
- GRBs drive jets
- Need a rapidly rotating core
- Role of binarity is poorly understood
 - Does it help rapid rotation?
 - Need to understand mass transfer

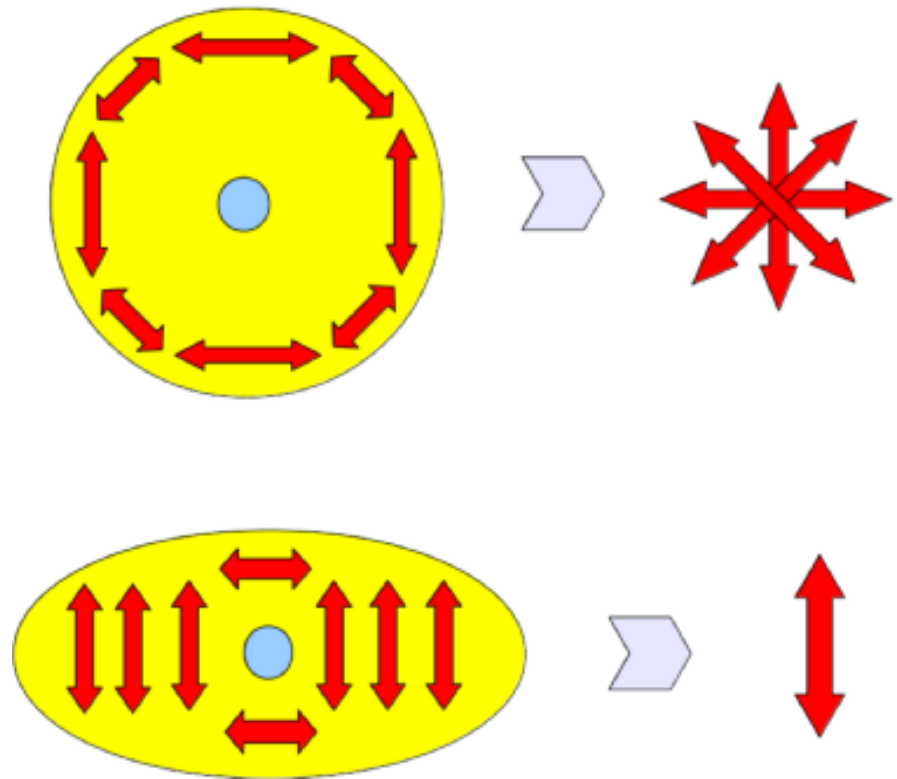


Cano et al. 2017

Polarization

Scattering region

Observed polarization

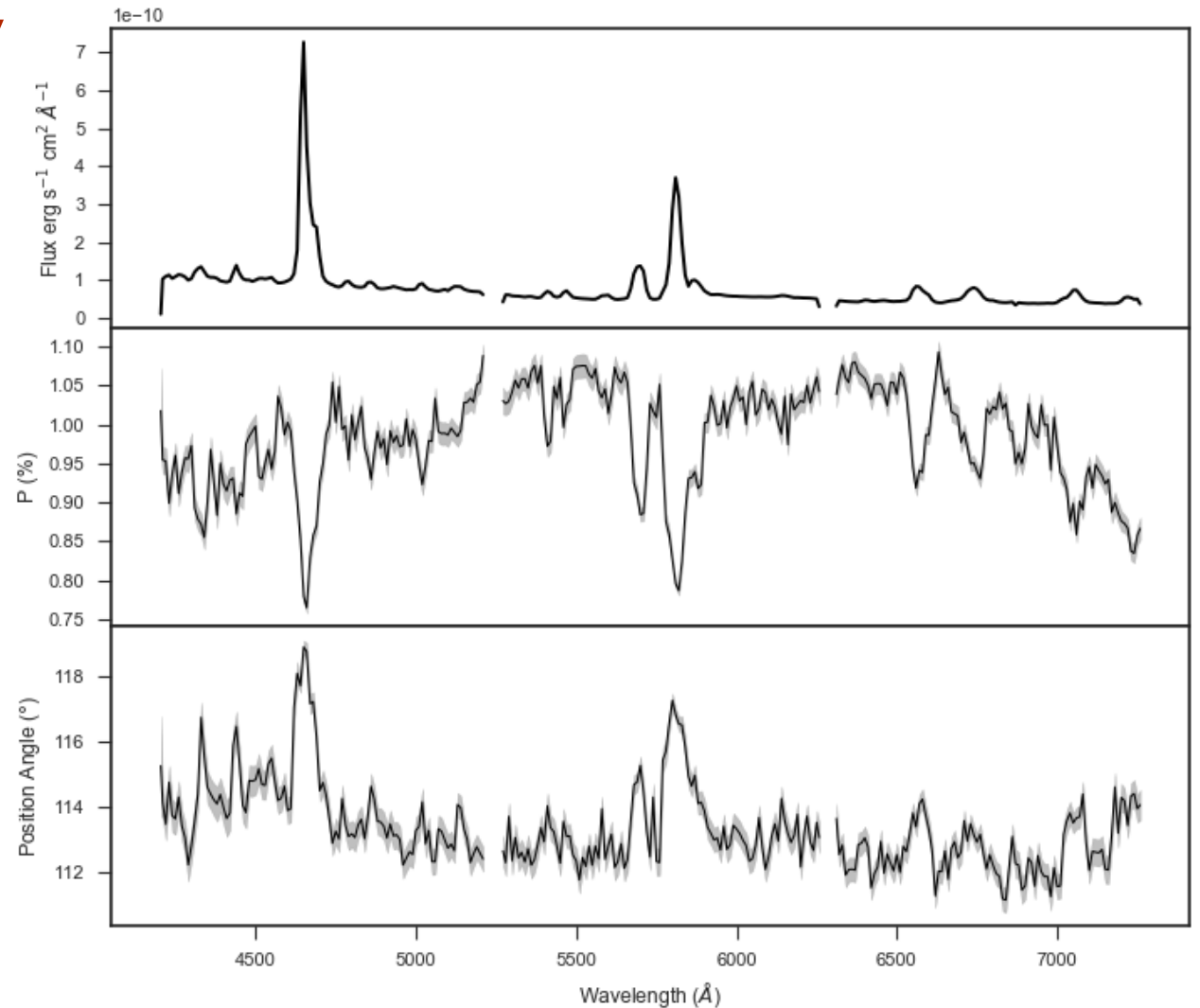


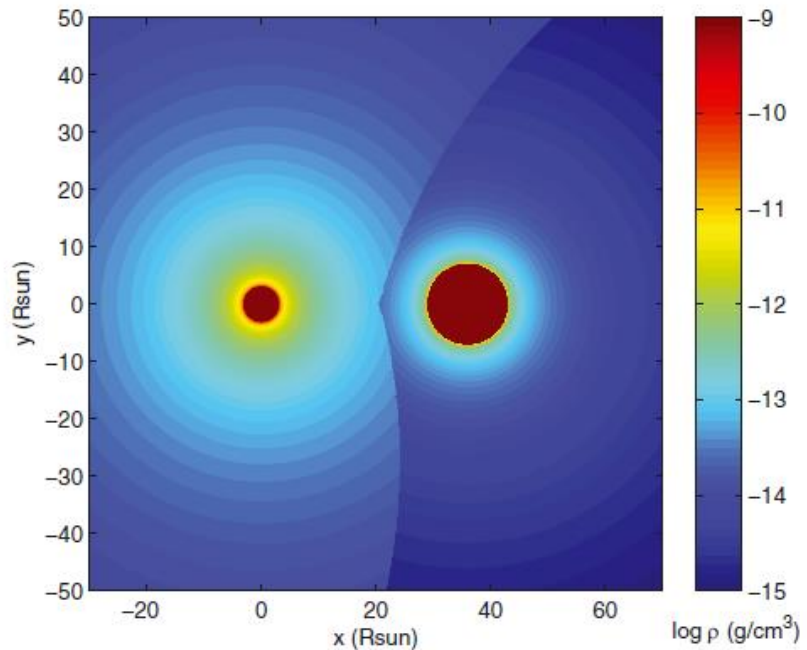
Stokes vectors

$$\begin{aligned}
 I &= \updownarrow + \leftrightarrow \\
 Q &= \updownarrow - \leftrightarrow \\
 U &= \nearrow - \nwarrow \\
 V &= \circlearrowleft - \circlearrowright
 \end{aligned}$$

