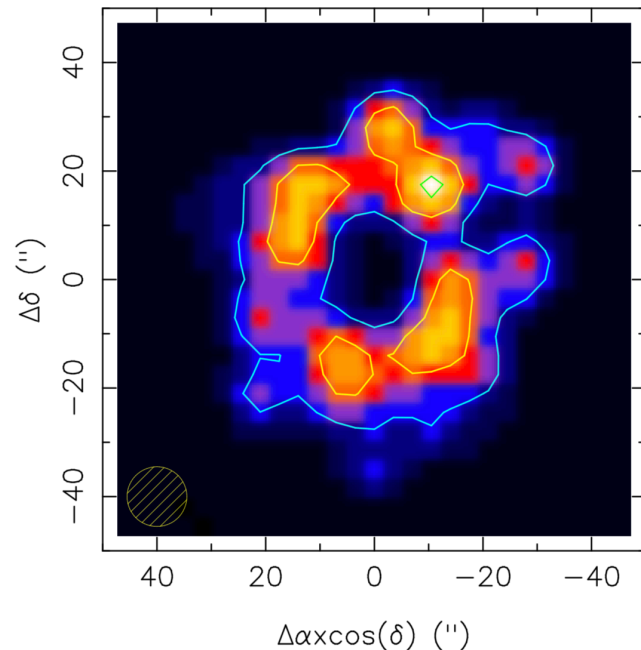


Activity & magnetism of ϵ Eridani observed with SPIRou, NARVAL, and TESS

P. Petit, C. Folsom, L. Yu, J.-F. Donati,
J. Morin, S. Marsden, A. Vidotto, S. Jeffers

ϵ Eridani

- Young Sun-like star with debris disc



Lestrade & Thilliez 2015

Parameter	Value	reference
Magnitude	V = 3.7	
	H = 1.75	
Spectral type	K2V	Valenti & Fischer 2005
Distance	3.2 pc	Van Leeuwen 2007
Effective temperature	5146 ± 30 K	Valenti & Fischer 2005
Mass	$0.856 \pm 0.08 M_{\odot}$	Valenti & Fischer 2005
Radius	$0.74 \pm 0.01 R_{\odot}$	Baines & Armstrong 2012
$v \sin i$	2.2 ± 0.04 km/s	Brewer+ 2016
P_{rot}	11.68 d	Donahue+ 1996
Inclination	$46 \pm 2^{\circ}$	Jeffers+ 2014
Age	440 Myr	Barnes 2007

ϵ Eridani

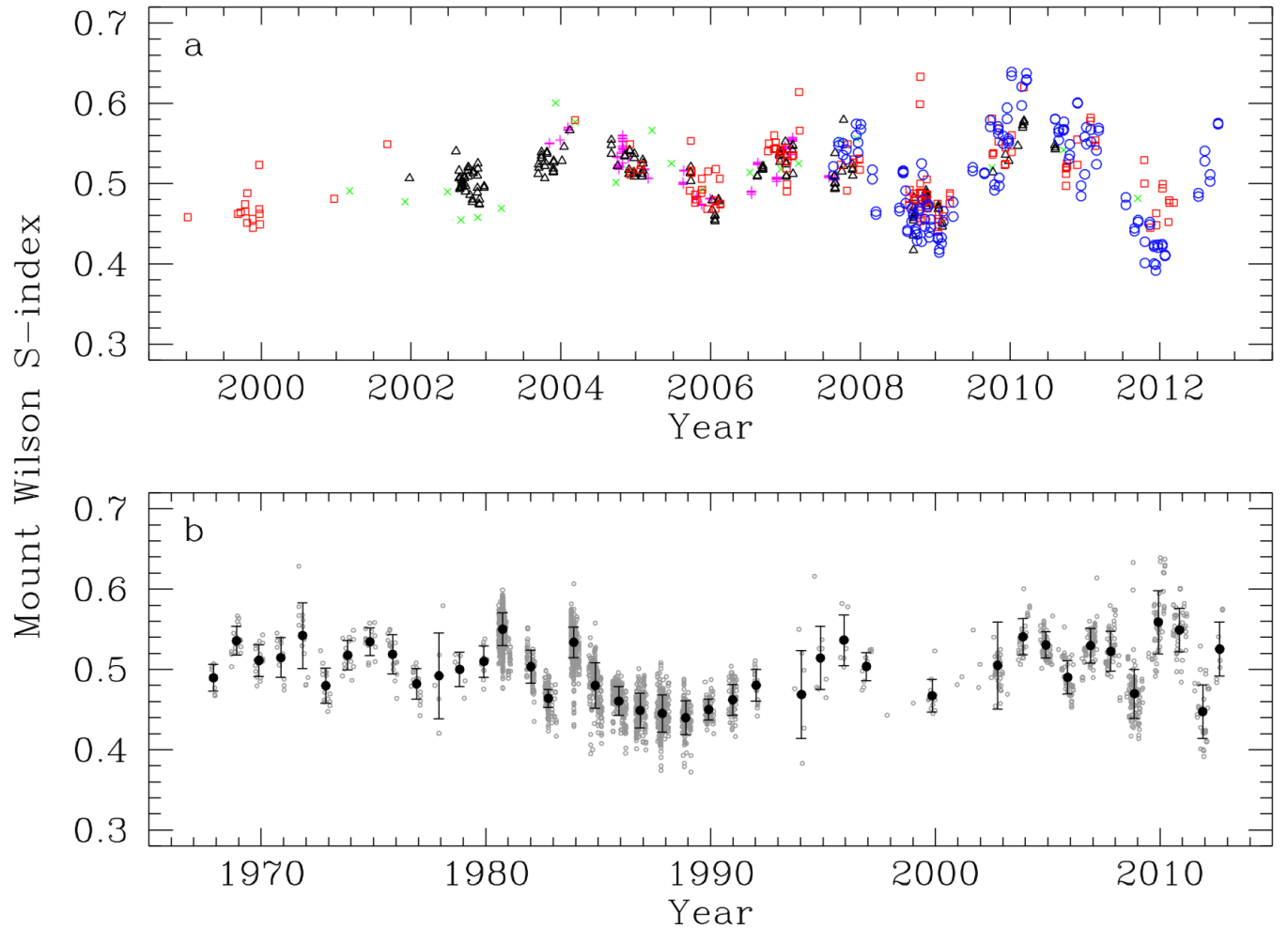
- Young Sun-like star with debris disc
- 2 planets

Planet	Mass	Period
B	1.55 M_J	2.5 d
C (unconfirmed)	0.1 M_J	102 d

Parameter	Value	reference
Magnitude	V = 3.7	
	H = 1.75	
Spectral type	K2V	Valenti & Fischer 2005
Distance	3.2 pc	Van Leeuwen 2007
Effective temperature	5146 ± 30 K	Valenti & Fischer 2005
Mass	$0.856 \pm 0.08 M_\odot$	Valenti & Fischer 2005
Radius	$0.74 \pm 0.01 R_\odot$	Baines & Armstrong 2012
$v \sin i$	2.2 ± 0.04 km/s	Brewer+ 2016
P_{rot}	11.68 d	Donahue+ 1996
Inclination	$46 \pm 2^\circ$	Jeffers+ 2014
Age	440 Myr	Barnes 2007

ϵ Eridani

- Young Sun-like star with debris disc
- 2 planets
- Magnetic cycle
 - Chaotic (Baliunas+ 1995)
 - 2.95 yr (Metcalf+ 2013)

