One star, two star, red star, blue star

Part I

Cole Johnston | MPA

11/10/2024

Image: Casey Reed

Aims

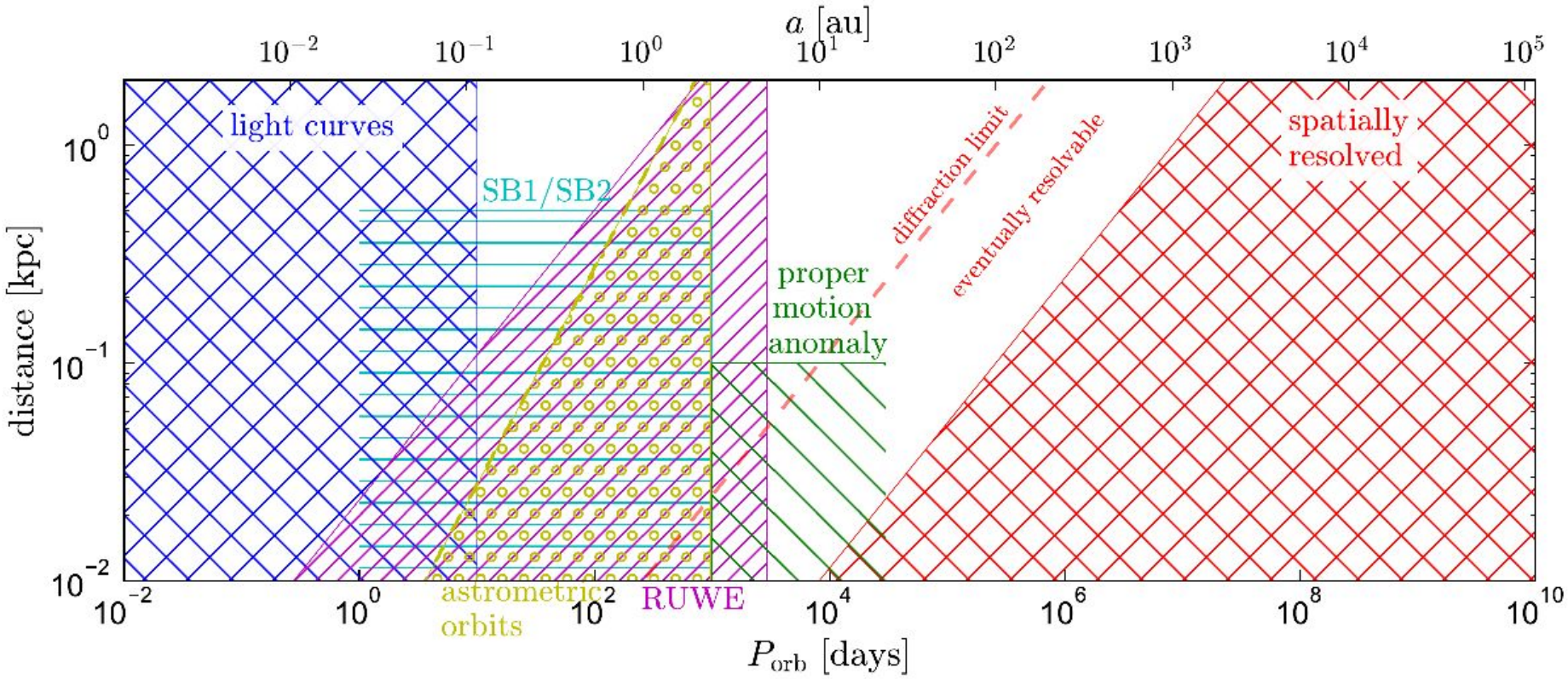
Part I: Orbits and Observations

- Describe binary orbits
- Understand observational techniques
- What do we get from different observations?

Part II: Examples

- Spectroscopy
  - Instrumental considerations
  - T_{eff} , logg, vsini, macro-turbulence
  - SB1
  - SB2 → Disentangling

How do we observe a binary?

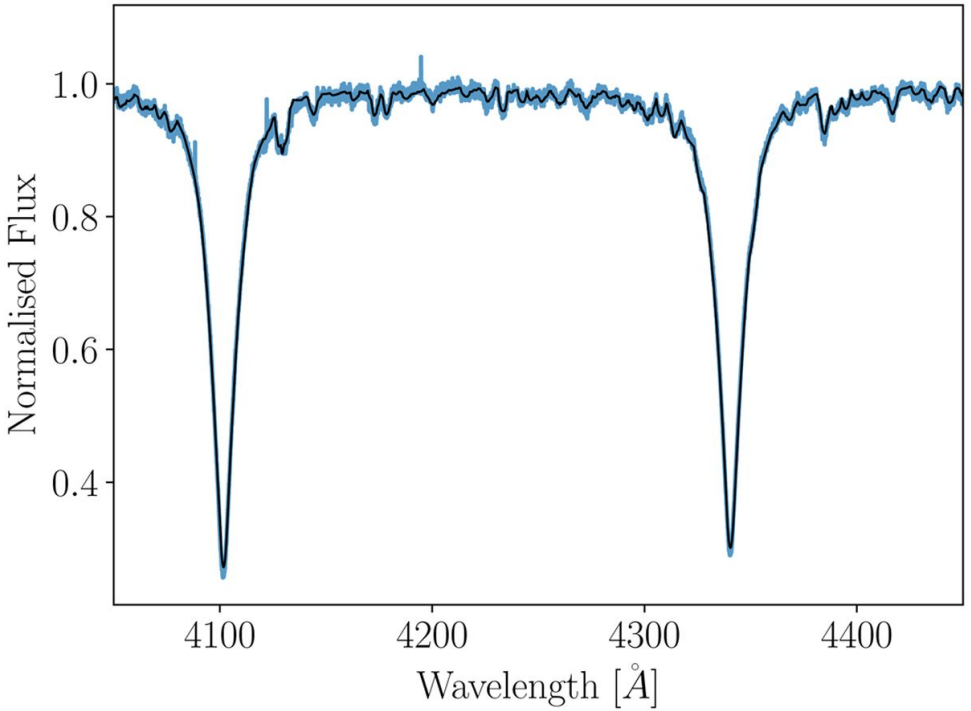


How do we observe a binary: Spectra - instrumental considerations

How do we go from photons to normalized flux?

Instrumental considerations

- light path
- total efficiency
- environmental factors
- response + blaze function
- wavelength solution
- normalisation



Royer et al., 2024

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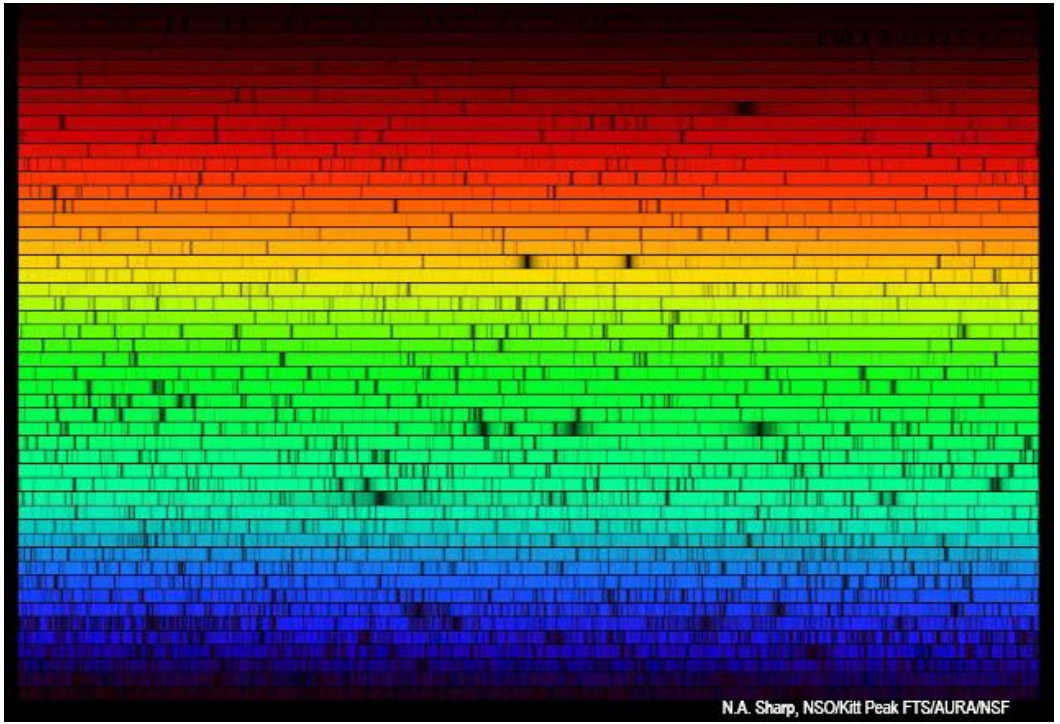
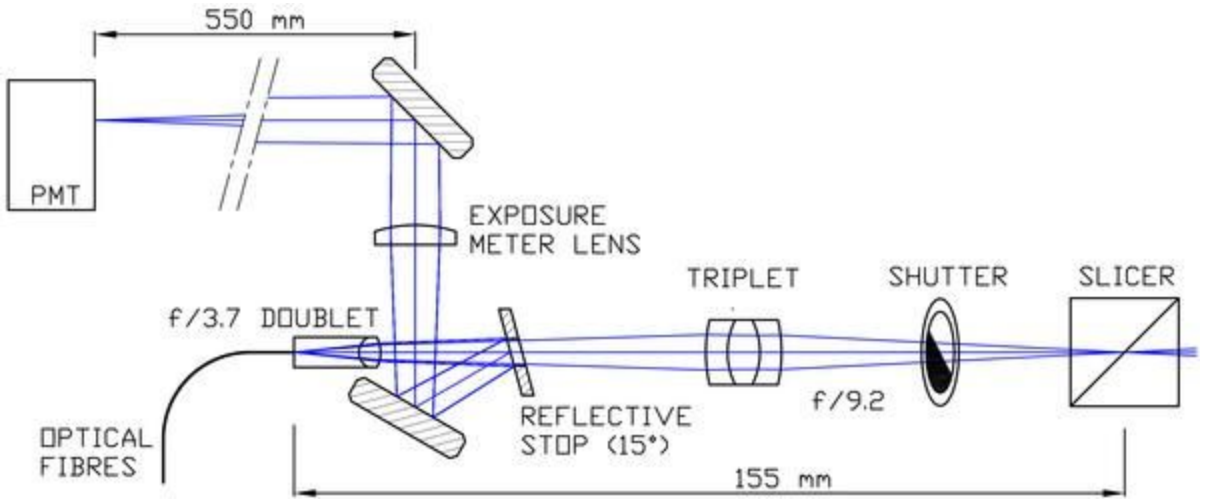
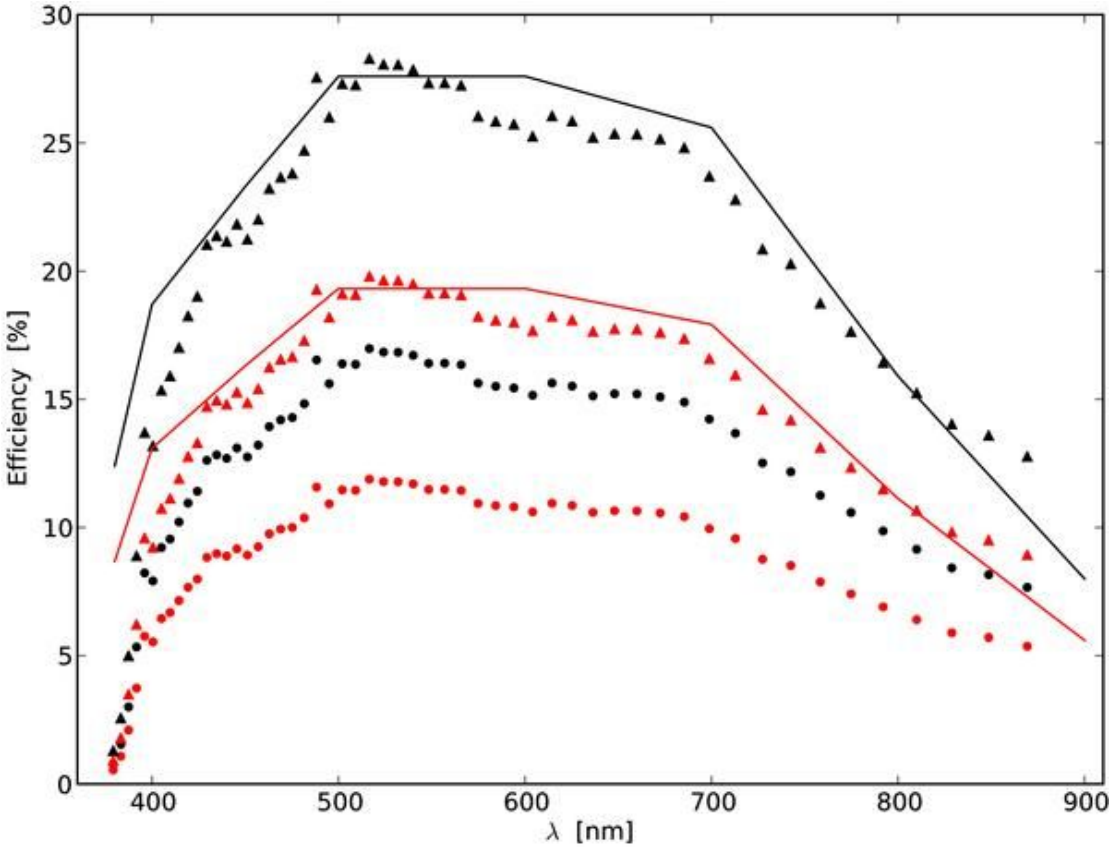