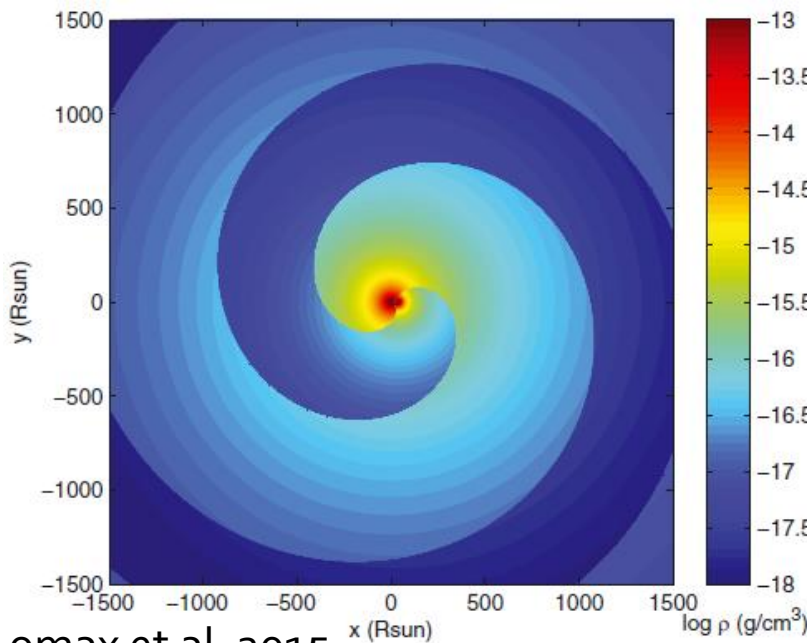
Spectropolarimetry

- Resolves line polarization
- Disentangles signals of CSM components vs continuum
- Useful for binary stars: can use relative polarization
- WR in particular have clear elements that are part of their wind

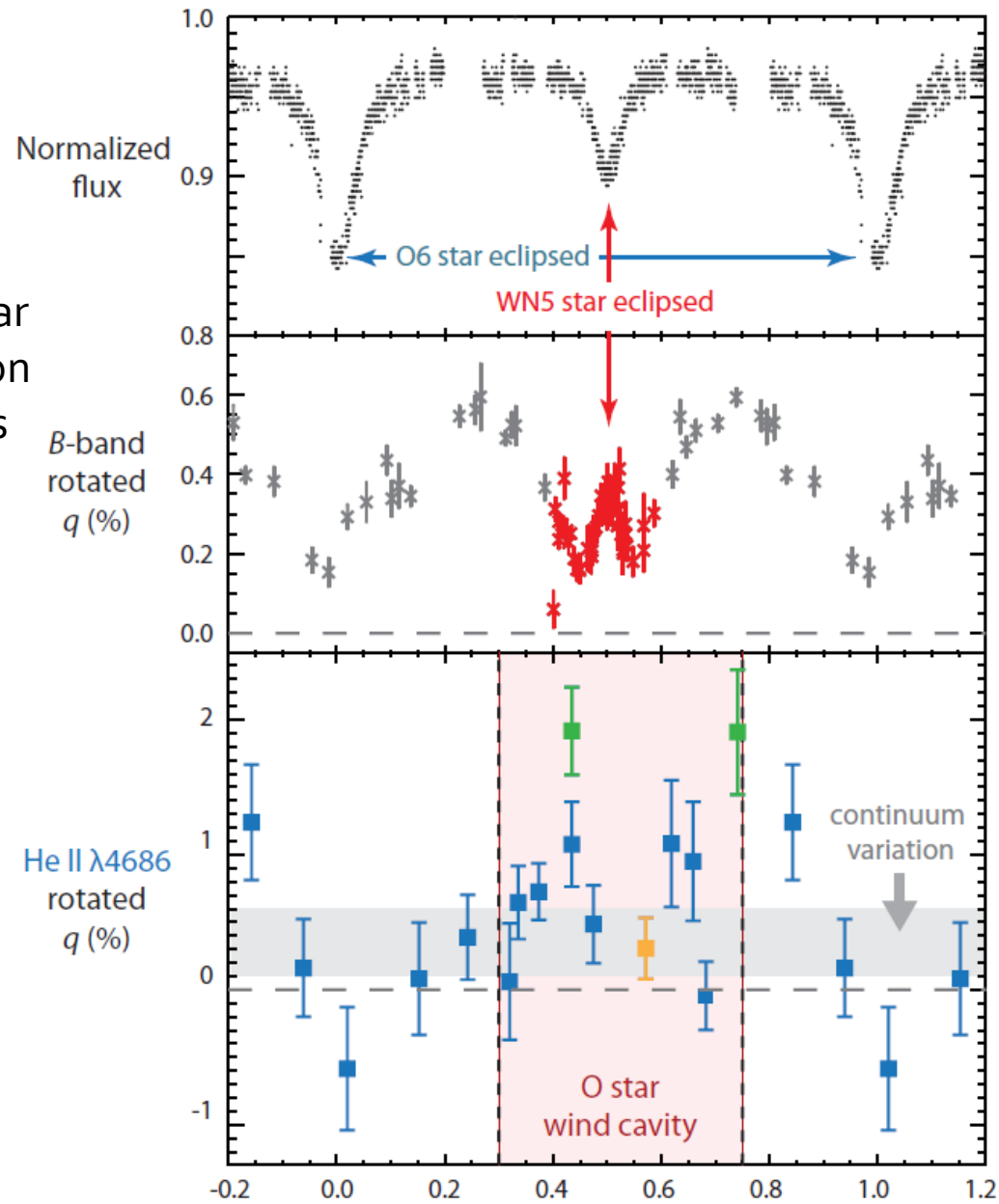




V444 Sgr X-ray model
 Pink region shows O star
 wind cavity phase region
 Line polarization shows
 behavior in matching
 region