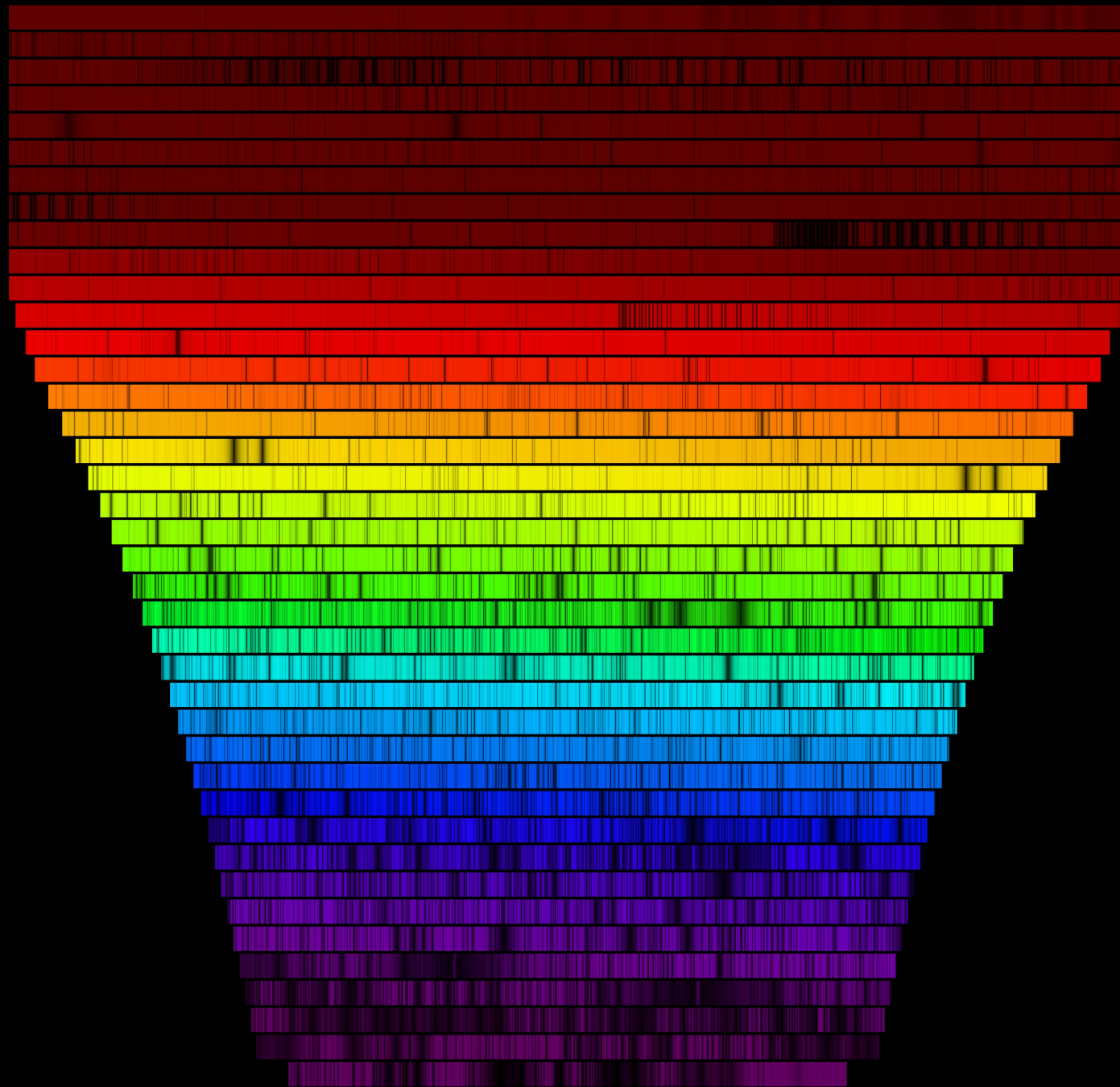


Observations

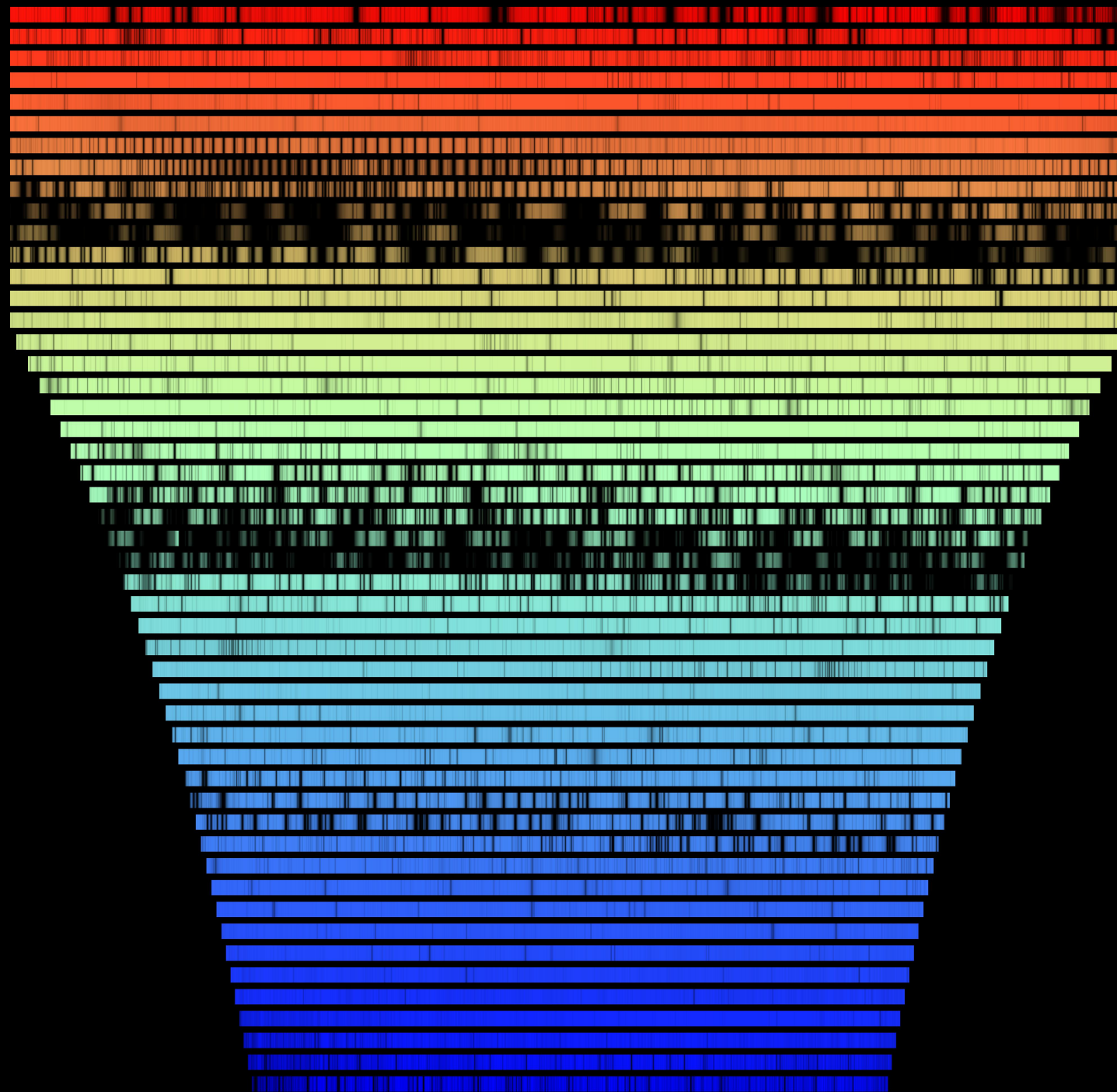
- SPIRou: 4 science verification spectra (21-25 Sept 2018)
- TESS: sector 4 (19 Oct - 15 Nov 2018)
- NARVAL: 20 Bcool spectra (18 Sept – 16 Nov 2018)



NARVAL spectrum



SPIRou spectrum
(with tellurics)