How do we observe a binary: light path



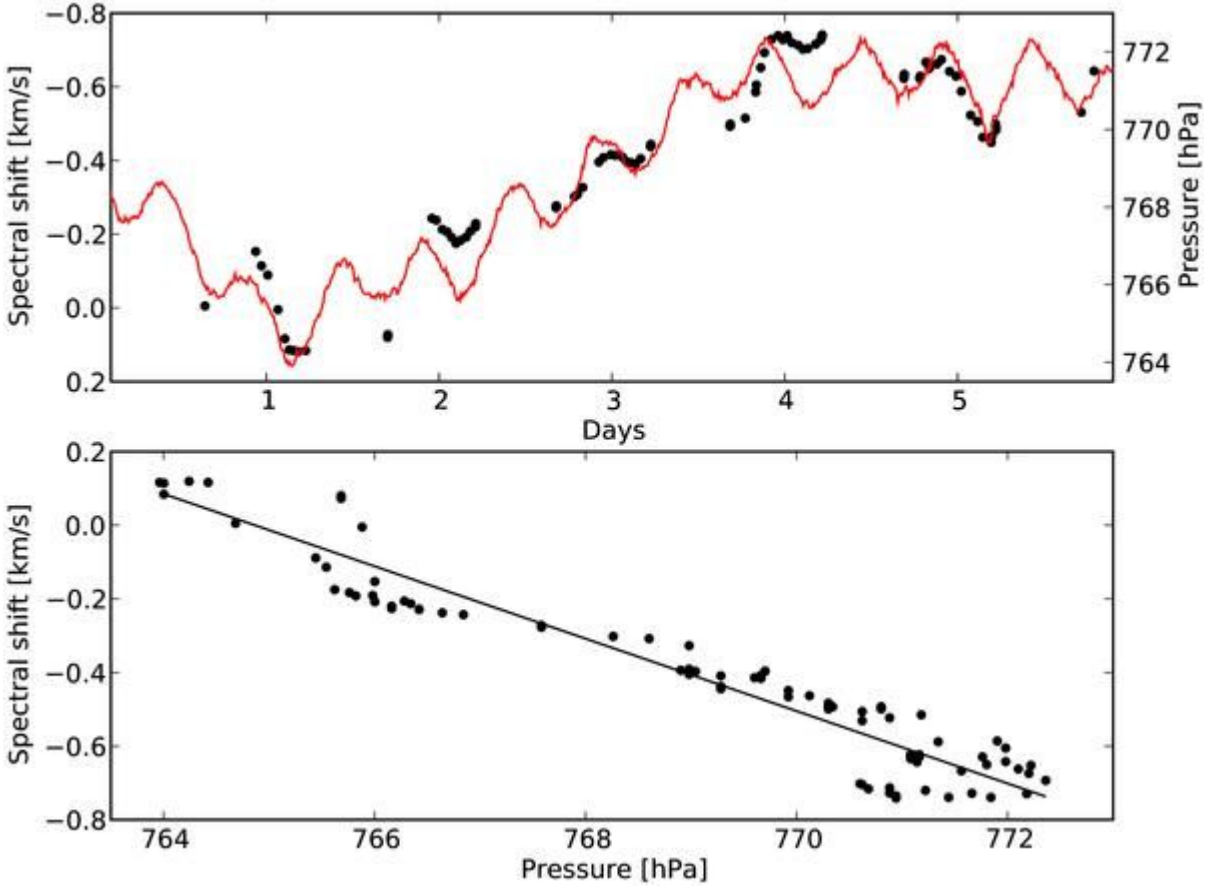
Raskins et al., 2011

How do we observe a binary: total efficiency



Raskins et al., 2011

How do we observe a binary: environmental factors



Raskins et al., 2011

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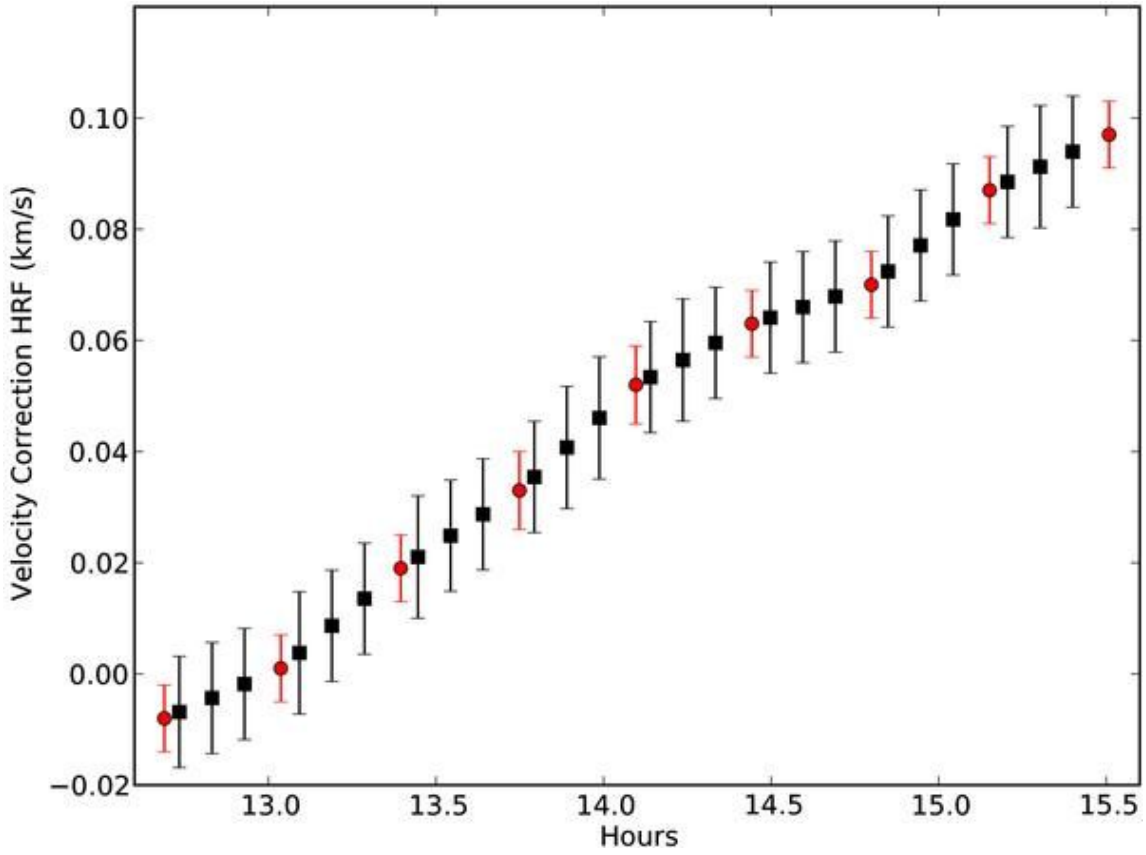
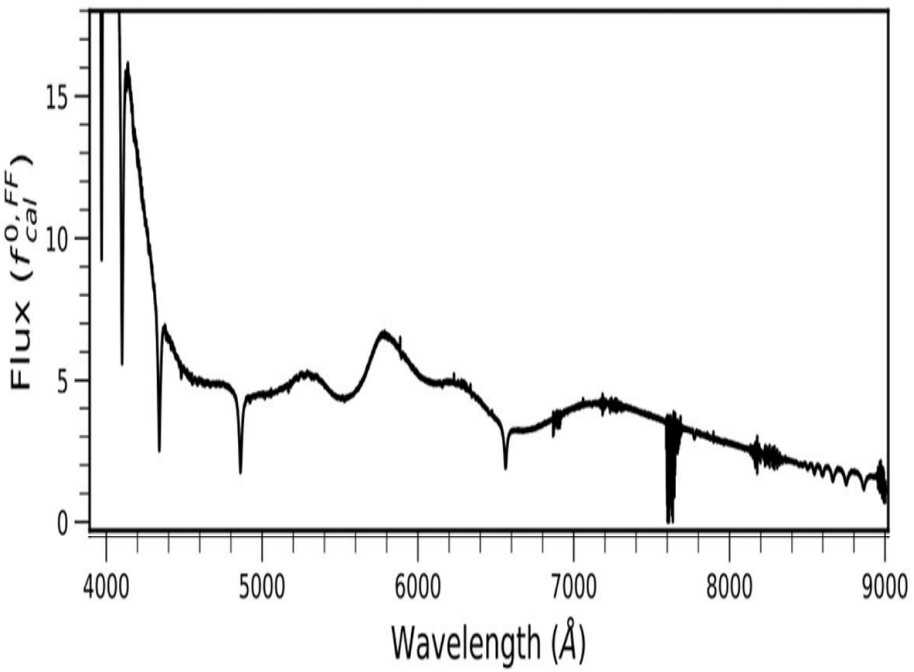
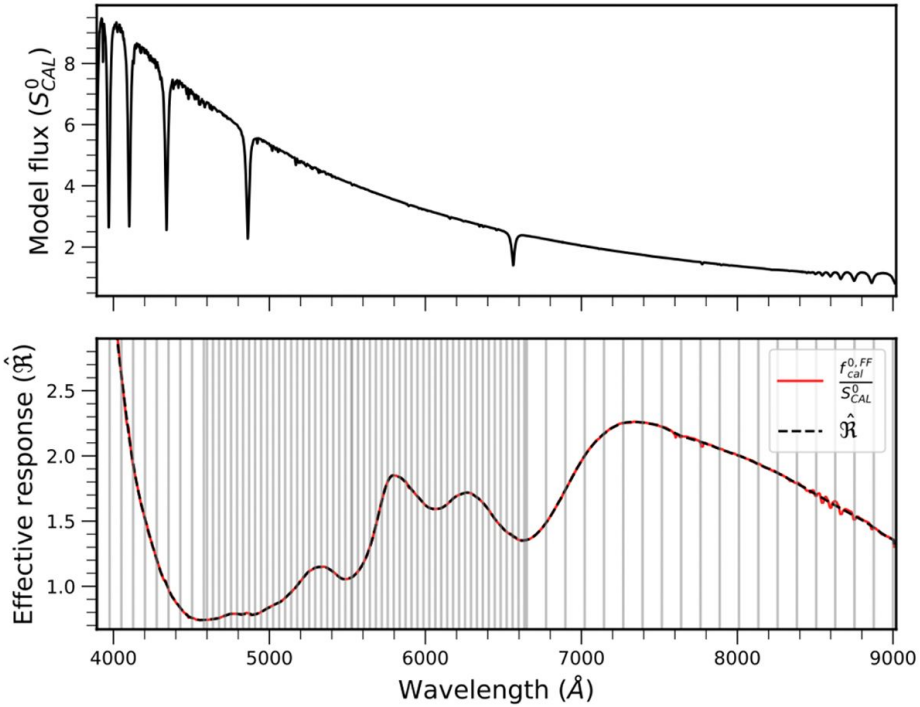