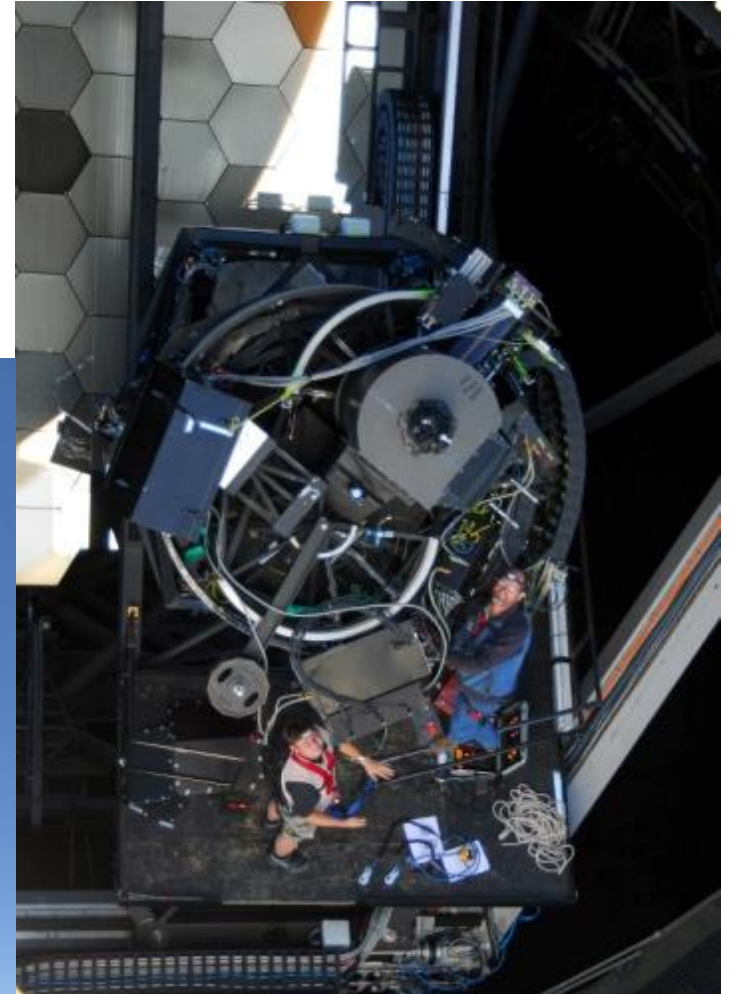
Lomax et al. 2015



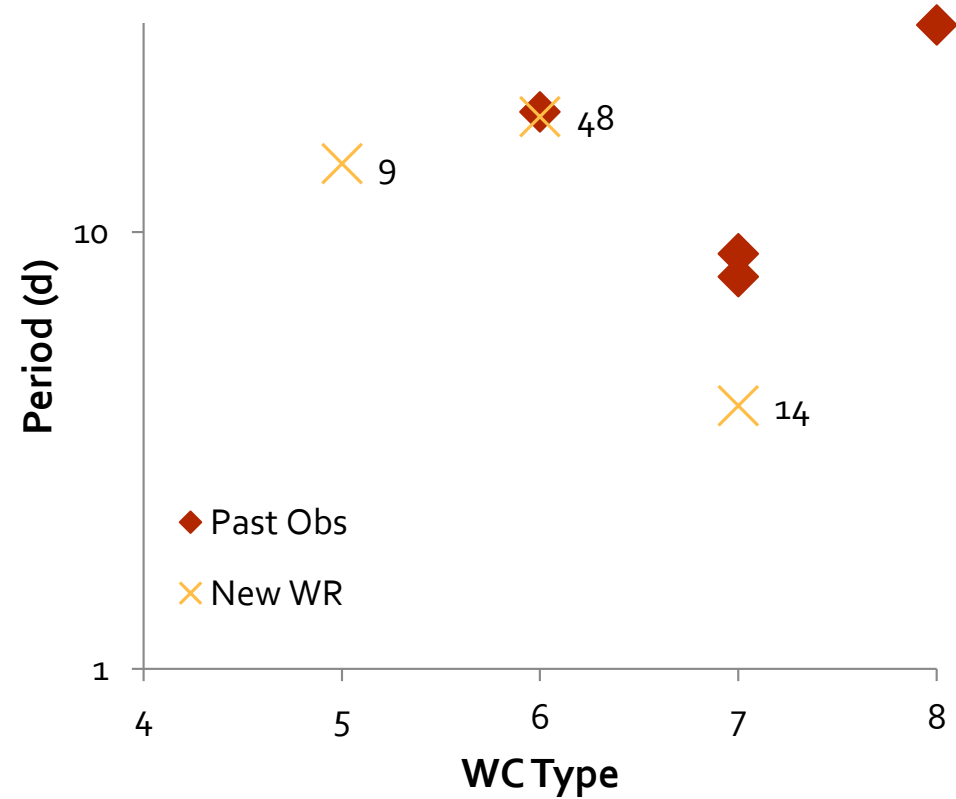
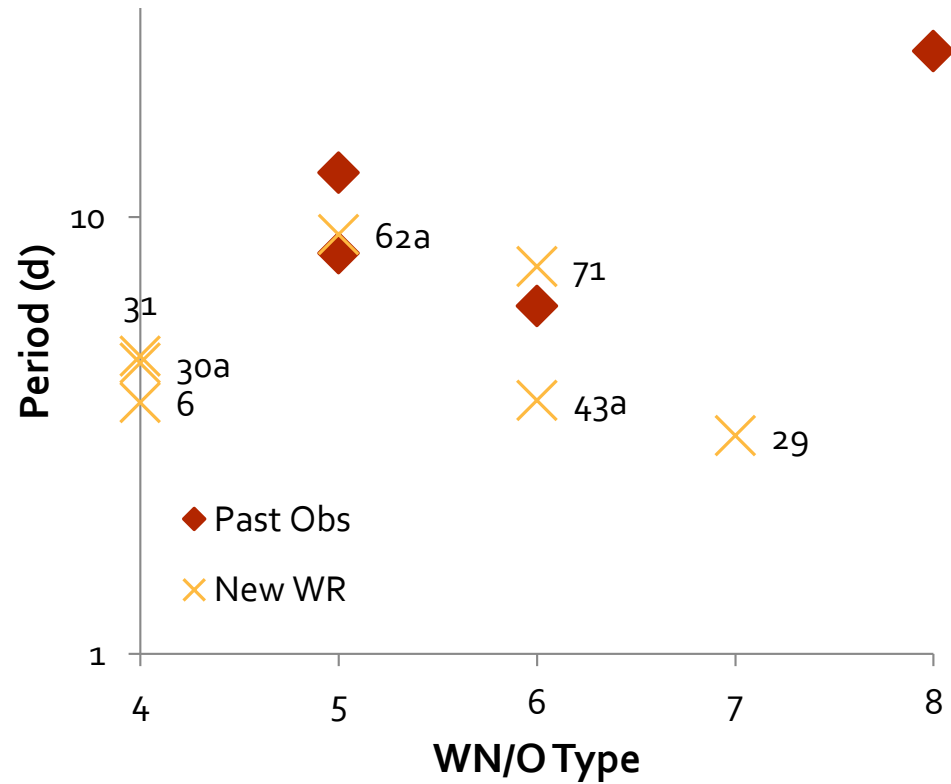
Hoffman et al. 2017

Spectropolarimetry with RSS

- 11-m fixed primary mirror
- Robert Stobie Spectrograph
 - 320-900nm
 - 1Å native resolution
 - Full Stokes spectropolarimetry
 - Multi-object spectropolarimetry
- Error on polarization $\sim 0.1\%$ or less