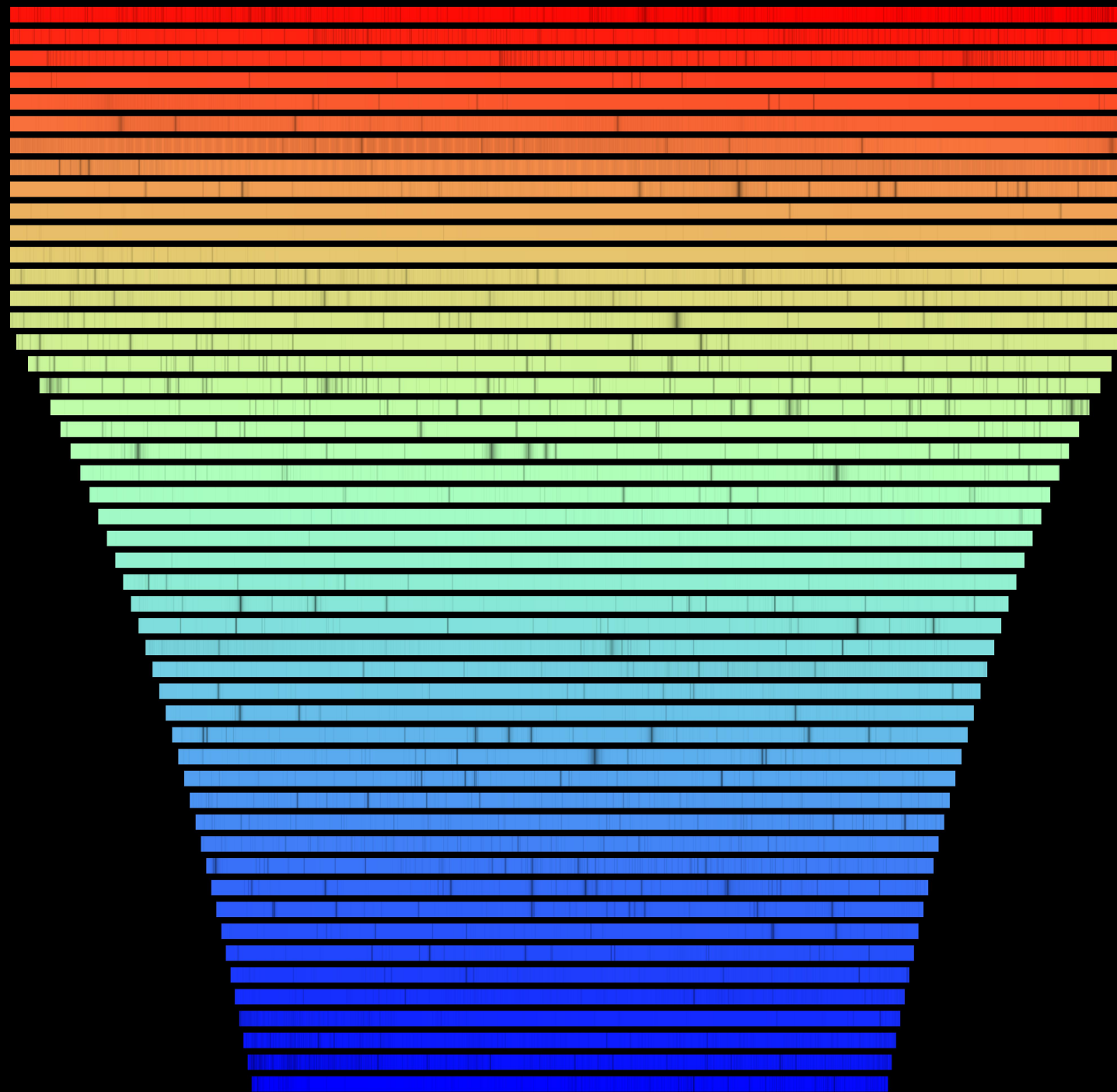
K

H

J

Y

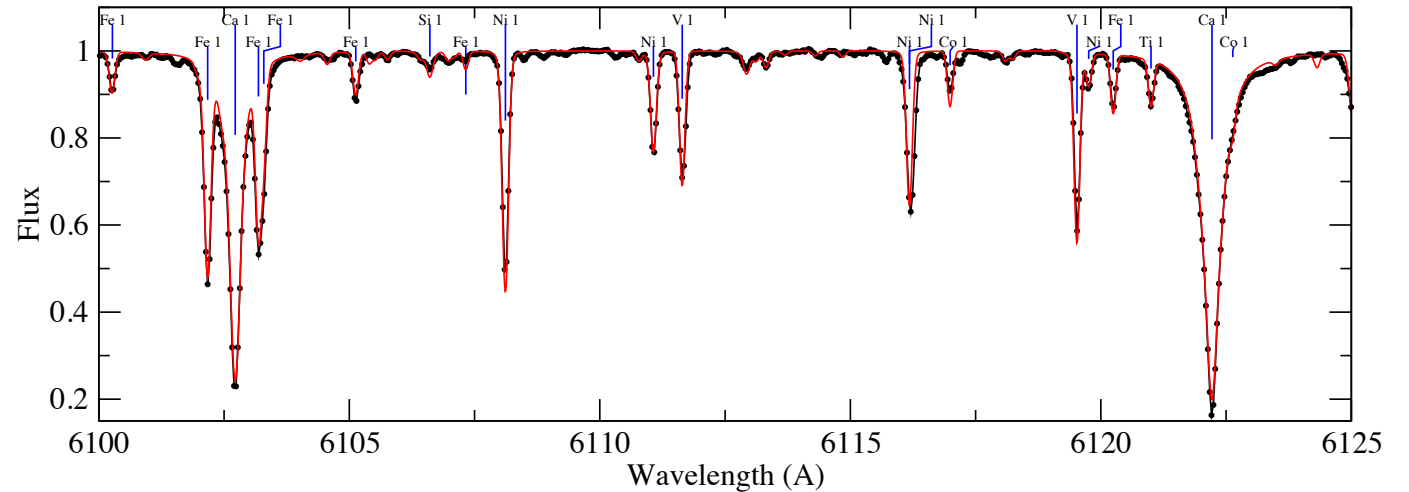
SPIRou spectrum
(without tellurics)



Fundamental Parameters

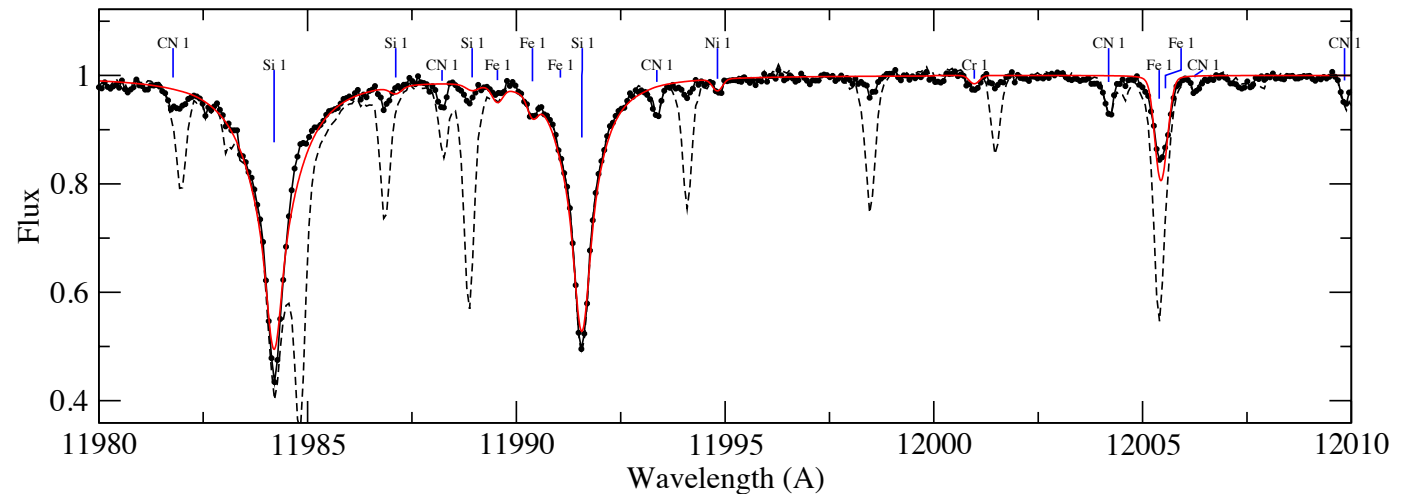
Optical values

Parameter	This study
T_{eff}	5035 ± 79 K
$\log g$	4.54 ± 0.07
$v \sin i$	2.87 ± 0.26 km/s
V_{mic}	0.99 ± 0.15 km/s
$[\text{Fe}/\text{H}]$	-0.08 ± 0.04



Infrared values

Parameter	This study
T_{eff}	5044 ± 69 K
$\log g$	4.47 ± 0.04
$v \sin i$	3.59 ± 0.7 km/s
V_{mic}	0.55 ± 0.33 km/s
$[\text{Fe}/\text{H}]$	-0.05 ± 0.06



Zeeman broadening

Free B / Free ff

B 1.9 ± 0.1 kG

Filling fac. 0.17 ± 0.02

consistent with [Valenti+ 1995](#)