Raskins et al., 2011

How do we observe a binary: response function





Royer et al., 2024

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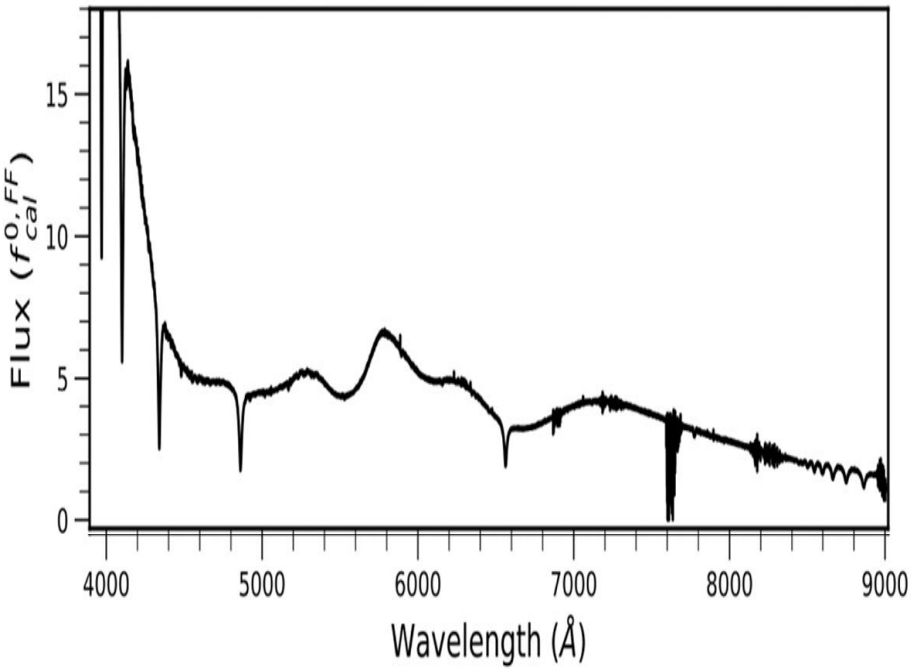
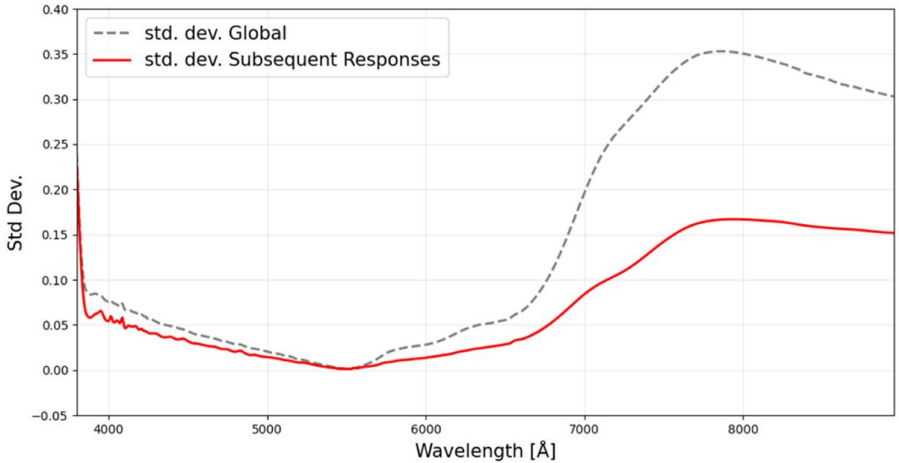
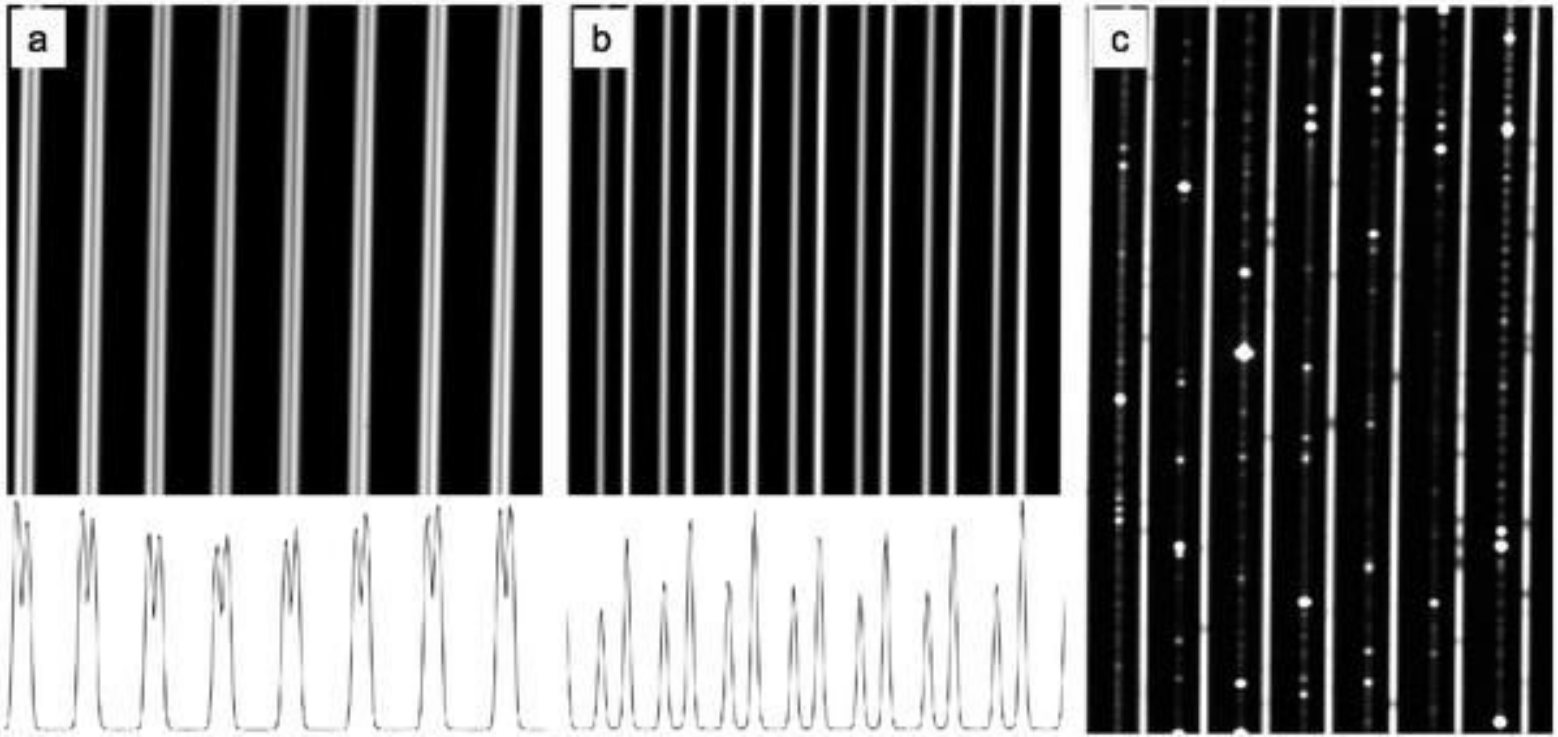




Royer et al., 2024

How do we observe a binary: blaze function



Raskins et al., 2011

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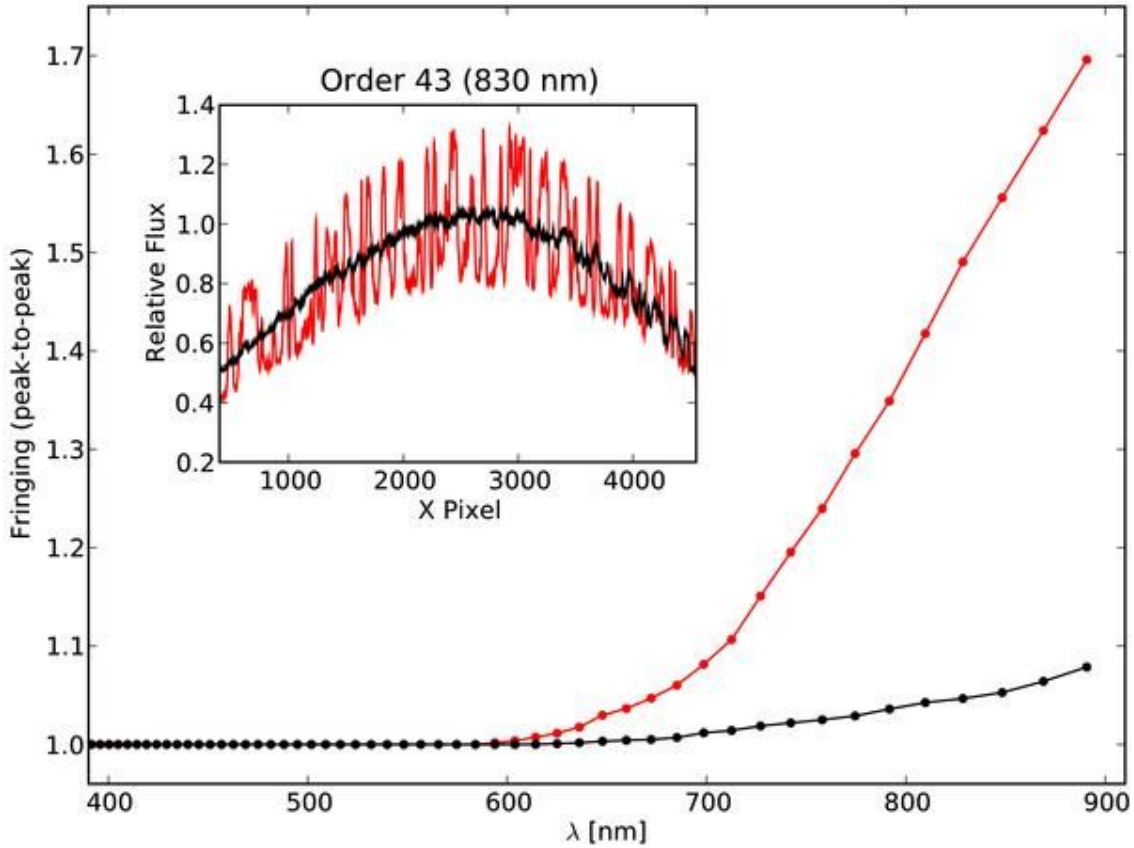