Target period/type



Good coverage across multiple WR types

Total: 17 targets, 6 WC, 10 WN, 1 WO

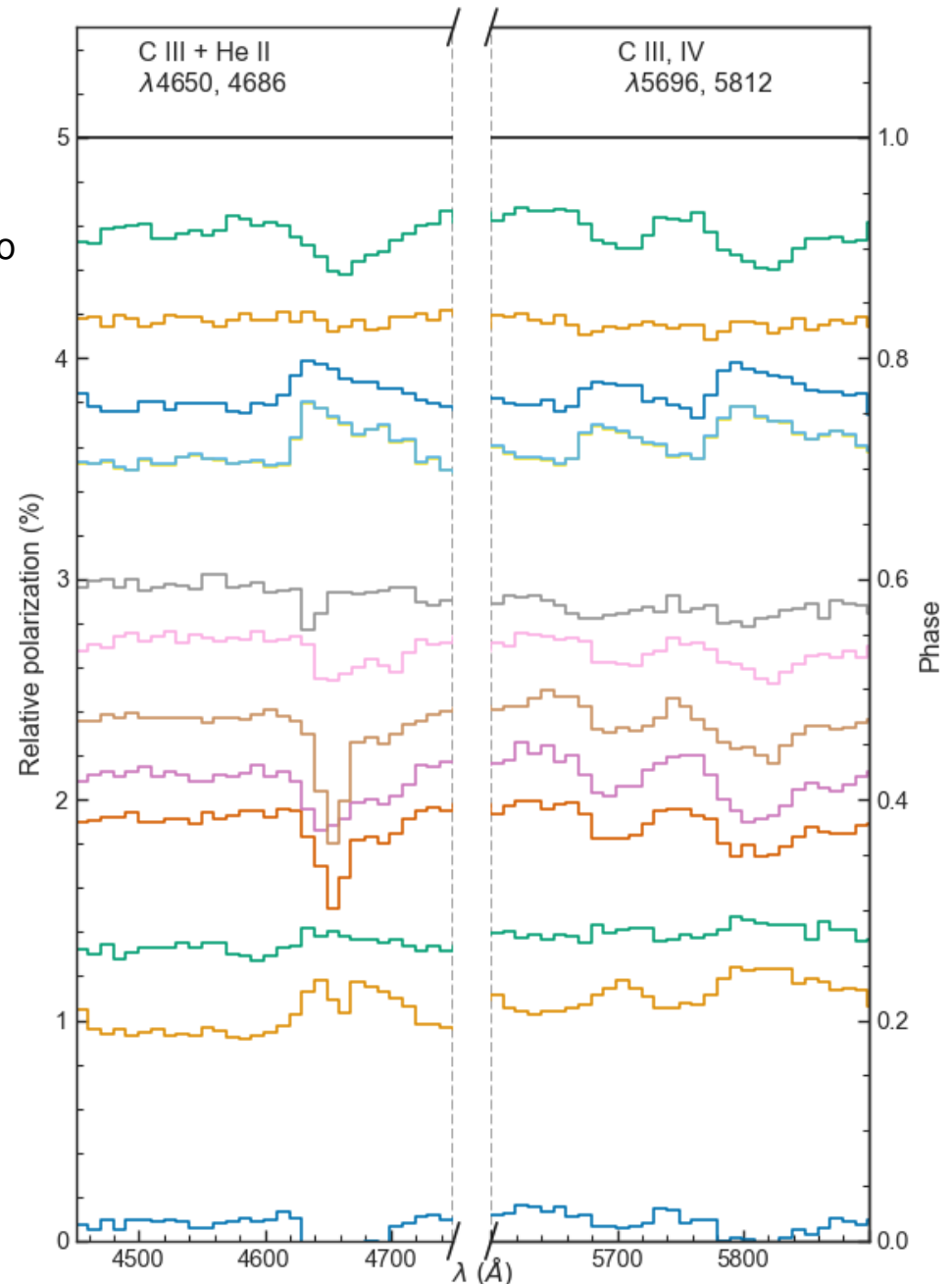
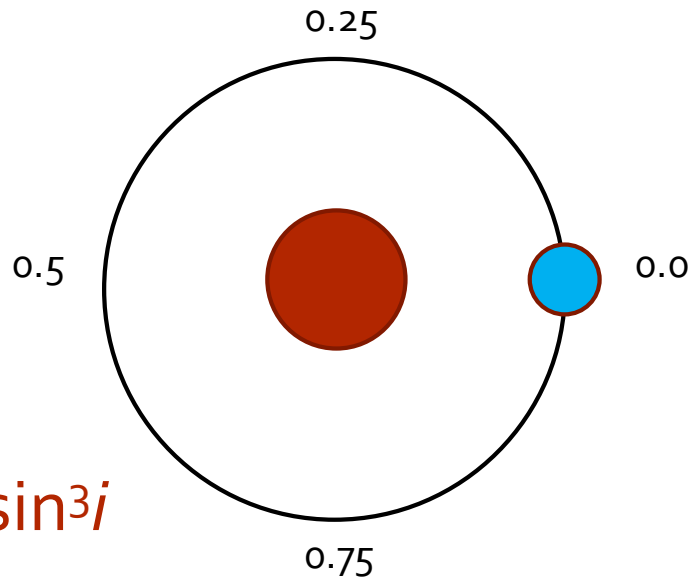
WR 42

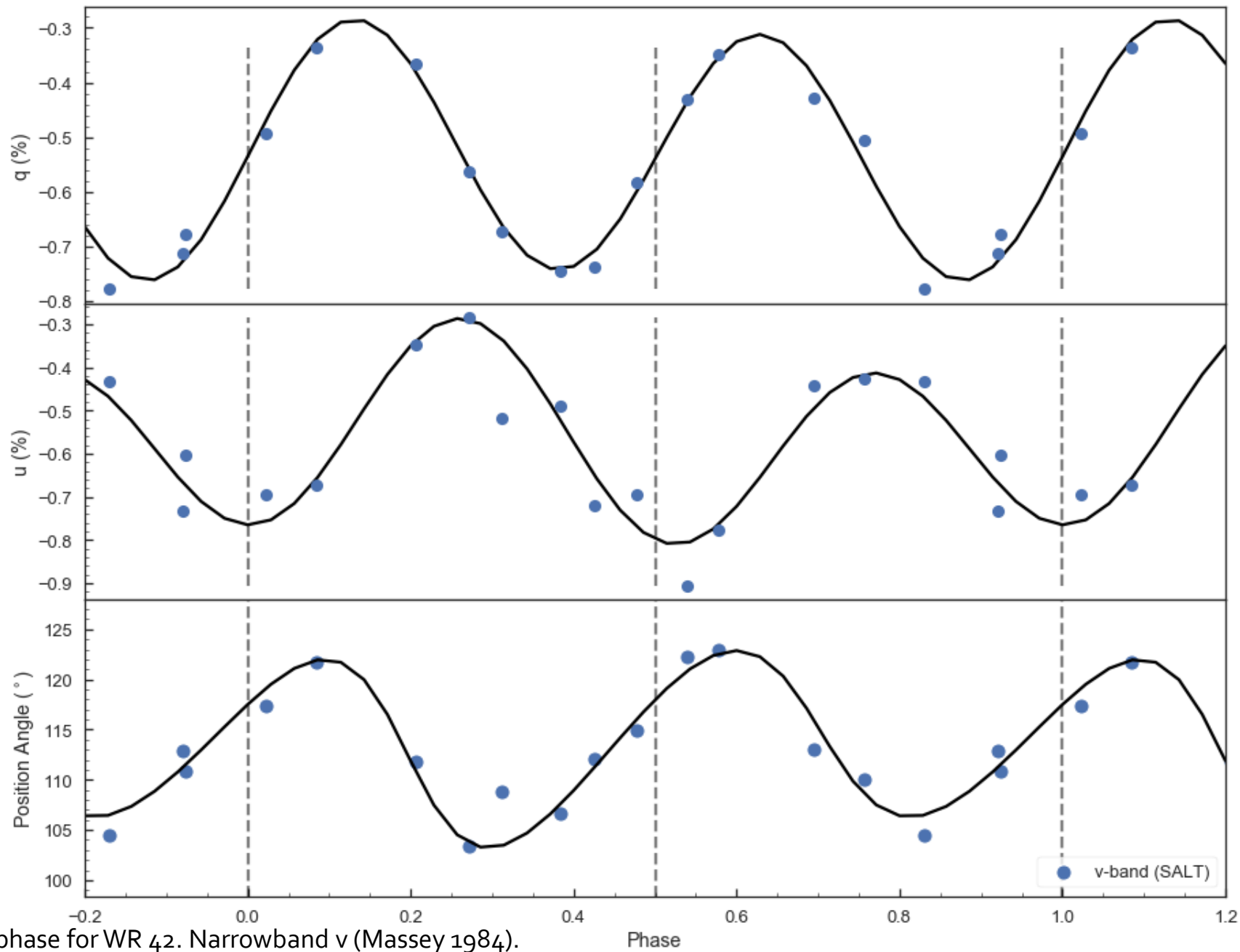
- WC₇+O₇V
- $3.7 + 6.2 M_{\odot} \sin^3 i$
- 7.9d period
- 38-44 deg inclination
- ~160kms rotation rate of O star
(Shara et al. 2017)
- See Fullard et al. RNAAS 2018