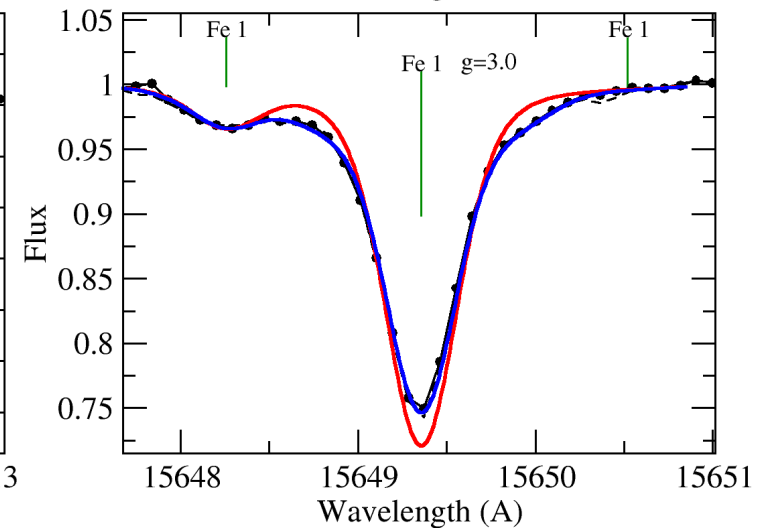
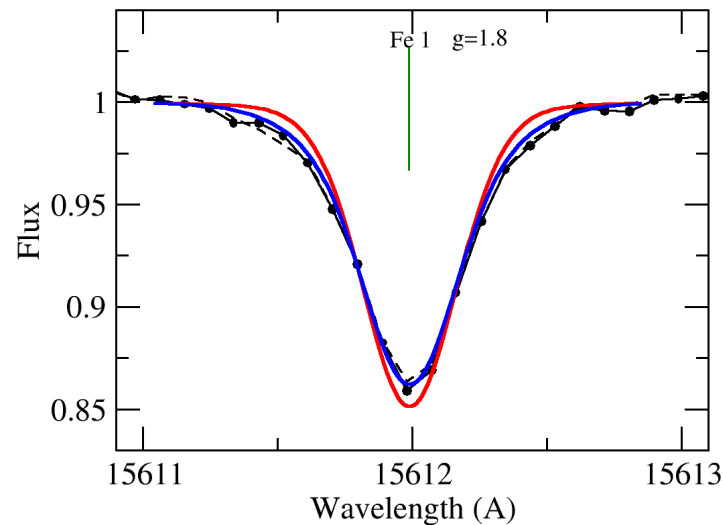
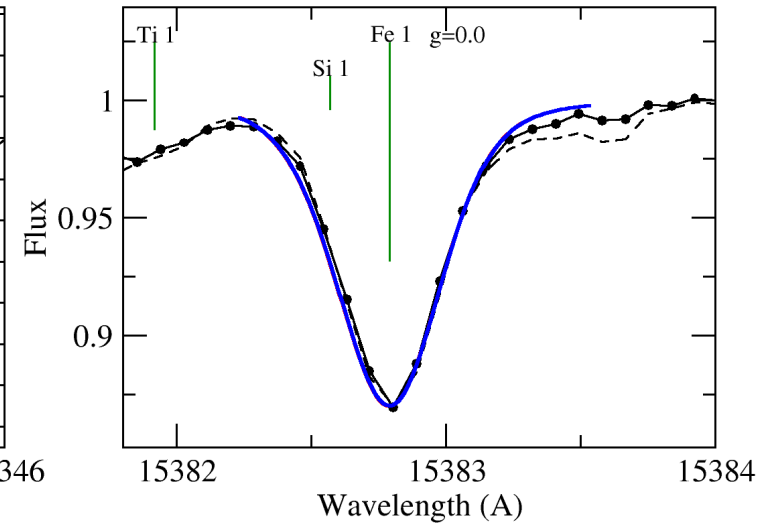
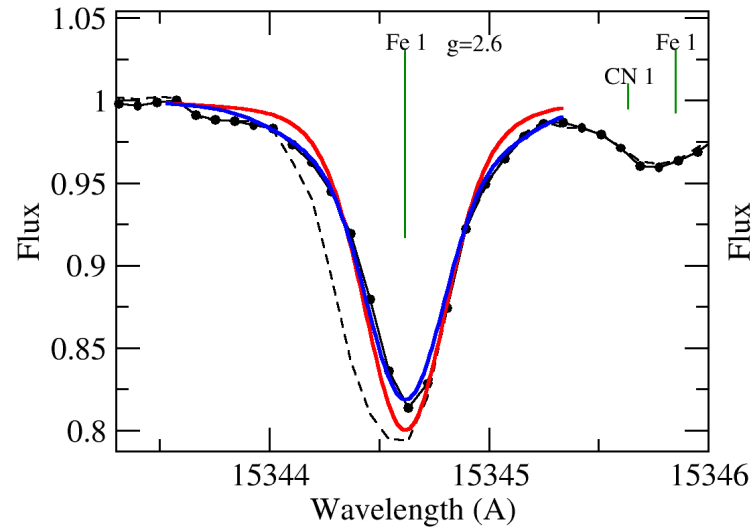
Fixed B / Free ff

ff (1 kG) 0.03 ± 0.6

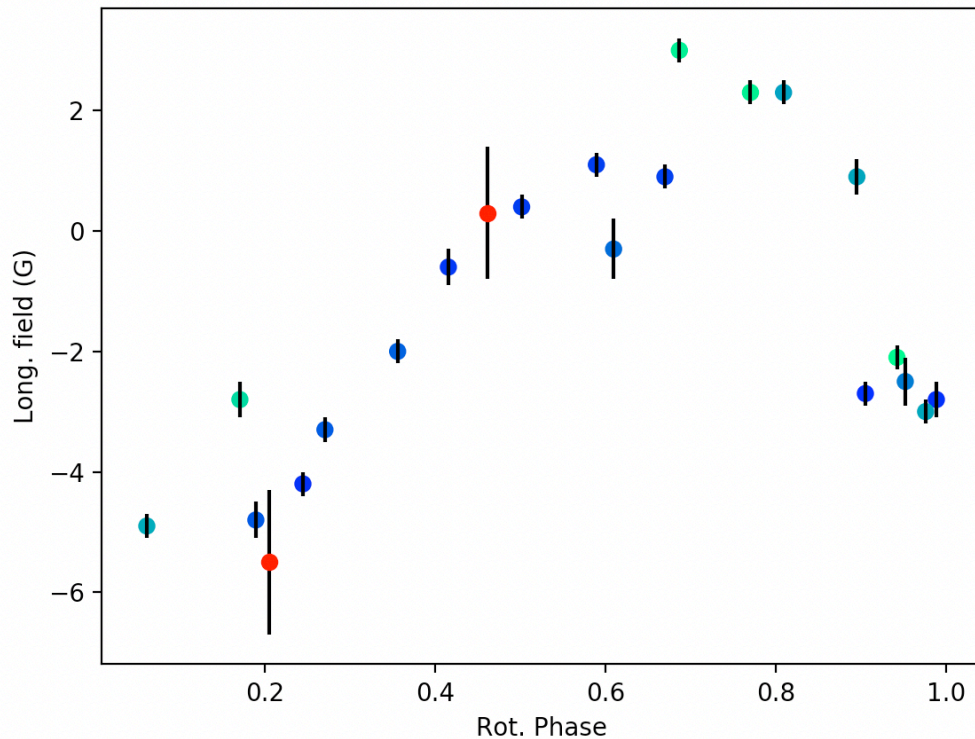
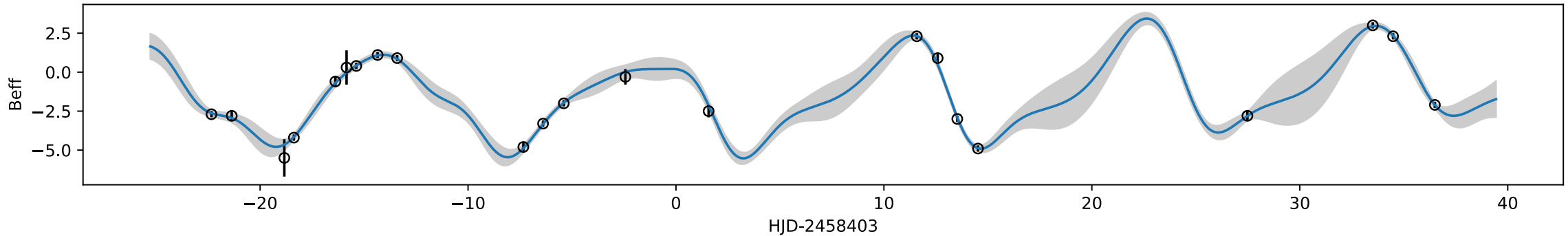
ff (2 kG) 0.16 ± 0.03

ff (3 kG) 0.01 ± 0.02

(No detection in NARVAL spectra)



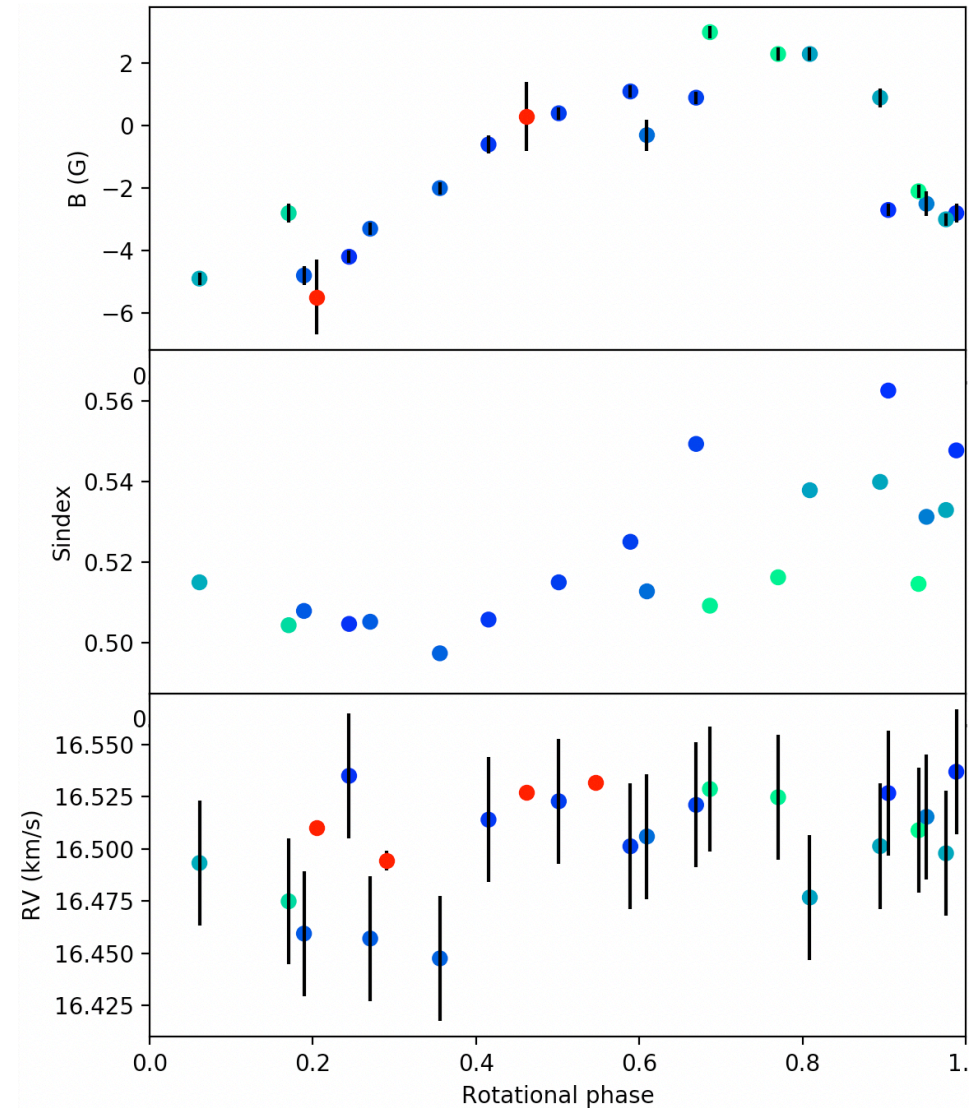
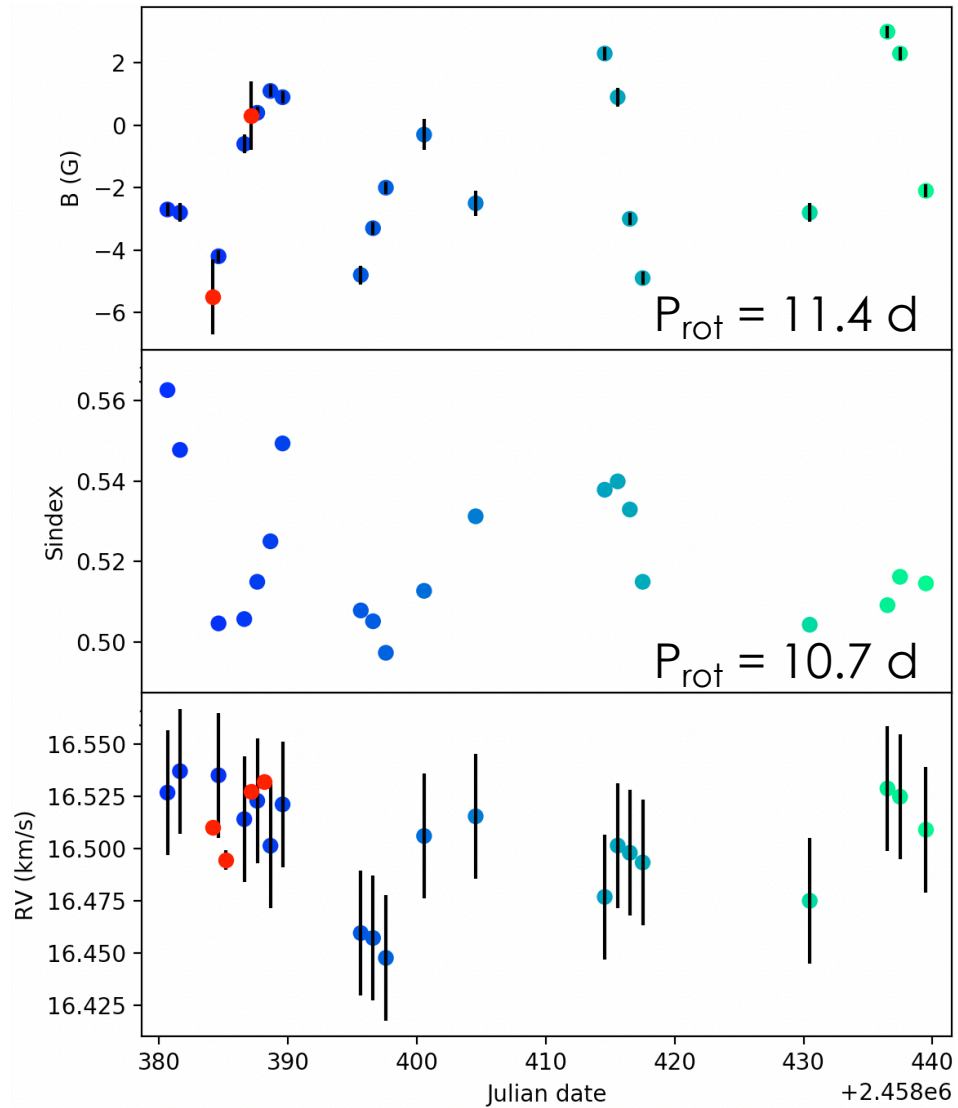
Longitudinal magnetic field



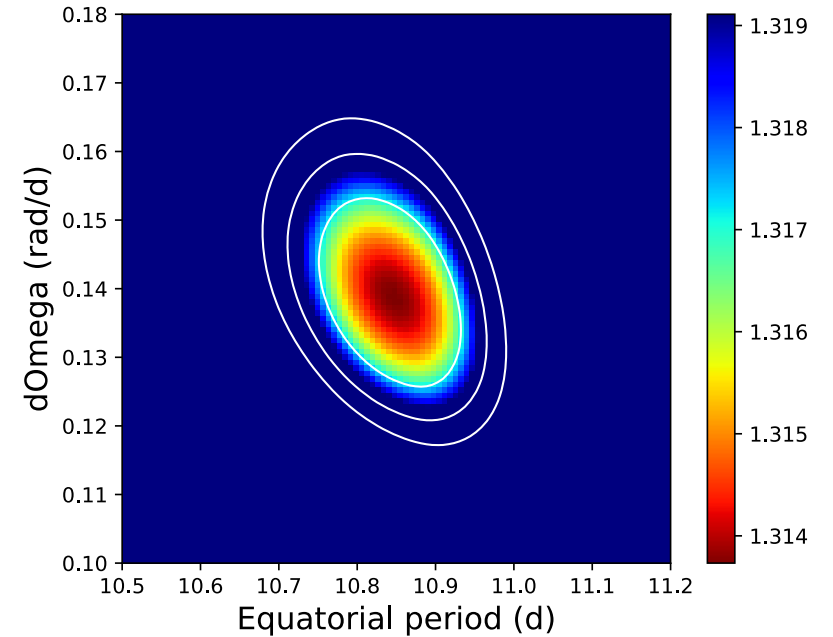
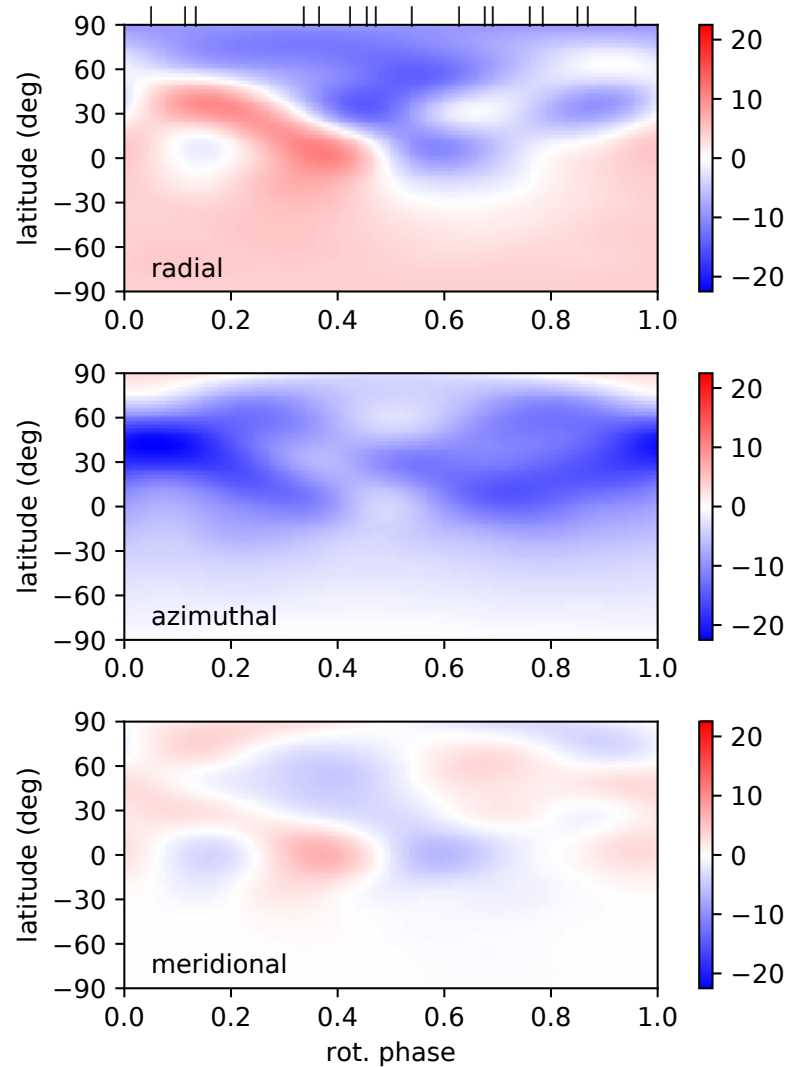
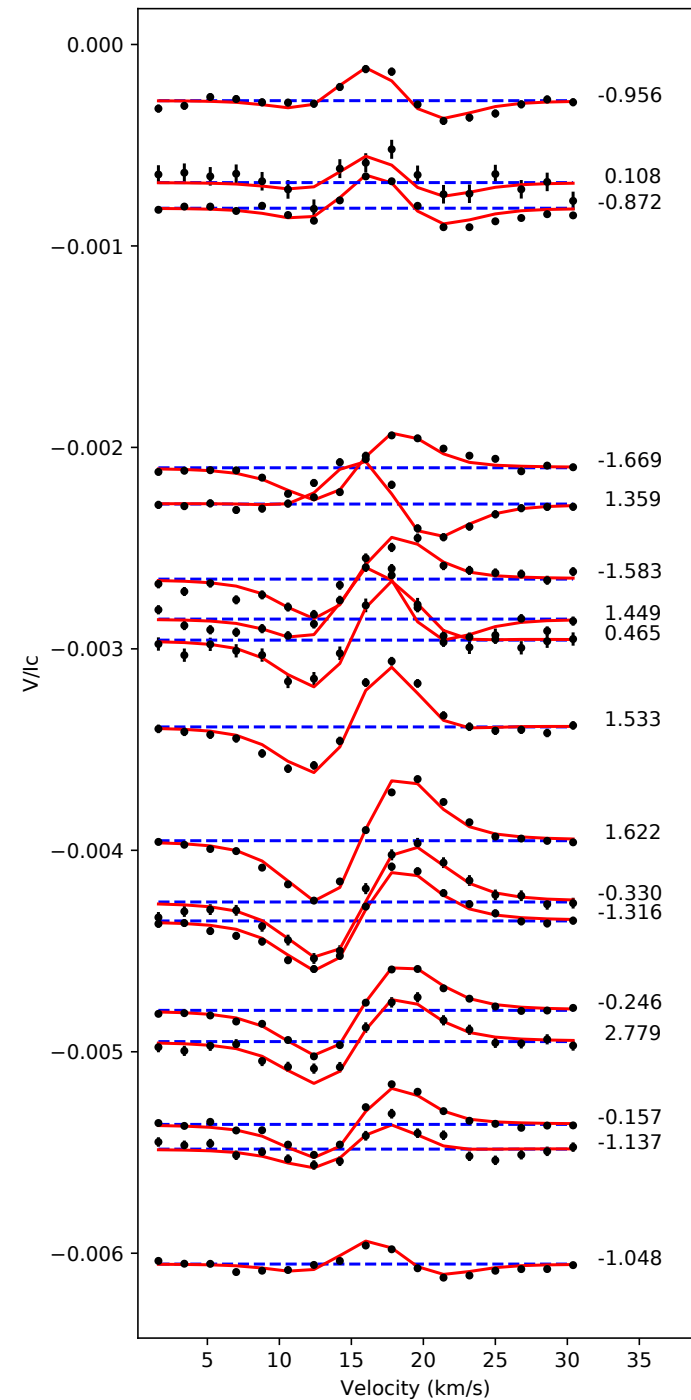
Gaussian process regression:

- $P_{\text{rot}} = 11.4 \pm 0.3 \text{ d}$
- Decay time = $31 \pm 9 \text{ d}$

Other activity proxies



Large-scale field geometry

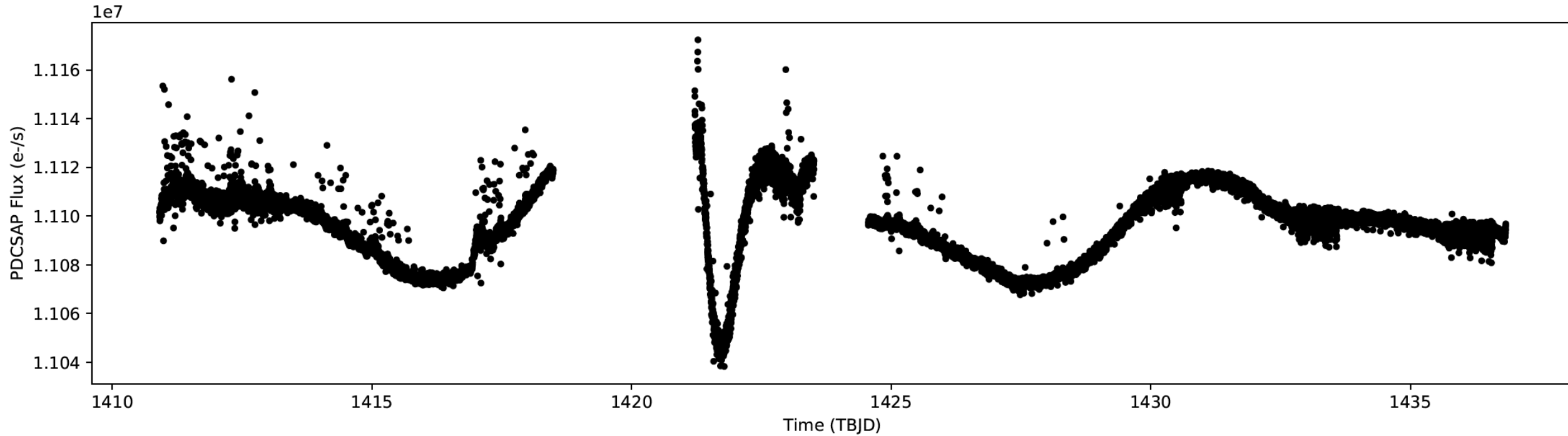


Differential rotation x3 solar

- **laptime ~ 45 d**
- 30% smaller than **Jeffer+ 2014**

TESS photometry

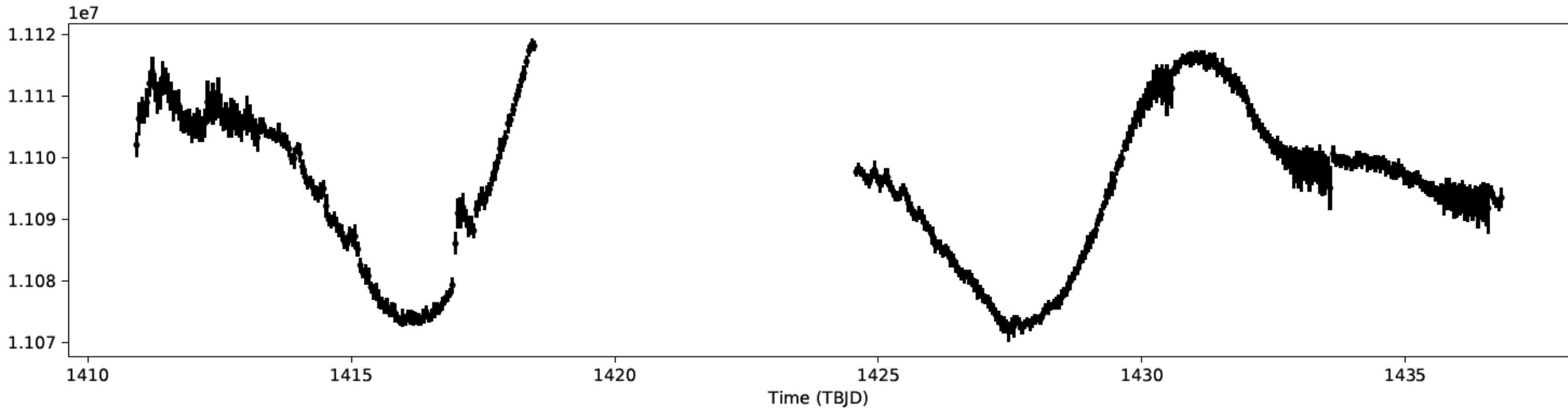
eps Eri Light Curve - Sector 4



- Observations interrupted twice
- Sharp variations between interruptions
(also seen on neighbouring stars \rightarrow instrumental effect)

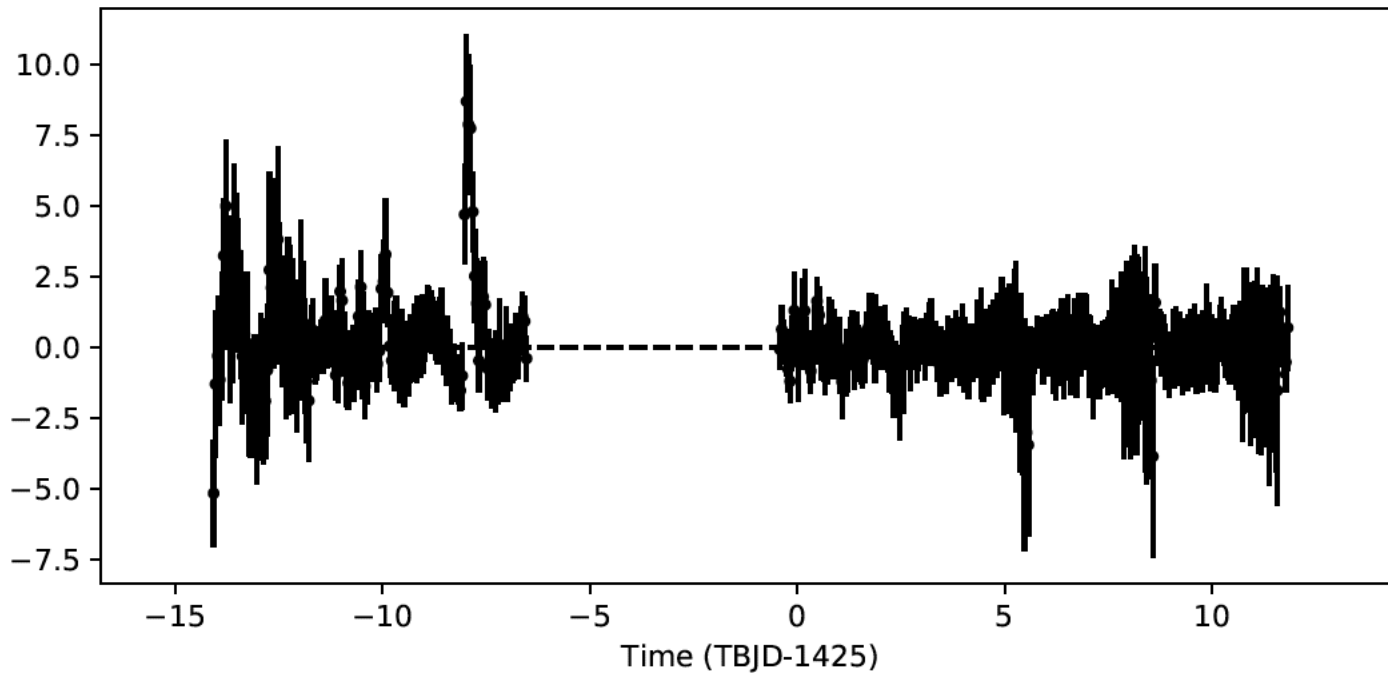
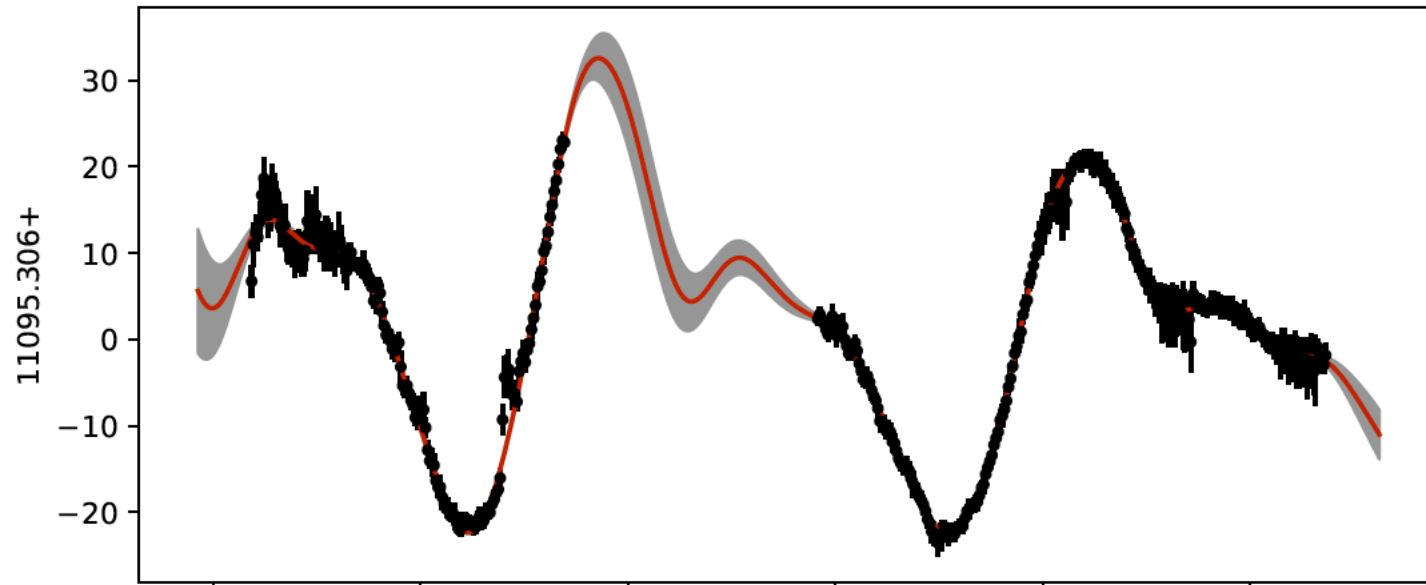
TESS photometry

Curated data:



- Observations interrupted twice
- Sharp variations between interruptions
(also seen on neighbouring stars → instrumental effect)

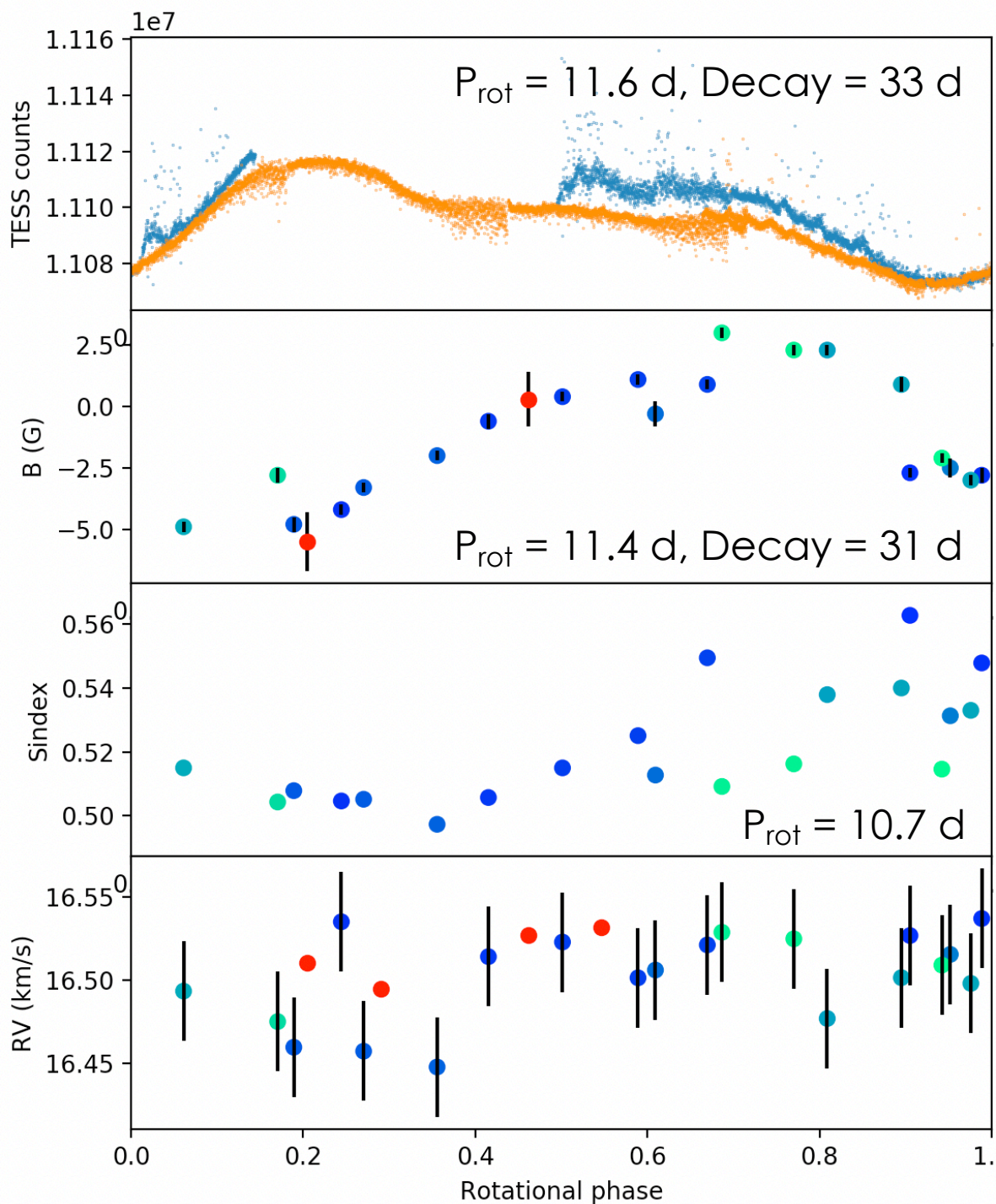
TESS photometry



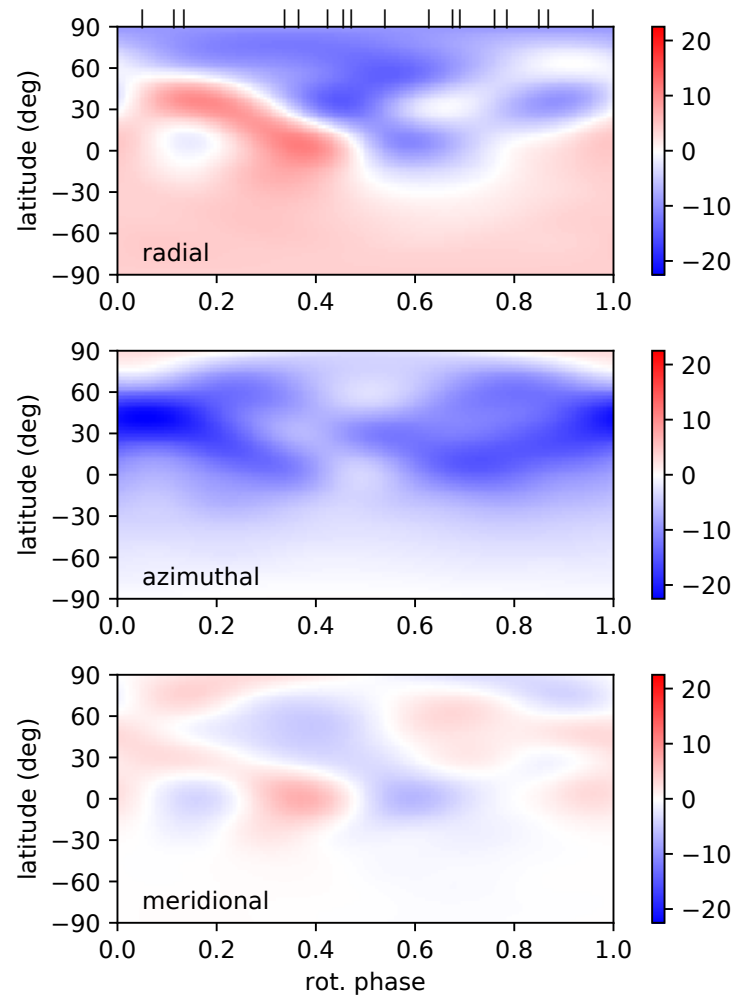
Gaussian process regression:

- $P_{\text{rot}} = 11.6 \pm 0.2 \text{ d}$
- Decay time = $33 \pm 10 \text{ d}$

At a glance



$P_{\text{eq}} = 10.8 \text{ d}, \text{laptime} = 45 \text{ d}$



Conclusions

- SPIRou measurement of fundamental parameters
→ promising for stars plagued by spots in VIS domain
- SPIRou able to measure Zeeman broadening in moderately active stars (many lines available)
- ESPaDOnS+SPIRou in parallel would be great!