Raskins et al., 2011

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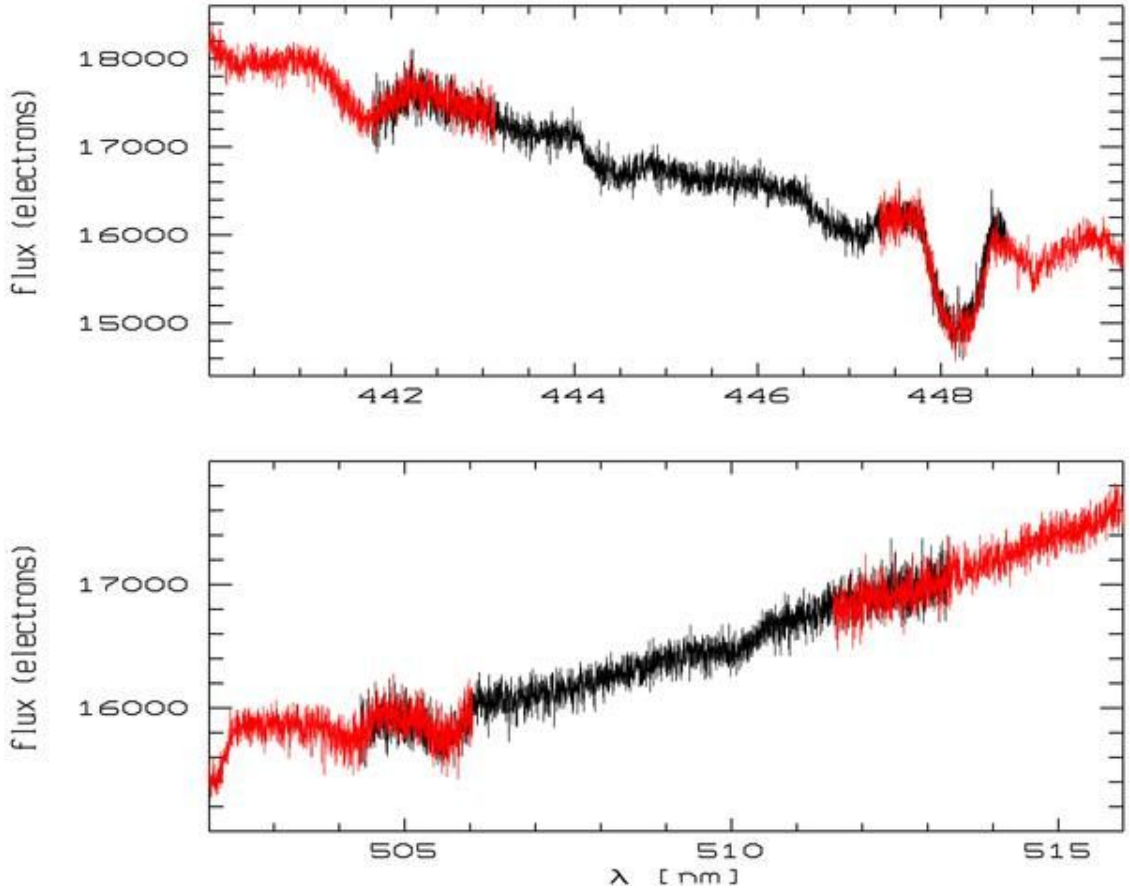
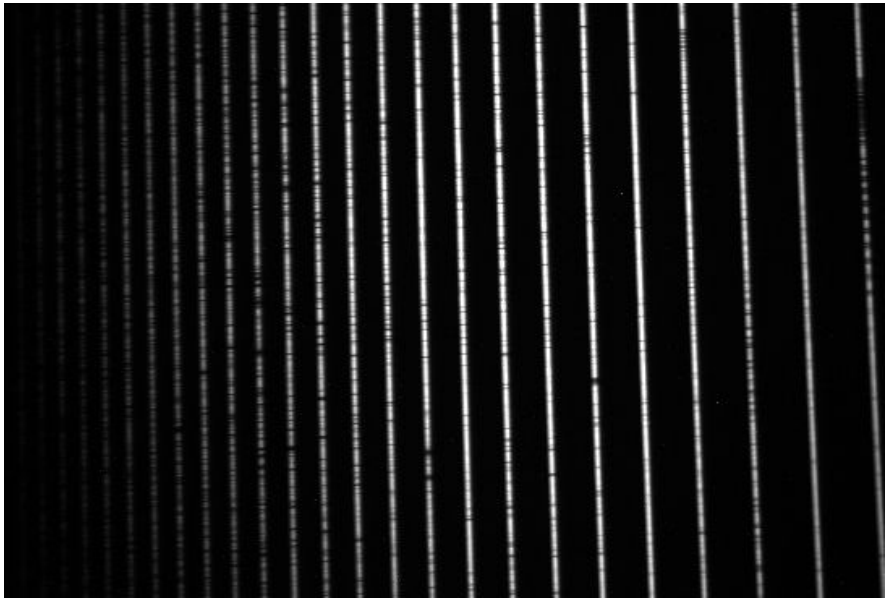
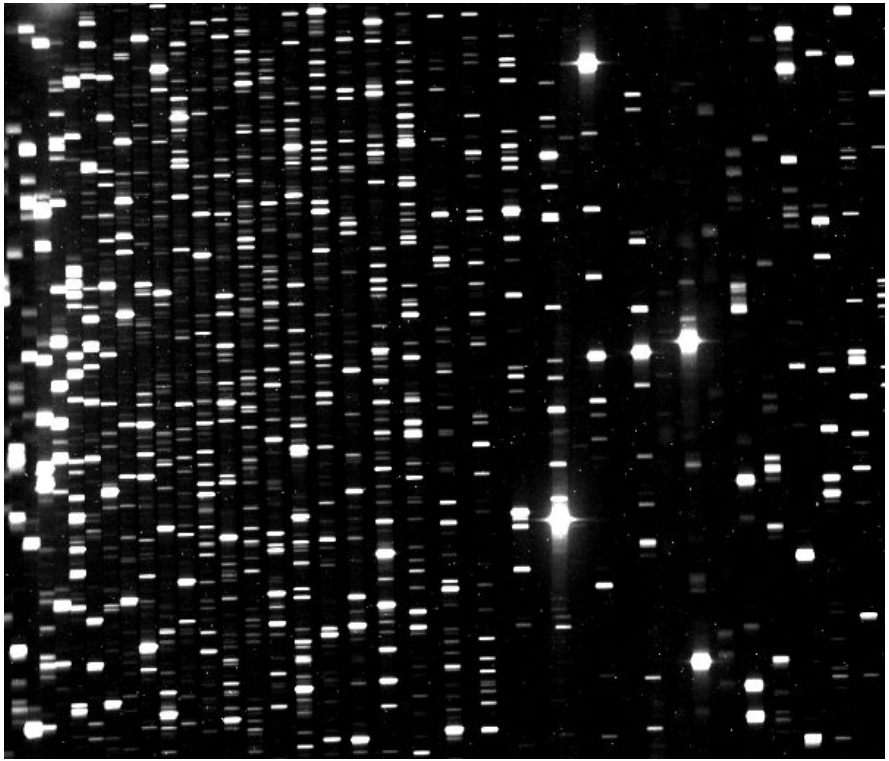


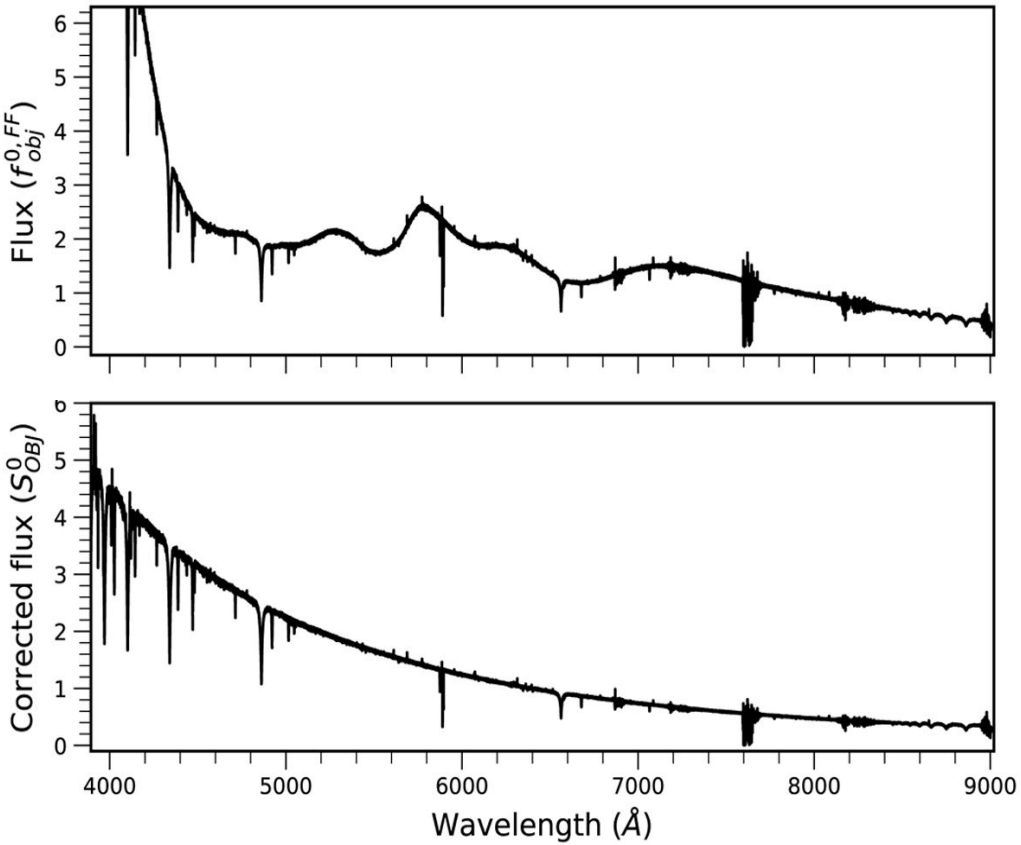
Raskins et al., 2011

How do we observe a binary: wavelength solution





How do we observe a binary: normalisation



Royer et al., 2024

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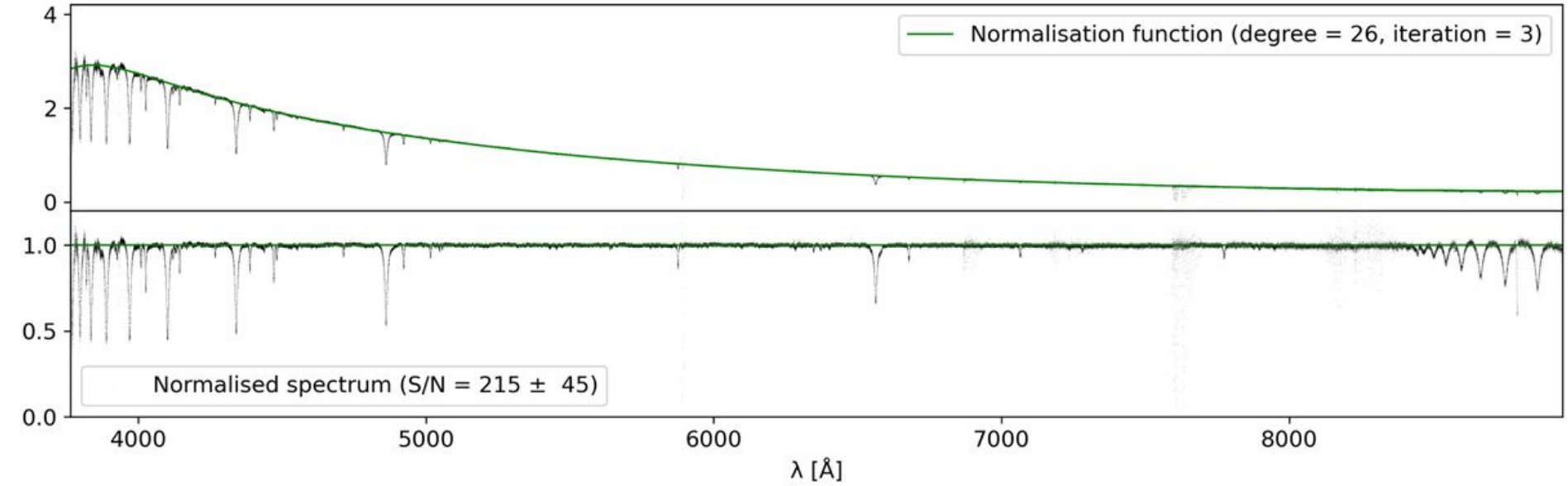