10Å binning

Atmospheric eclipser

Note complex line effects around phase 0.5

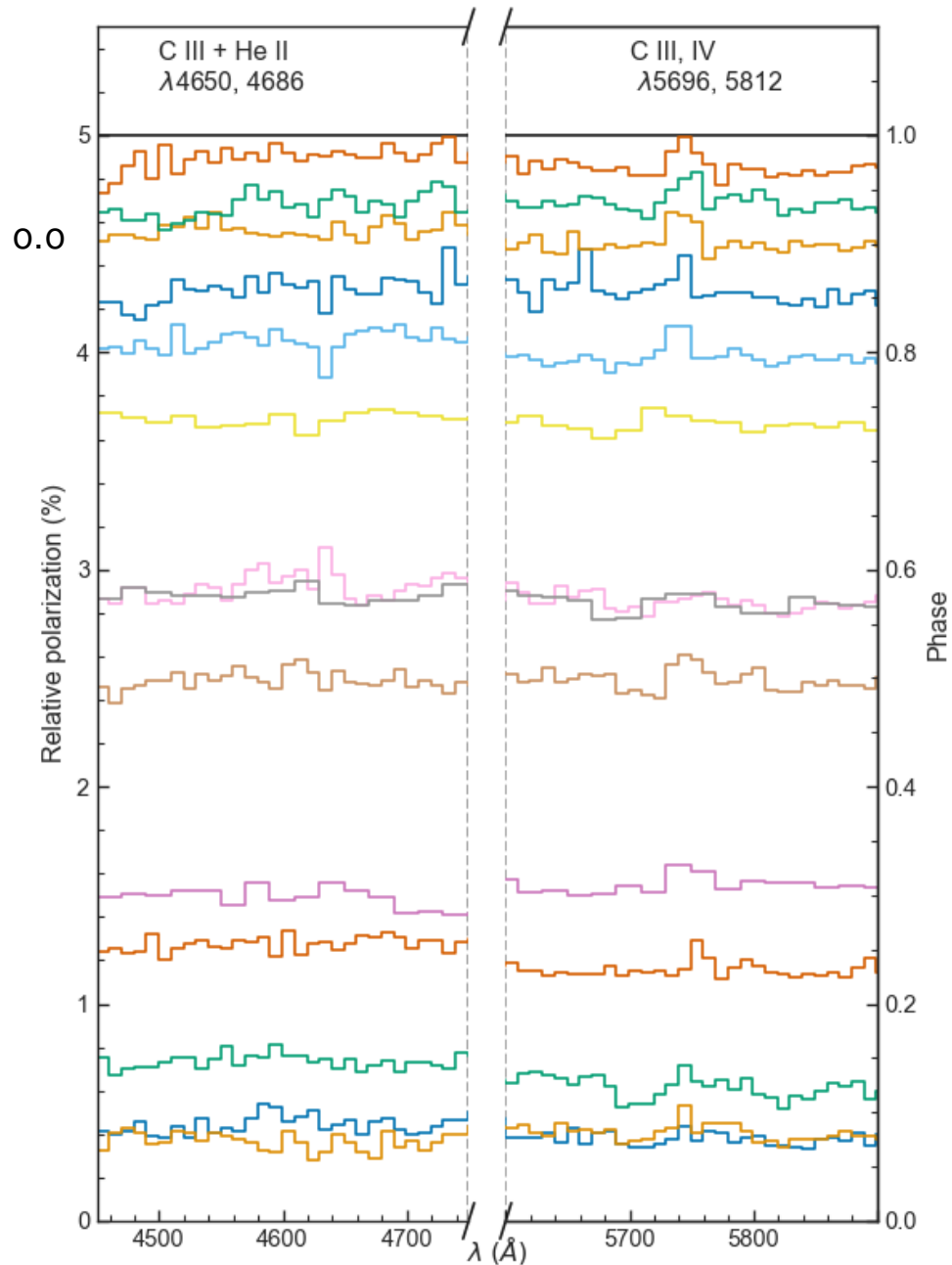
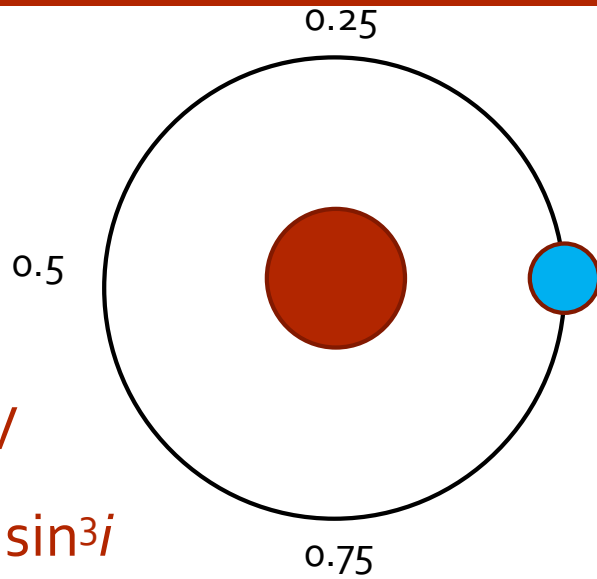


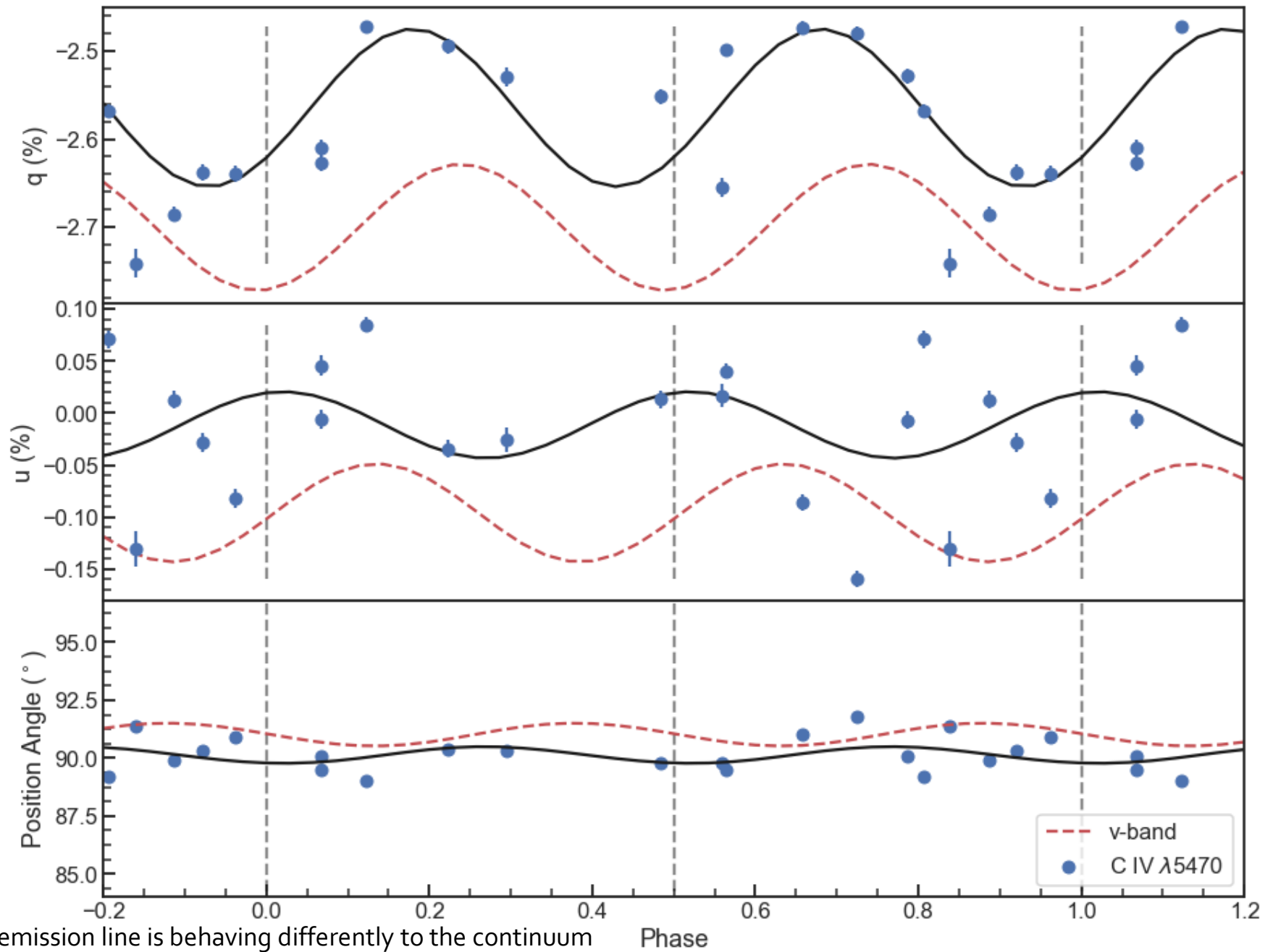


Polarization versus phase for WR 42. Narrowband v (Massey 1984).

WR 113

- WC8+O8/9III/V
- $10.6 + 22.3 M_{\odot} \sin^3 i$
- 29.7d period
- 310km/s O star rotation rate
- 63.5-78 deg inclination angle



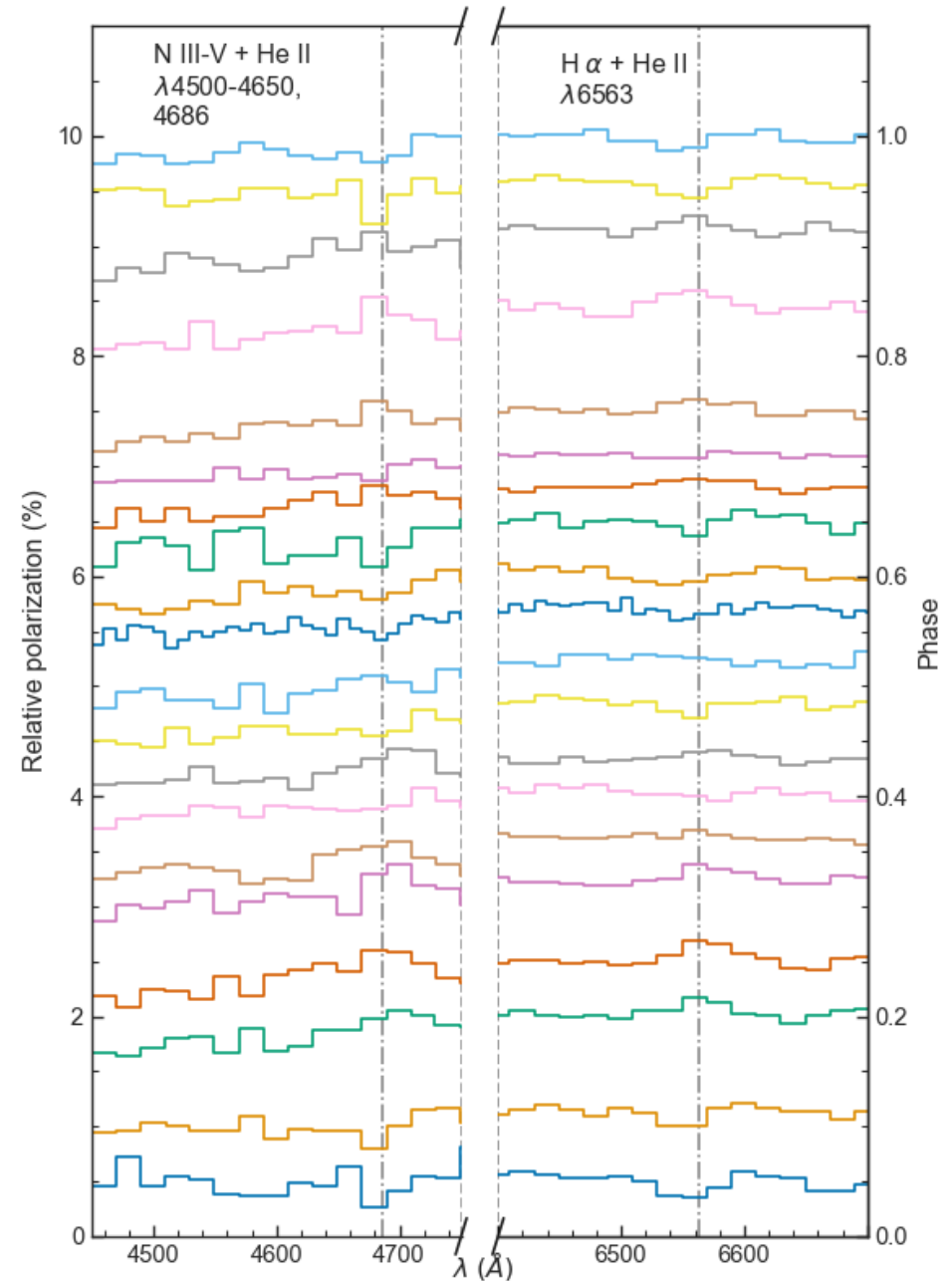
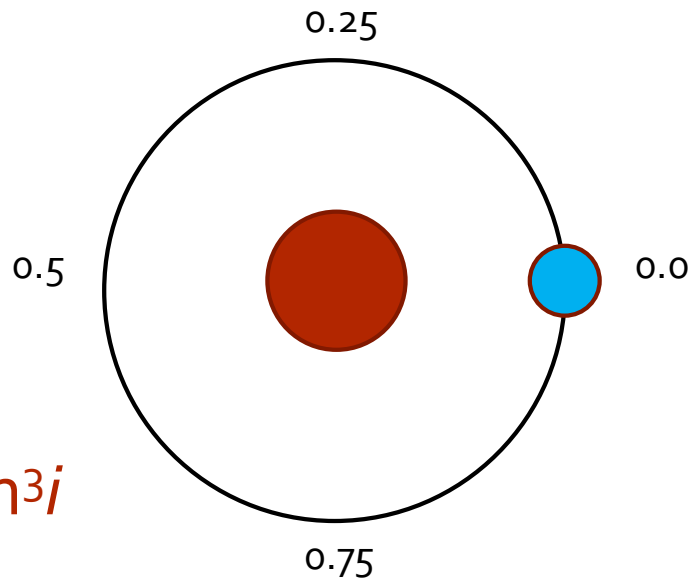