Royer et al., 2024

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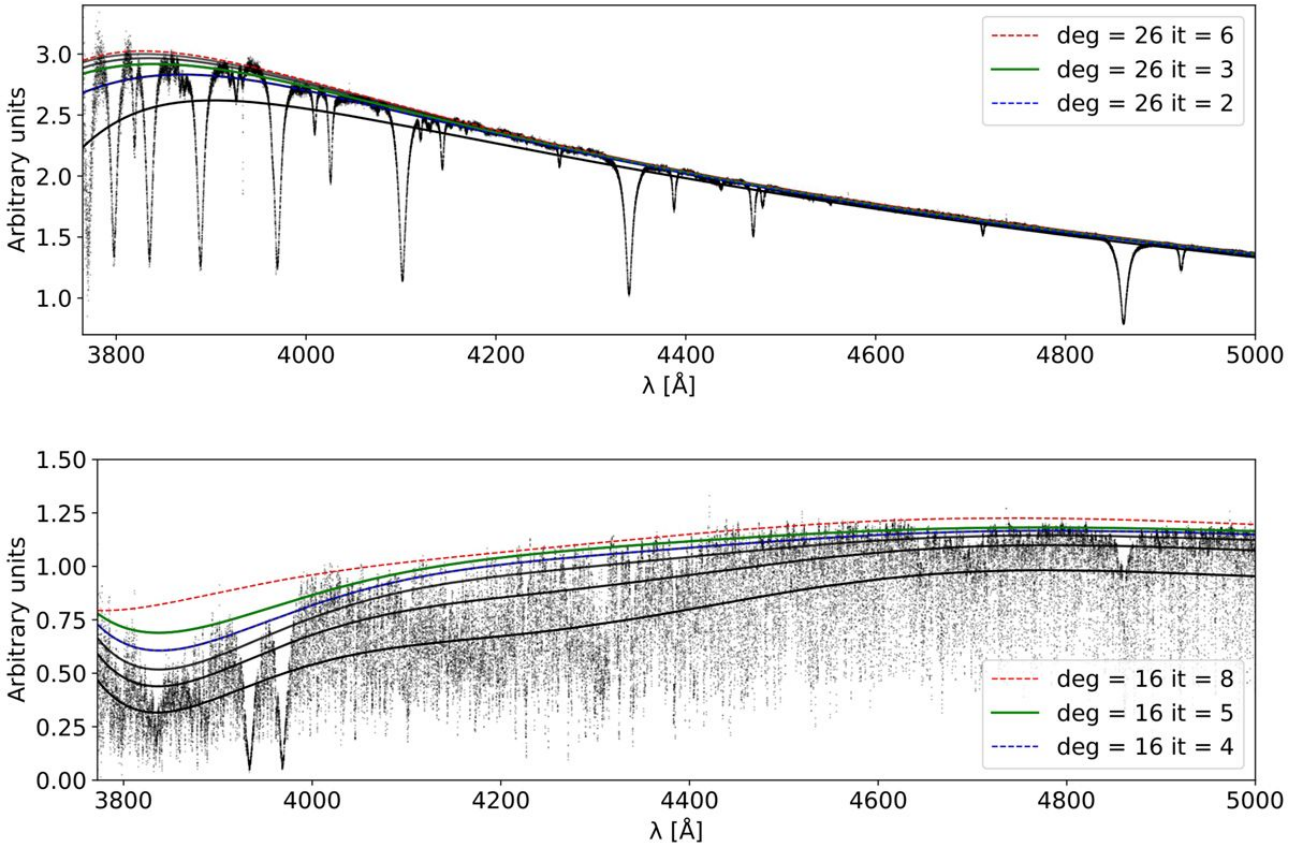


Royer et al., 2024

How do we observe a binary: atmosphere modelling

- What code do you use?
- What temperature / logg is your target?
- Grid based vs. ionisation balance?

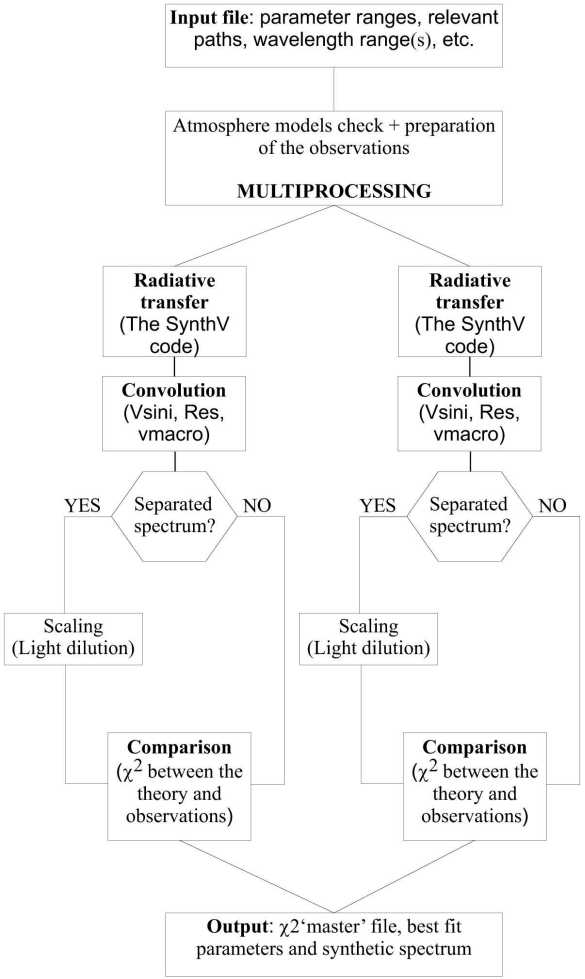
GSSP
LTE
Grid based (at first)

Royer et al., 2024

How do we observe a binary: atmosphere modelling

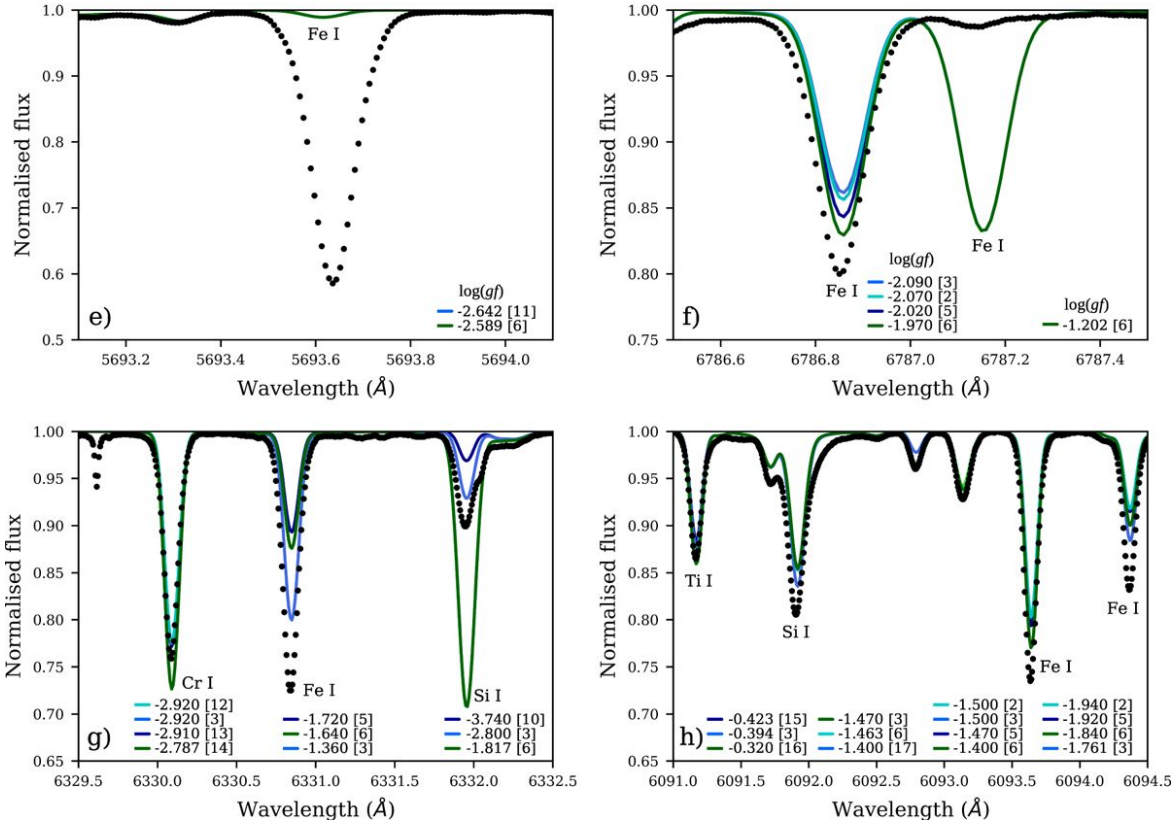
- line list + oscillator strength
- metallicity
- T_{eff} & log*g*
- micro-turbulence
- macro-turbulence
- vsini
- resolution