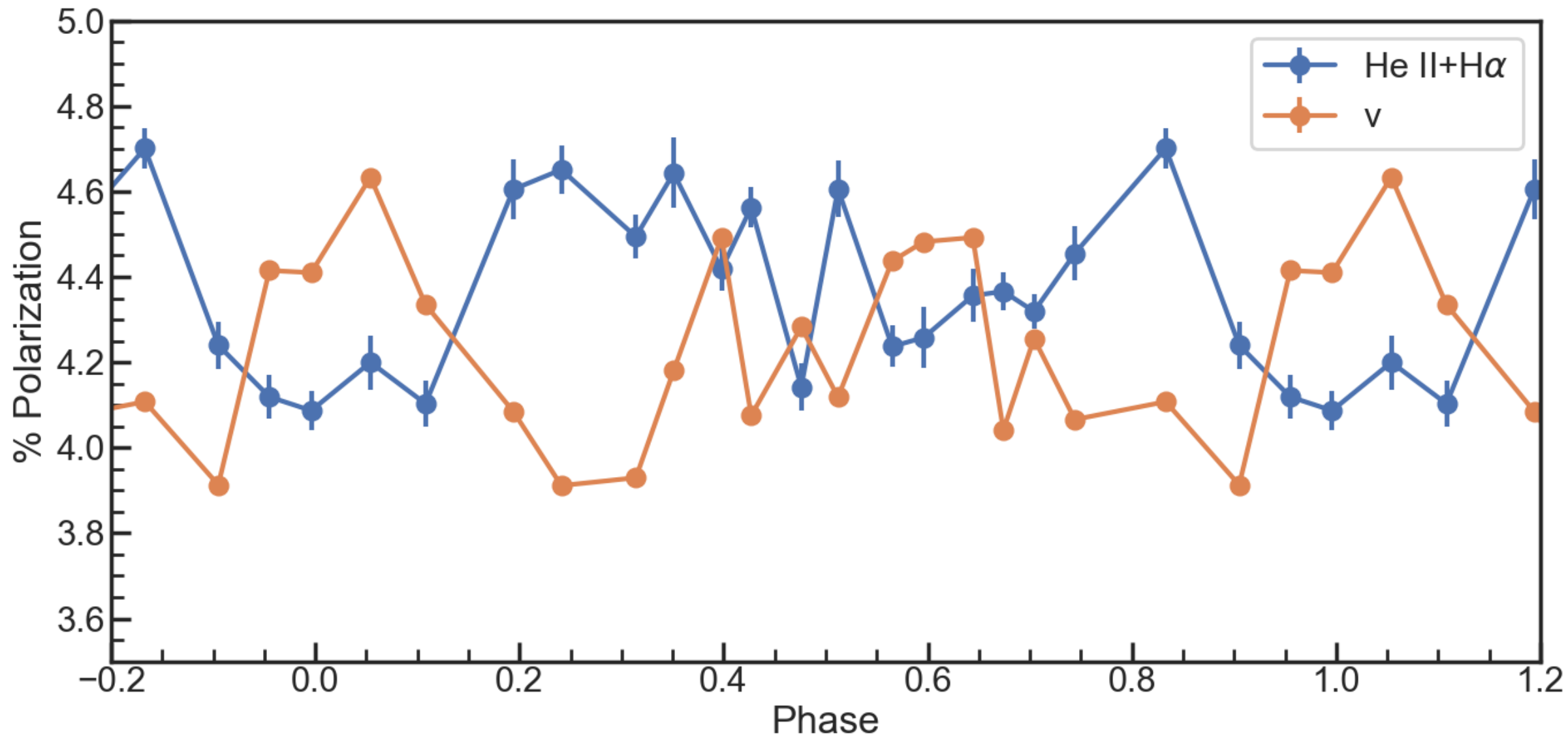
WR113 Clear that the emission line is behaving differently to the continuum

Phase

WR 47

- WN6+O5V
- $40 + 47 M_{\odot} \sin^3 i$
- 6.2d period
- 3kpc distance
- 67-90 deg inclination
- ~90kms rotation rate of O star

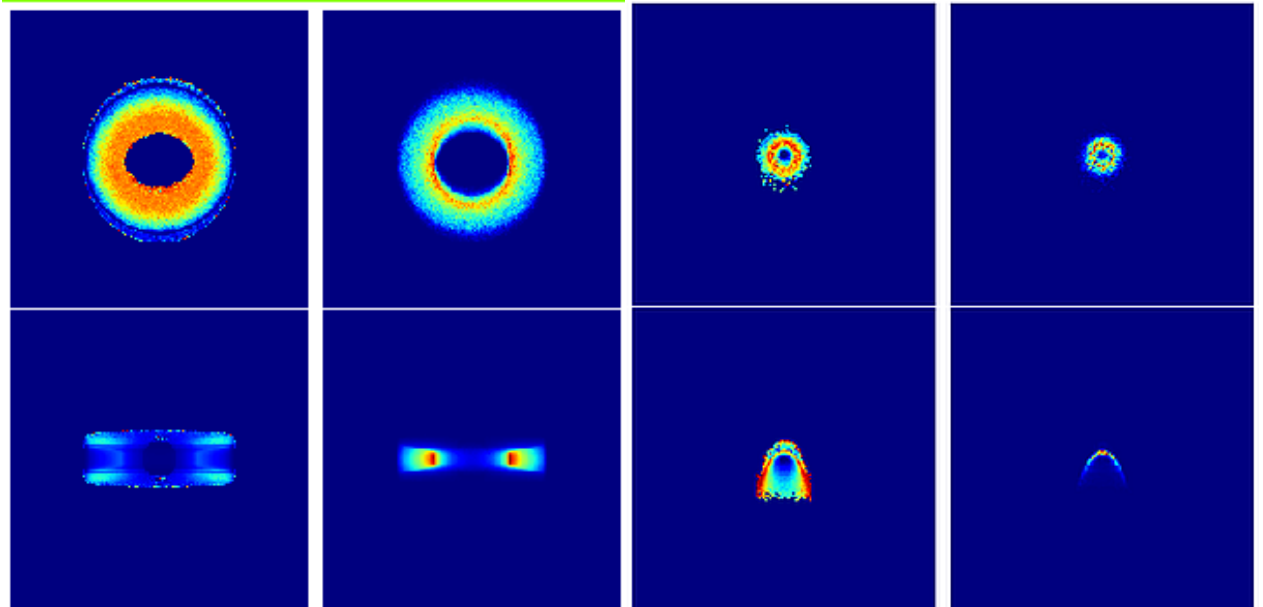
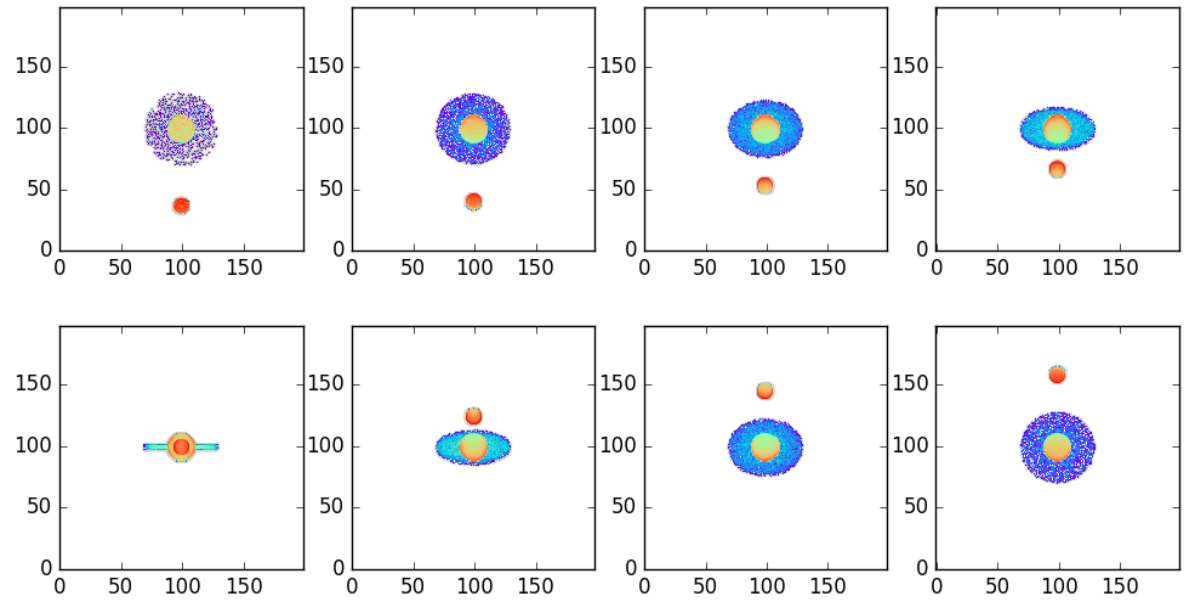




Polarization versus phase for WR 47. Narrowband v (Massey 1984) and 6563A line.

Future Work

- More WR stars:
 - WR 30, WR 79, WR 97
 - More samples of existing stars
- Modeling of spectropolarimetric effects



Acknowledgements



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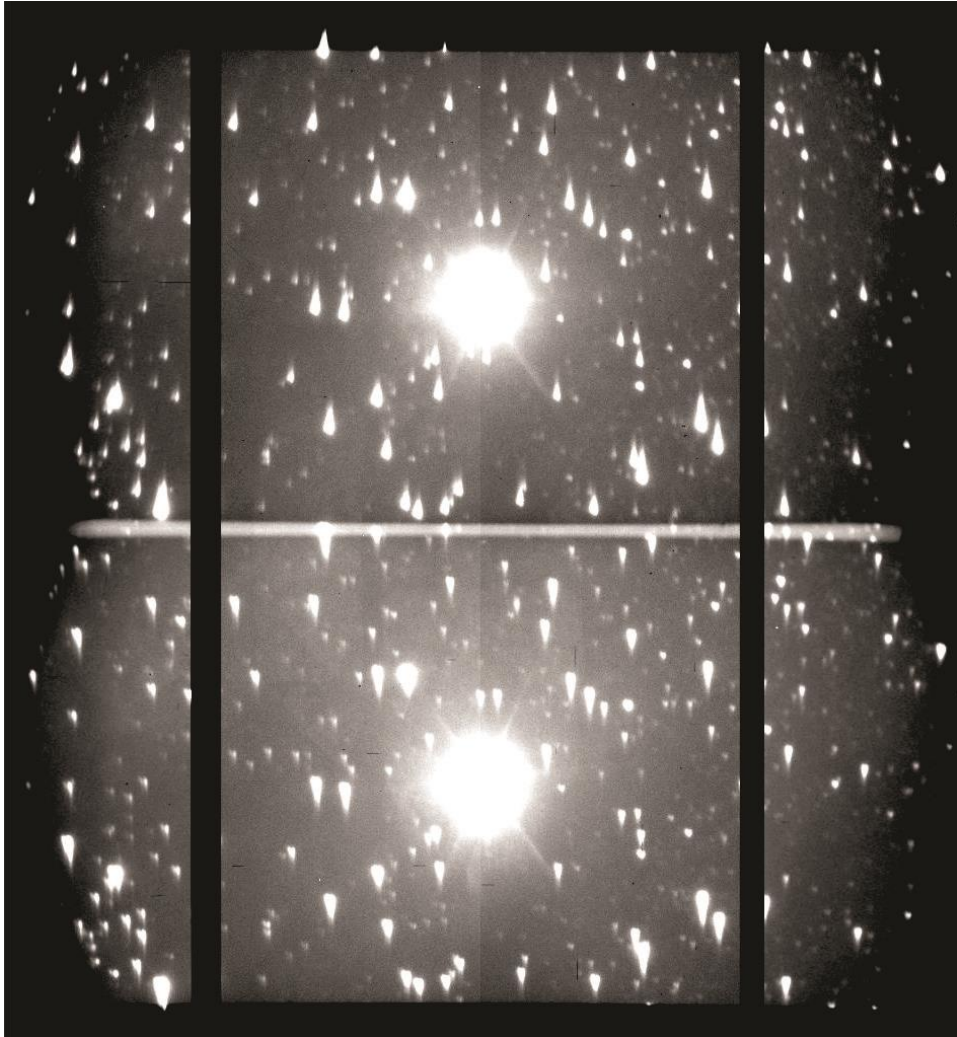
Kenneth Nordsieck



SALT observing team



ISP measurement



- RSS 12-sec imaging spectropolarimetric exposure of the neighborhood of WR 113 (central saturated source) from 10 Sept 2017.
- Top and bottom images are e and o spectra, respectively. Each field star creates a 3600–10000 Å spectrum 20" long.