- wavelength range
- parameter range



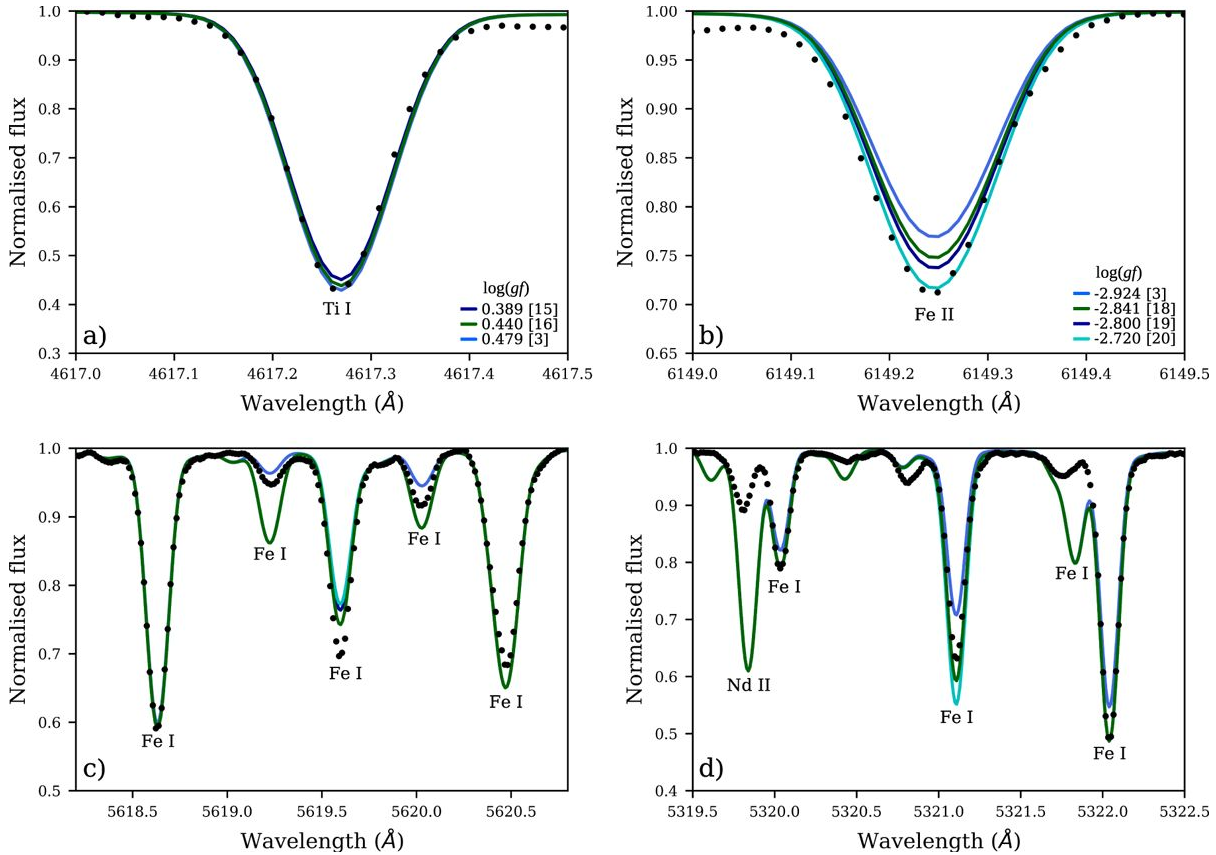
Tkachenko et al., 2015

How do we observe a binary: atmosphere modelling



Laverick et al., 2018

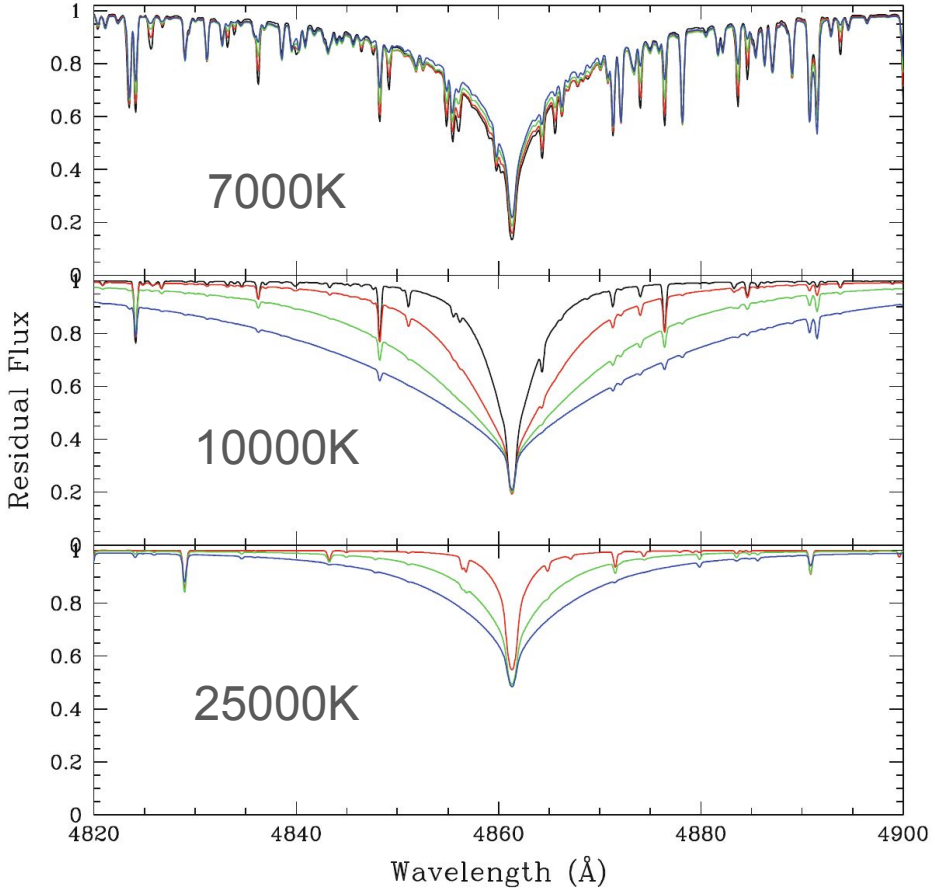
How do we observe a binary: atmosphere modelling



Laverick et al., 2018

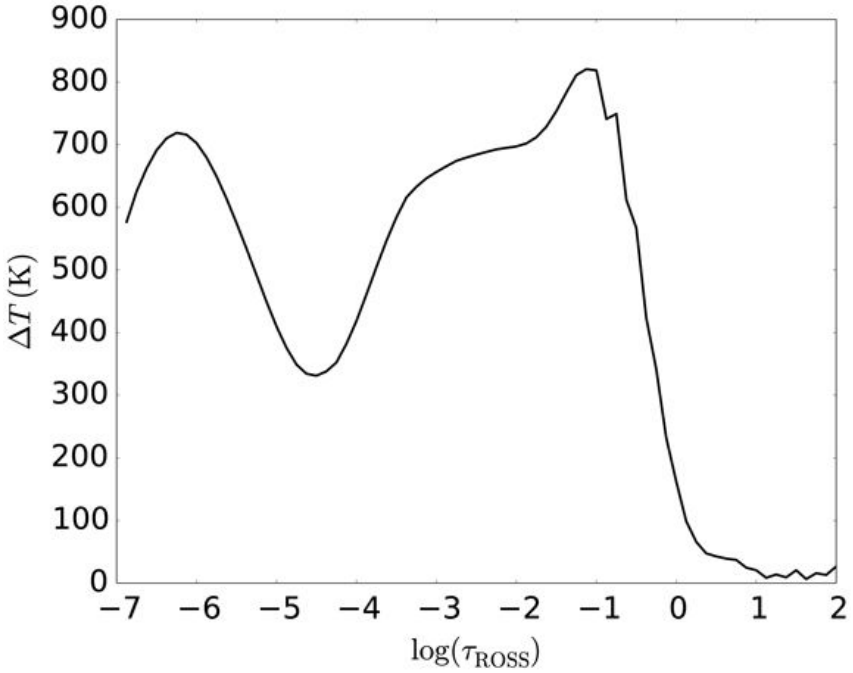
How do we observe a binary: atmosphere modelling

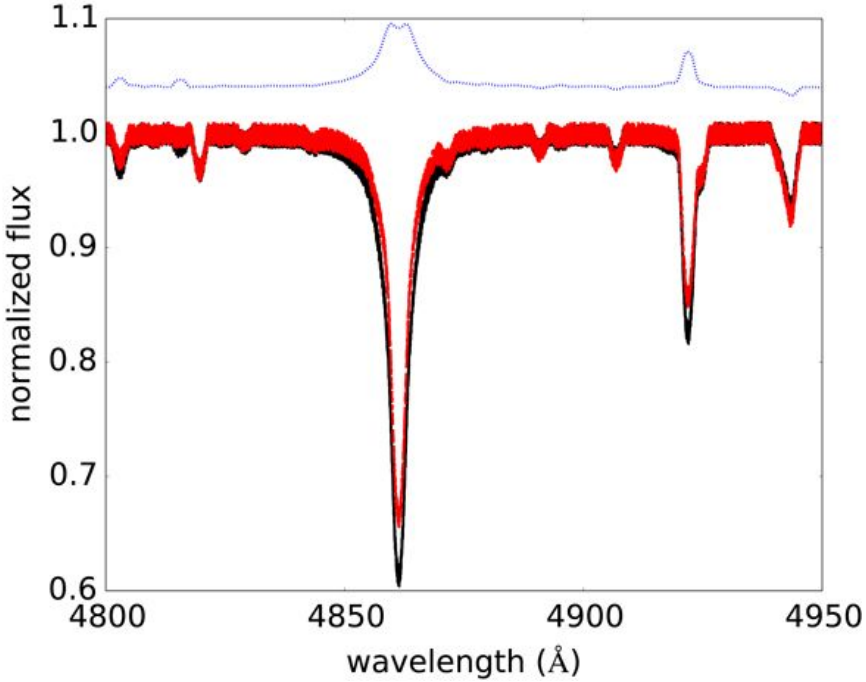
logg=2
logg=3
logg=4
logg=5



Catanzaro, 2014

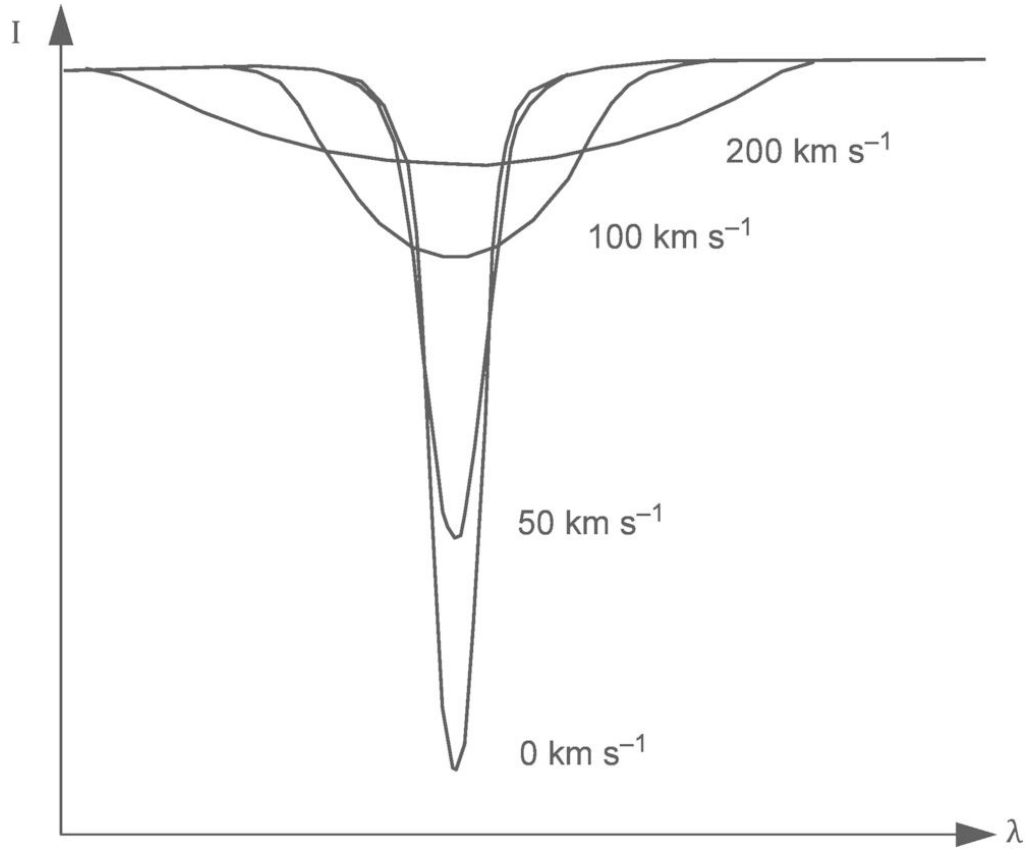
How do we observe a binary: atmosphere modelling





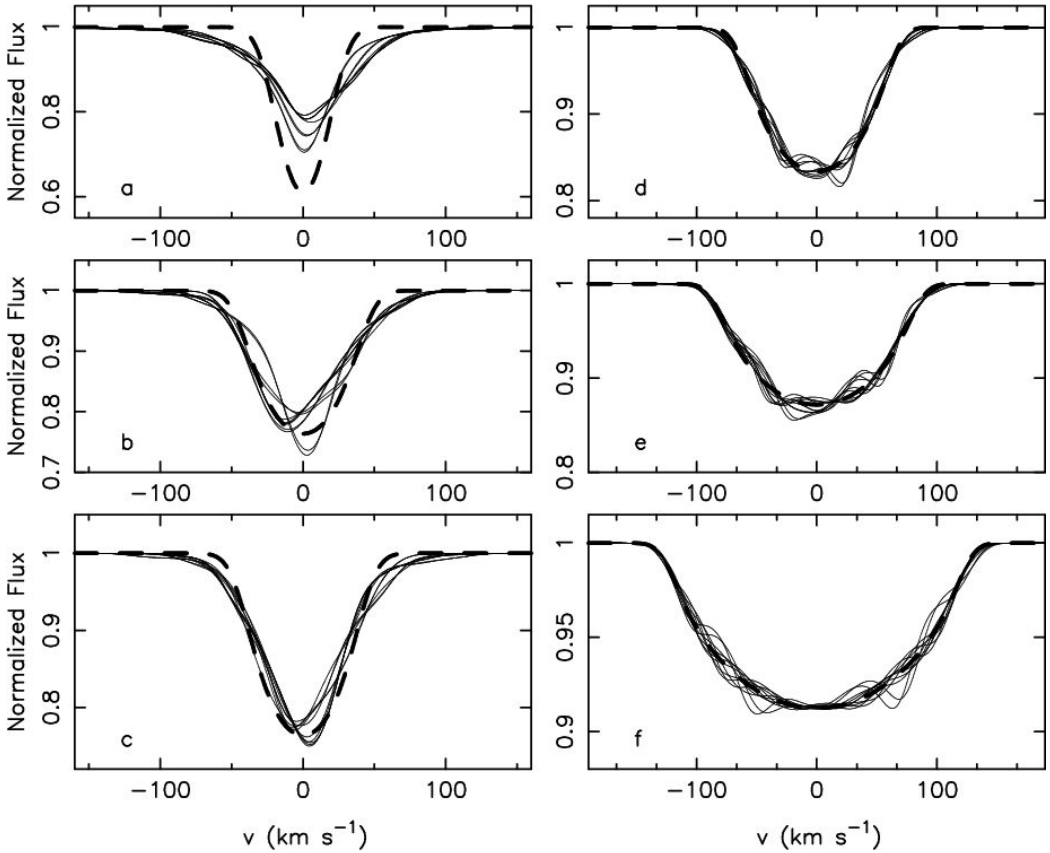
Tkachenko et al., 2020

How do we observe a binary: convolution & broadening



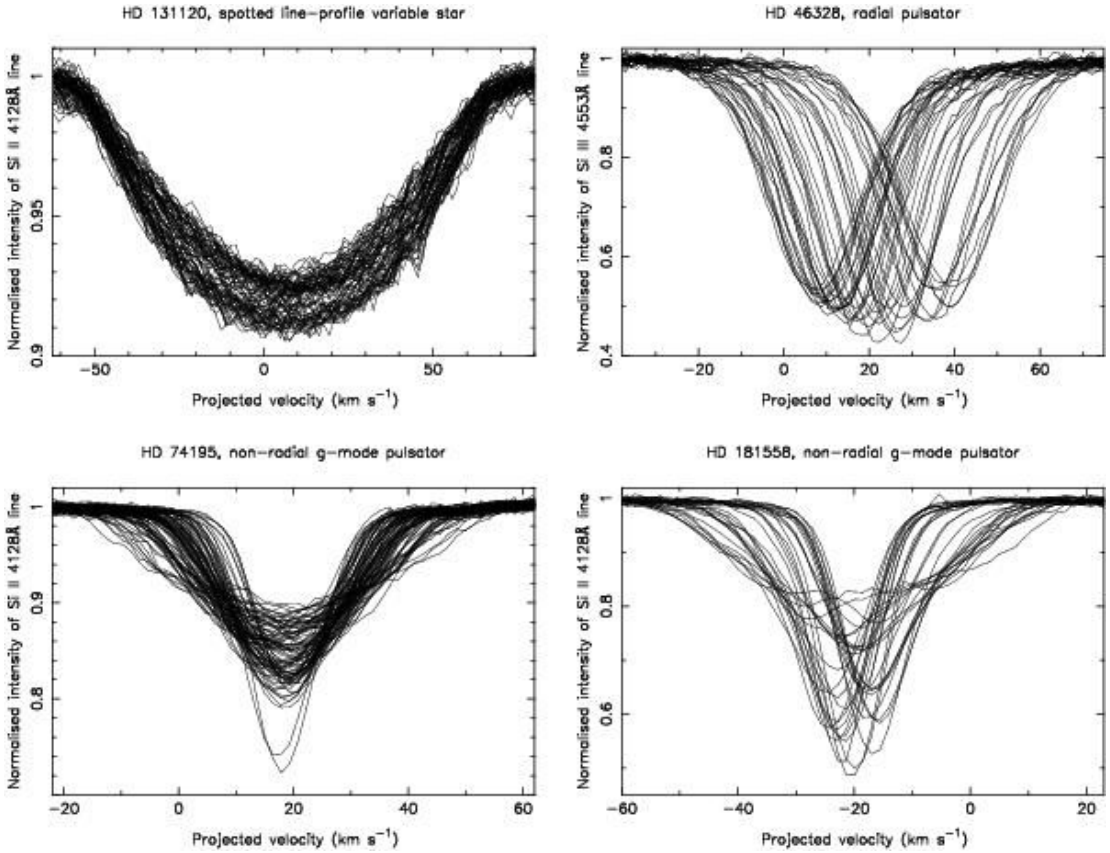
Trypsteen & Walker, 2017

How do we observe a binary: convolution & broadening



Aerts et al., 2009

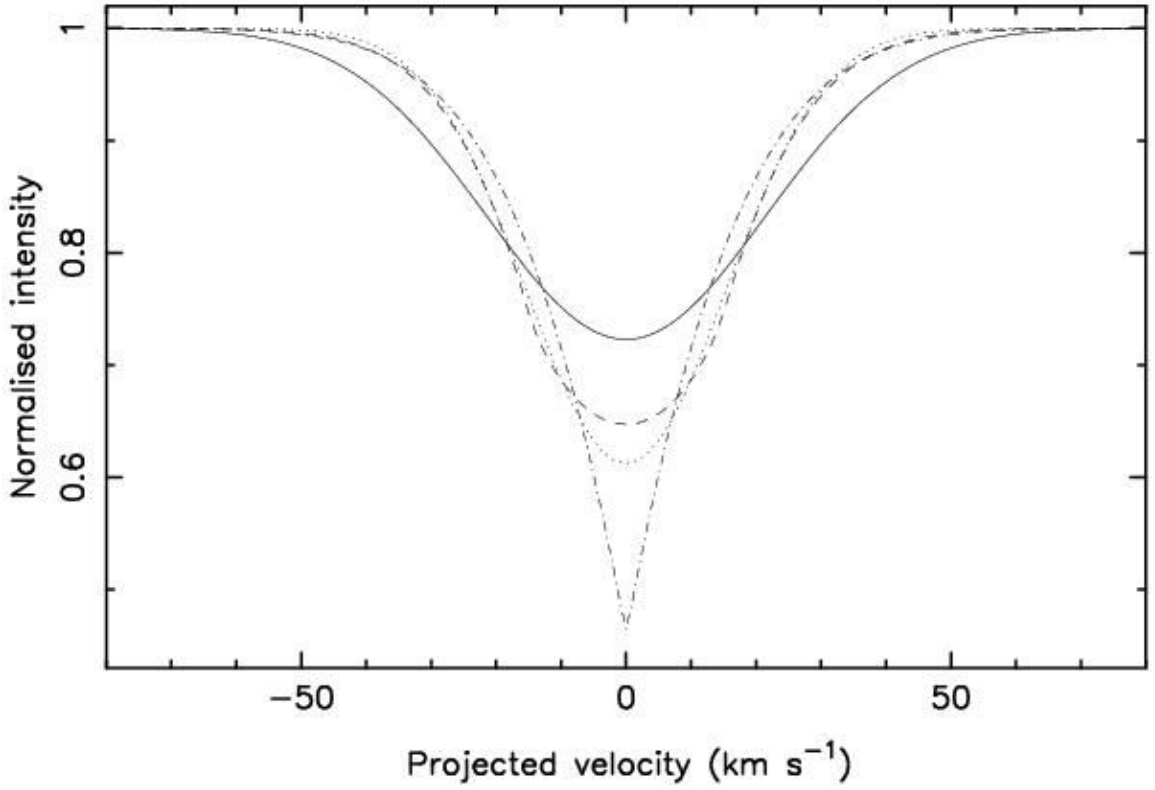
How do we observe a binary: convolution & broadening



Aerts et al., 2014

How do we observe a binary: convolution & broadening

- equal equivalent width
- $v\sin i$ = 15 km s^{-1}
- macroturbulent velocity = 20 km s^{-1}
- isotropic (full line)
- pure radial (dashed line)
- pure tangential (dashed-dot line)
- equal radial-tangential (dotted line)

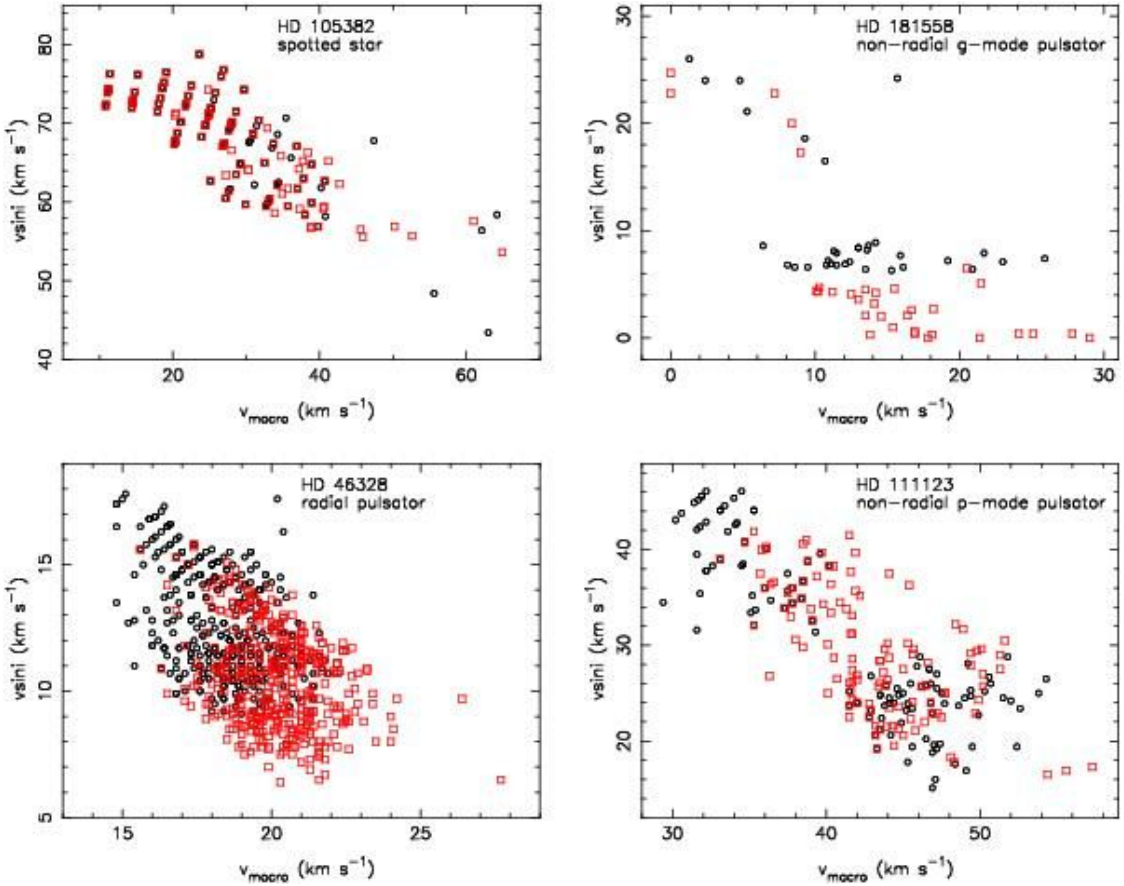


Aerts et al., 2014

How do we observe a binary: convolution & broadening

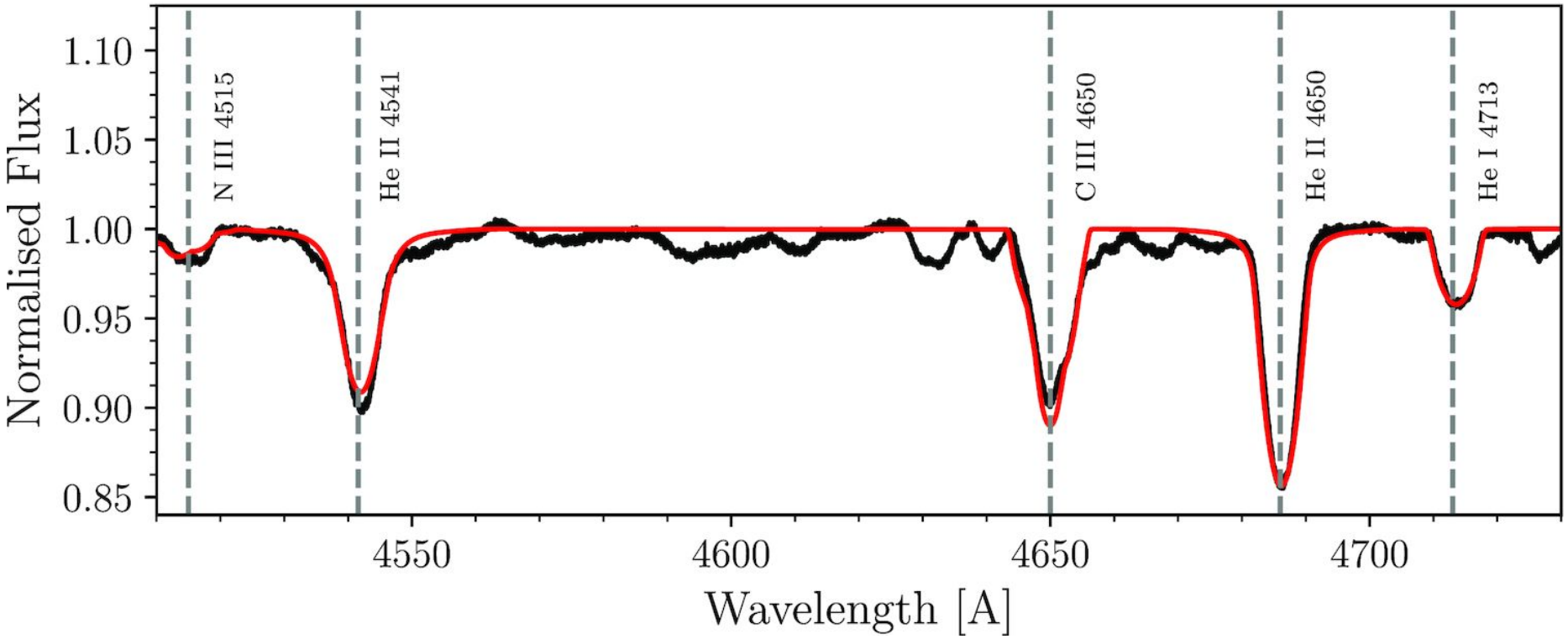
vsini is not uniquely measured!!!

$$v \sin i = \frac{2\pi R}{P_{rot}} \sin i$$



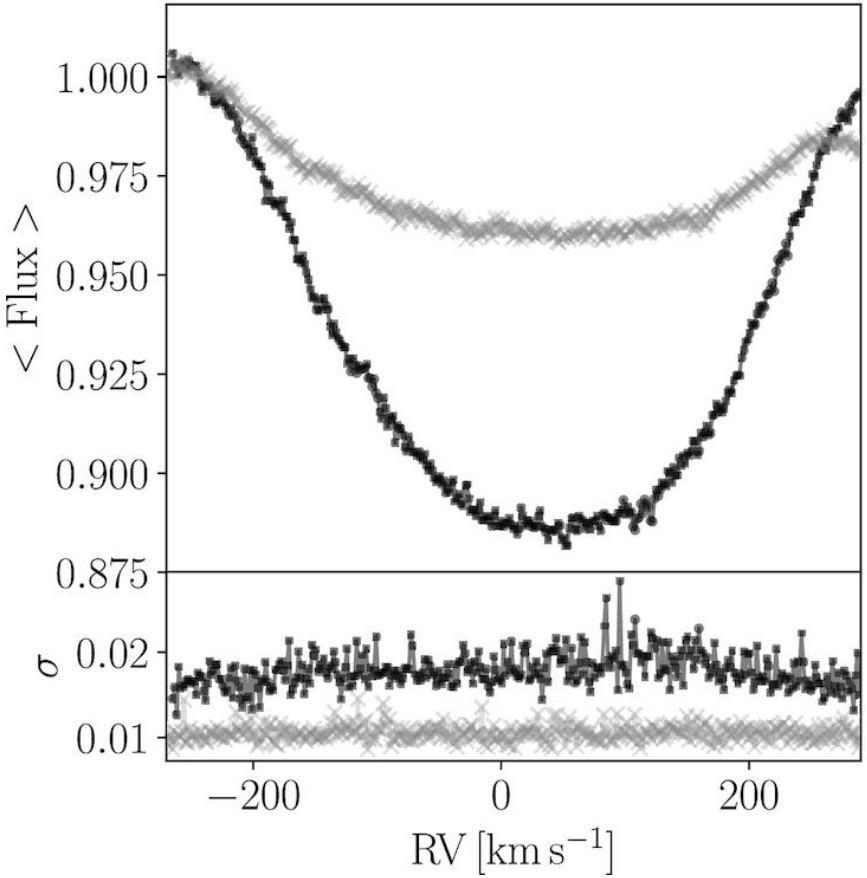
Aerts et al., 2014

How do we observe a binary: least squares deconvolution



Johnston et al., 2021b

How do we observe a binary: least squares deconvolution



Johnston et al., 2021b

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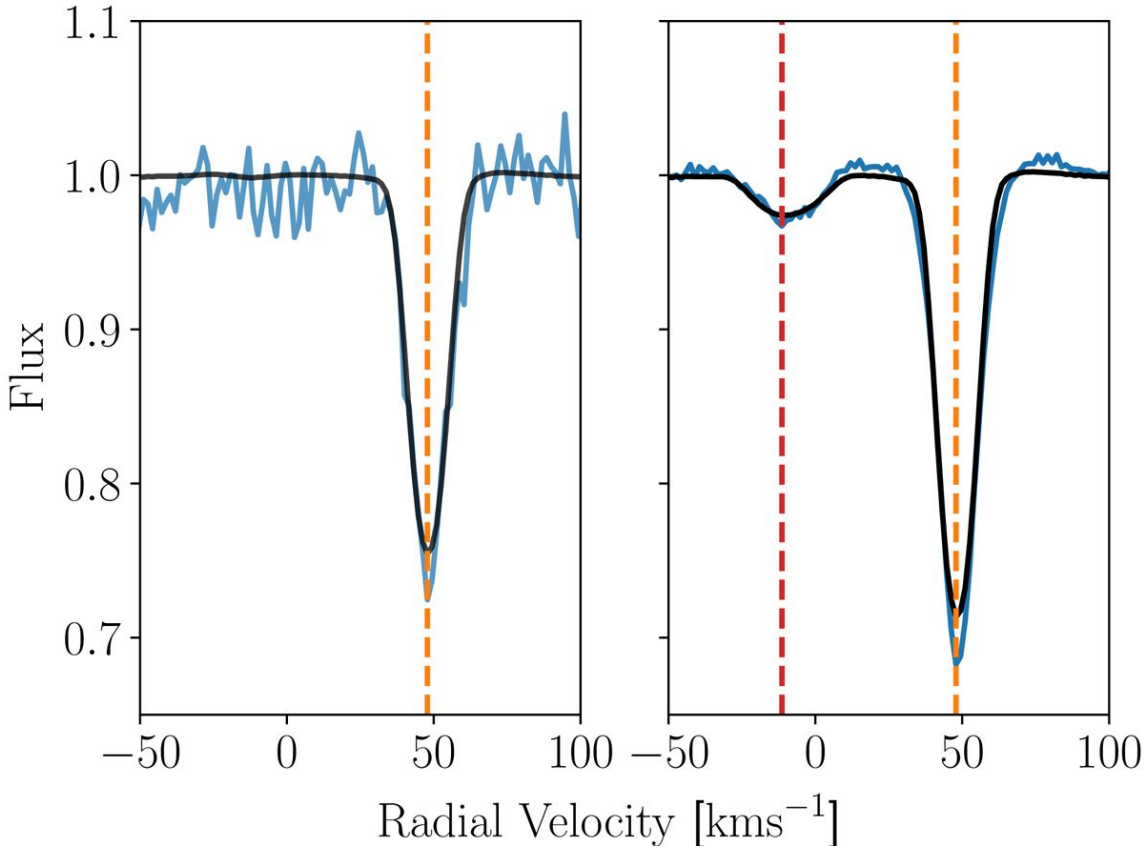
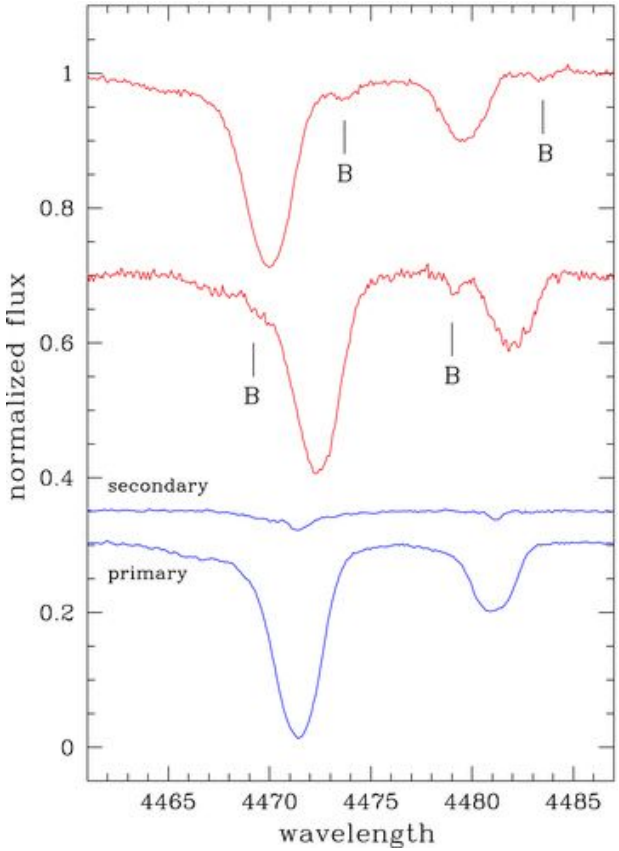


Sekaran et al., 2020a

How do we observe a binary: spectral disentangling



Pavlovski et al., 2015

RV fitting example ; go to: