

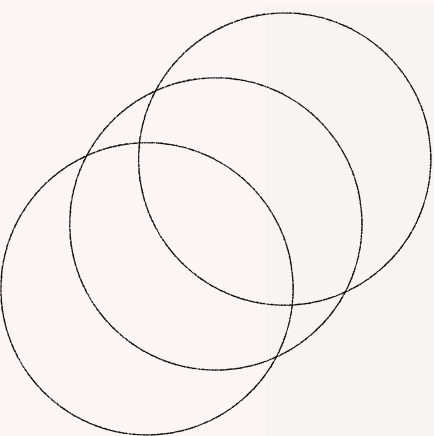
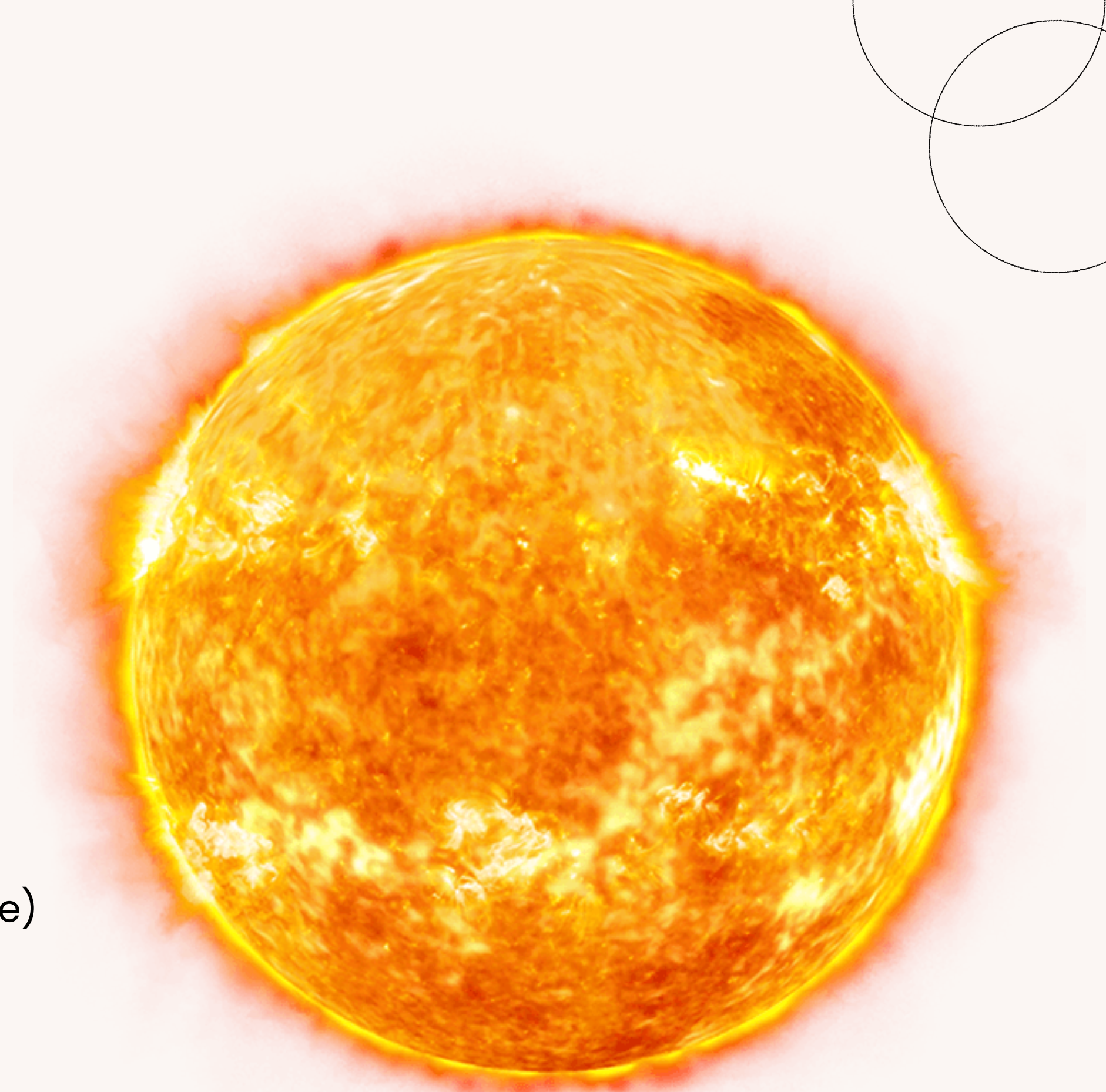
Presented By : **Manon Diez**

Second year PhD student

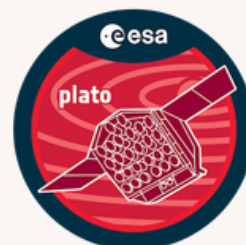
Magnetic geometry of M dwarfs in the southern PLATO field

Thesis supervisors

Julien Morin (LUPM Montpellier) & Pascal Petit (IRAP Toulouse)



UNIVERSITÉ
DE MONTPELLIER



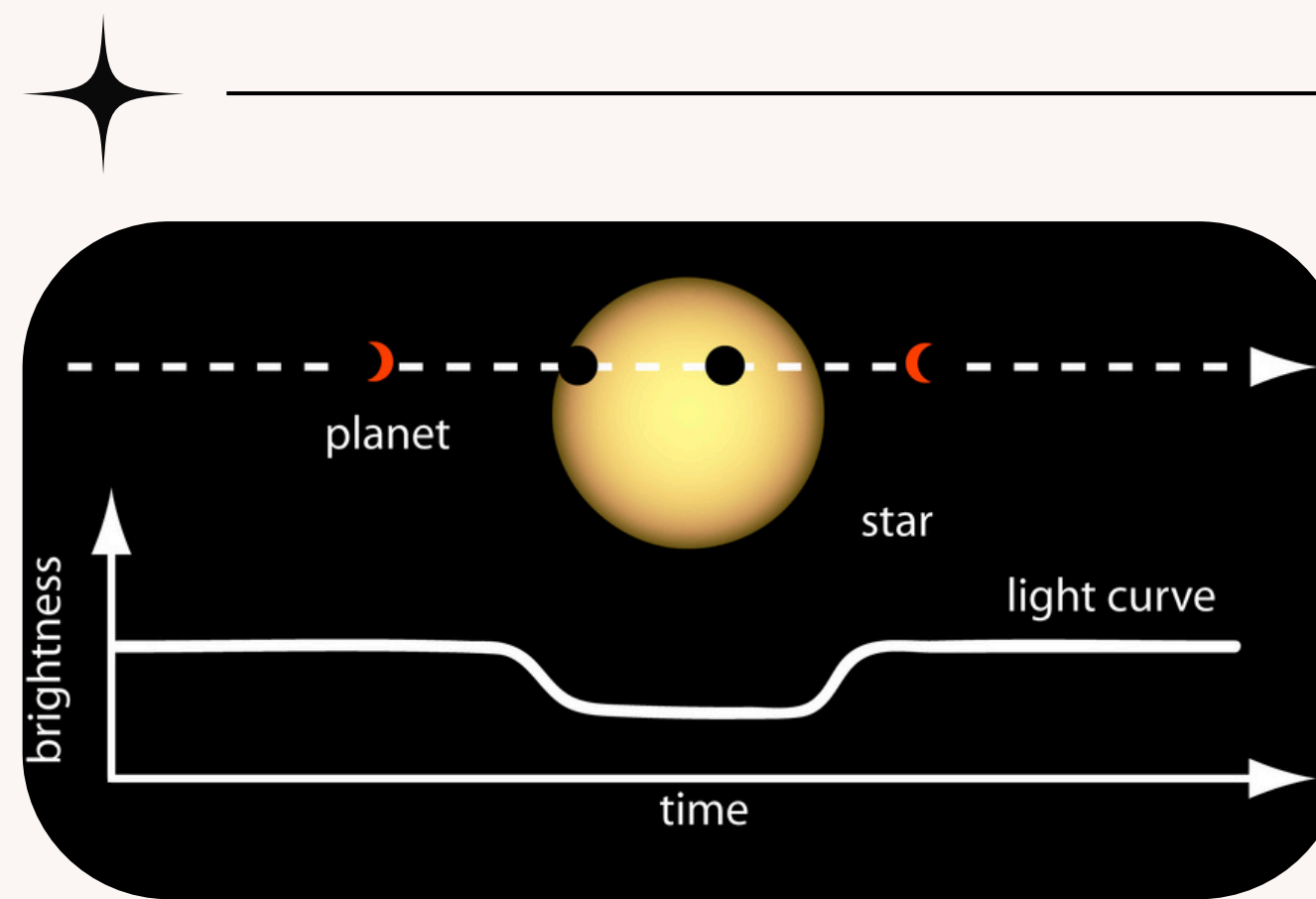
Journées 2026 de la SF2A (Grenoble)



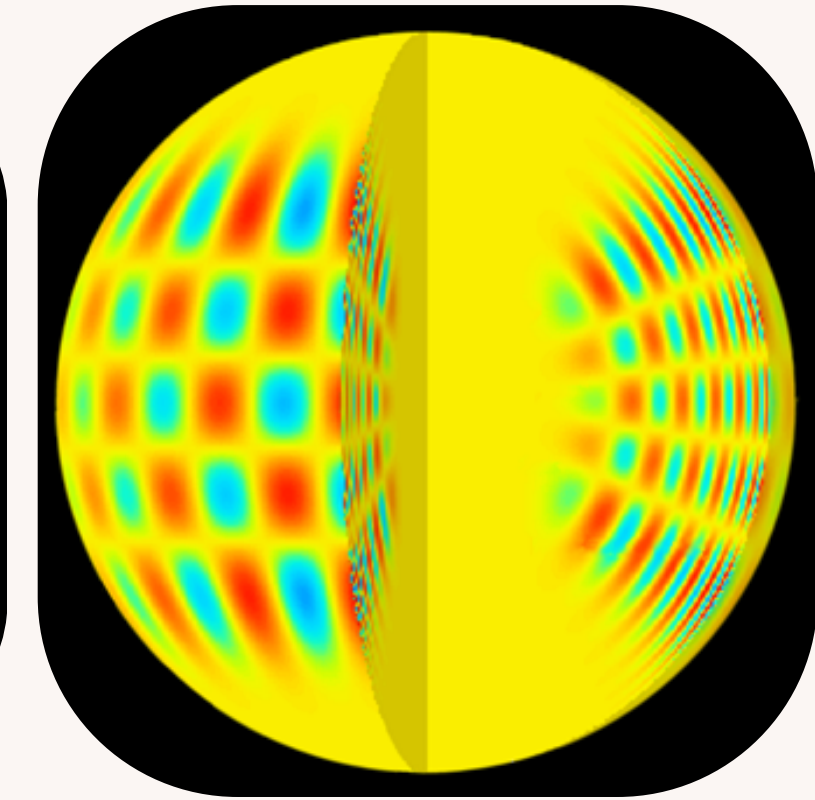
I- Context

PLATO Mission :

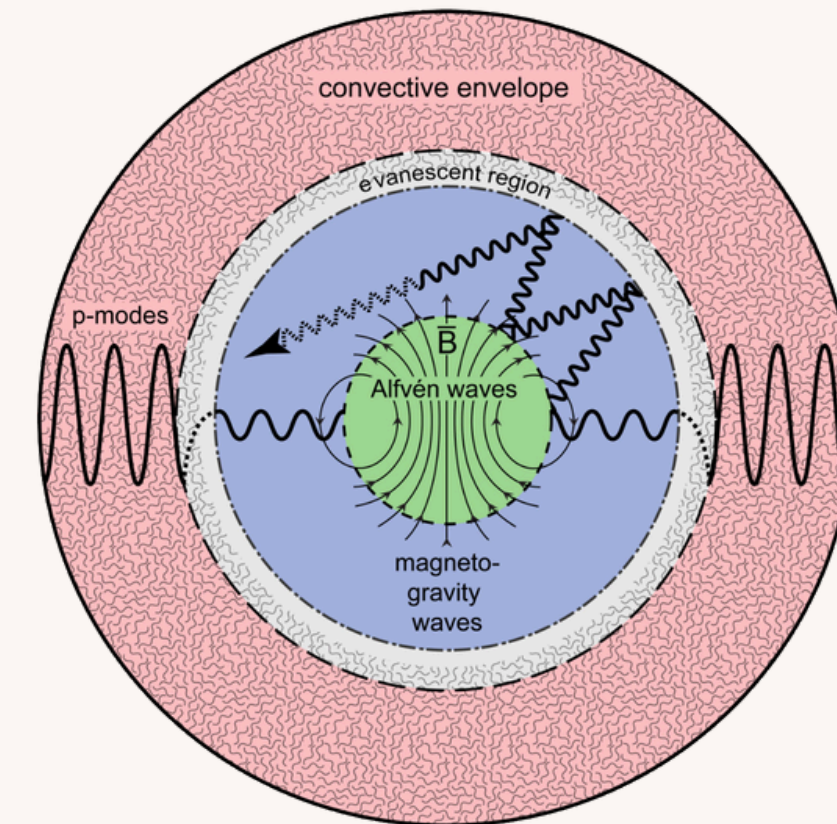
- ESA (European Spatial Agency)
- Launching in early 2027
- Photometry:
 - ↳ Detection of planets by the transit method
 - ↳ Stellar seismology
- 2 fields of view (North and South)



NASA Ames



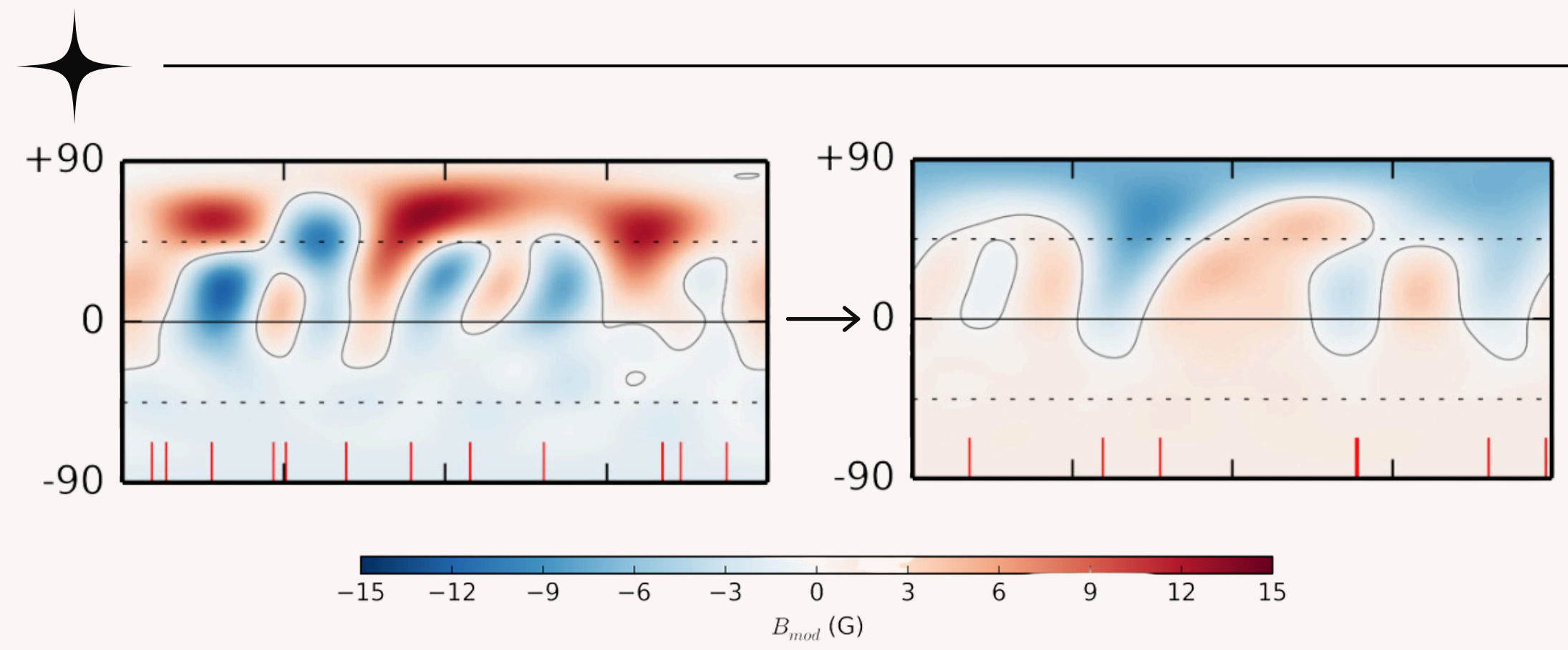
Héliosismologie : wikipédia



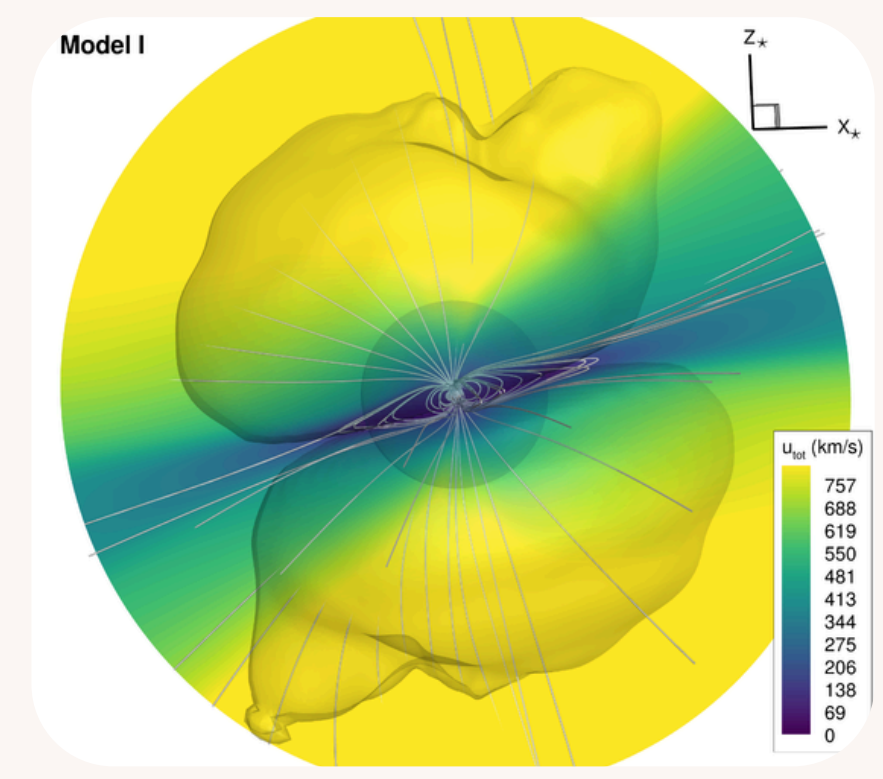
I- Context

Spectropolarimetry :

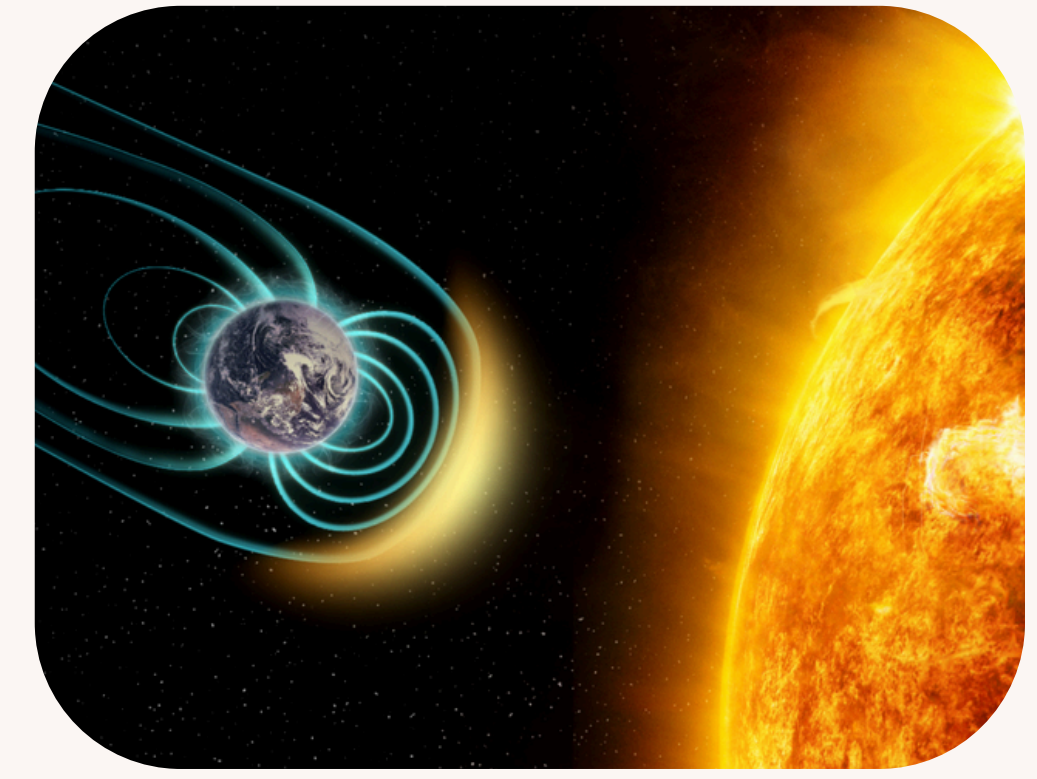
- ↳ Surface magnetic field measurement
- ↳ Differential rotation
- ↳ Wind-planet interaction



M. W. Mengel et al. 2015



Vidotto & al. 2023

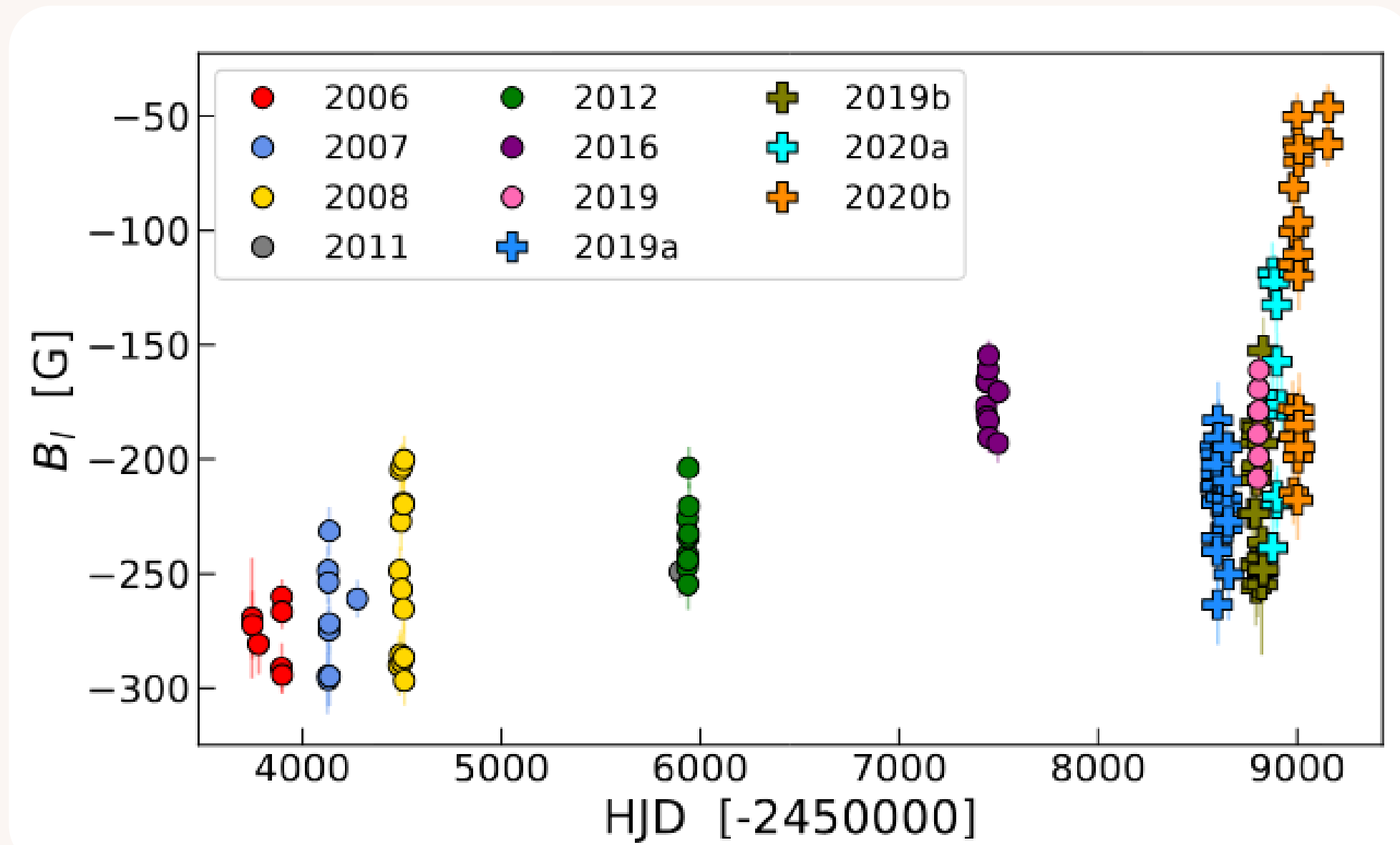


Center for Astrophysics
Harvard & Smithsonian

I- Context

M dwarfs

M dwarfs initially thought to be stable (Morin et al. 2008), but more complex behaviour revealed by SPIRou (Bellotti et al. 2023, 2024, Lehmann et al. 2024)

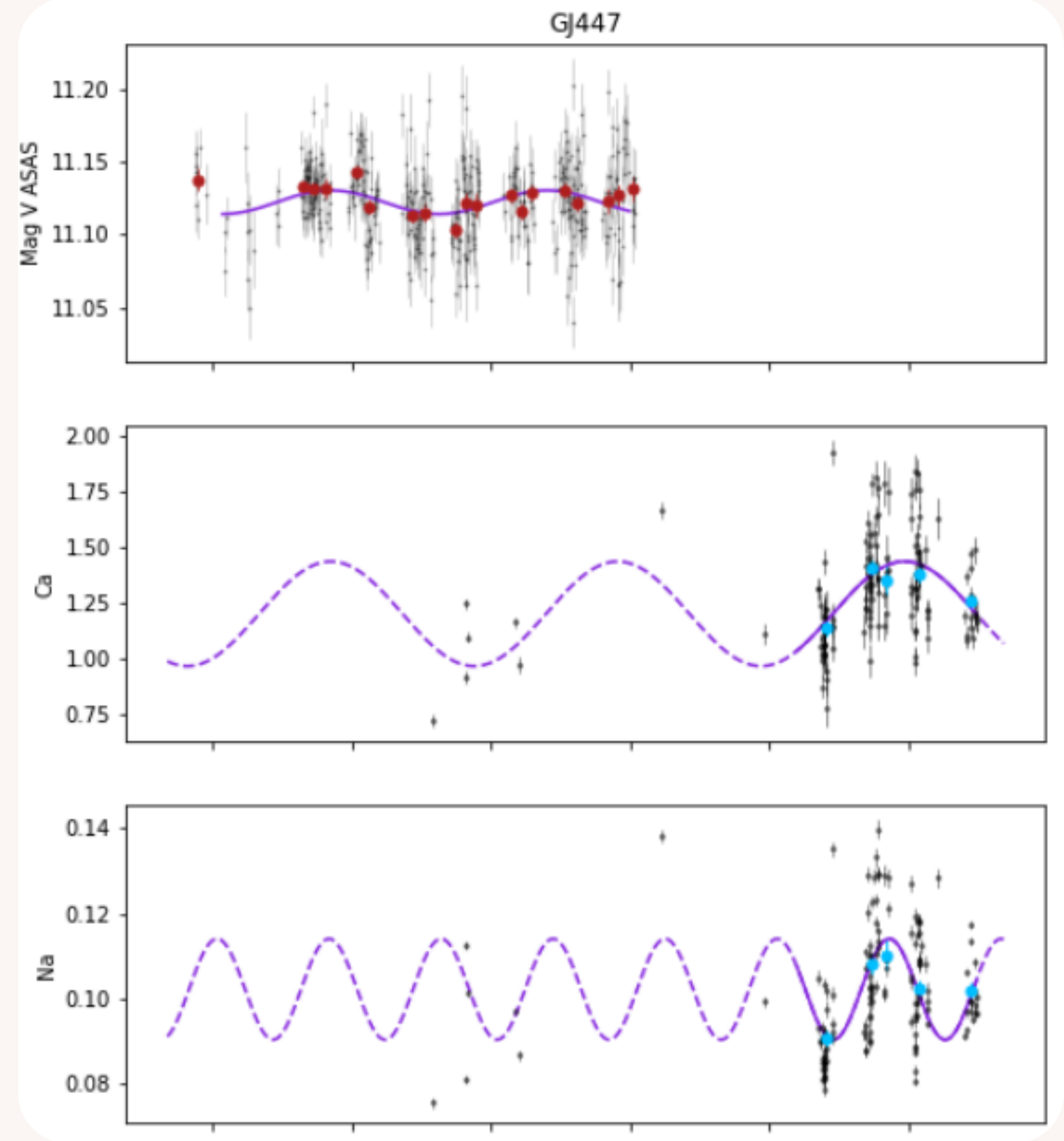


(Bellotti et al. 2023)

I- Context

M dwarfs

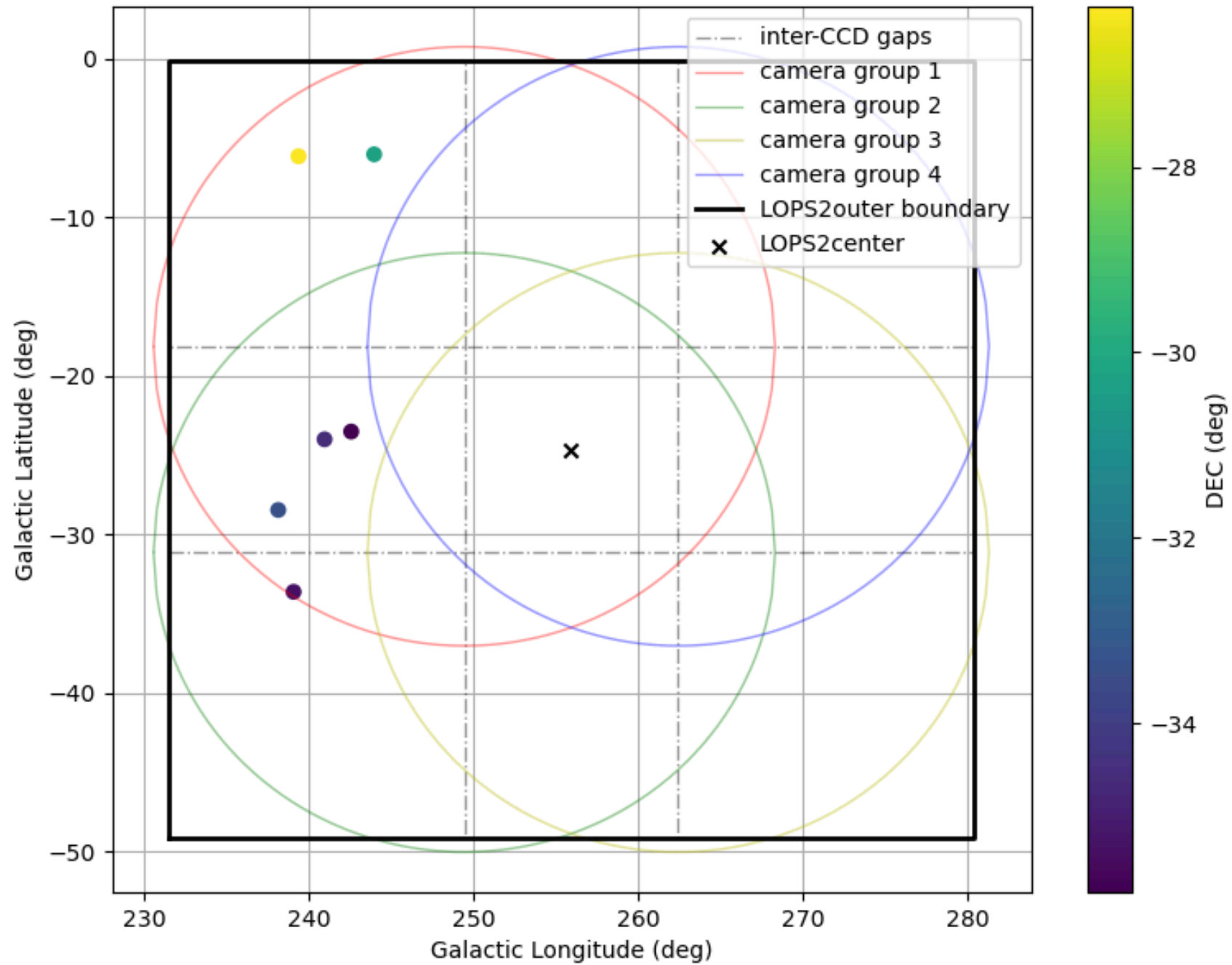
Long-term magnetic variability is ubiquitous in M dwarfs, but often too complex to be described by a single activity cycle (Mignon et al. 2023, Ibañez Bustos et al. 2025)



(Mignon et al. 2023)

II- Spectropolarimetric sample

M dwarfs



6 M Dwarfs in the PLATO field LOPS2

Objective :

Choose the best targets for spectropolarimetry from the millions present in the PLATO fields

Tools :

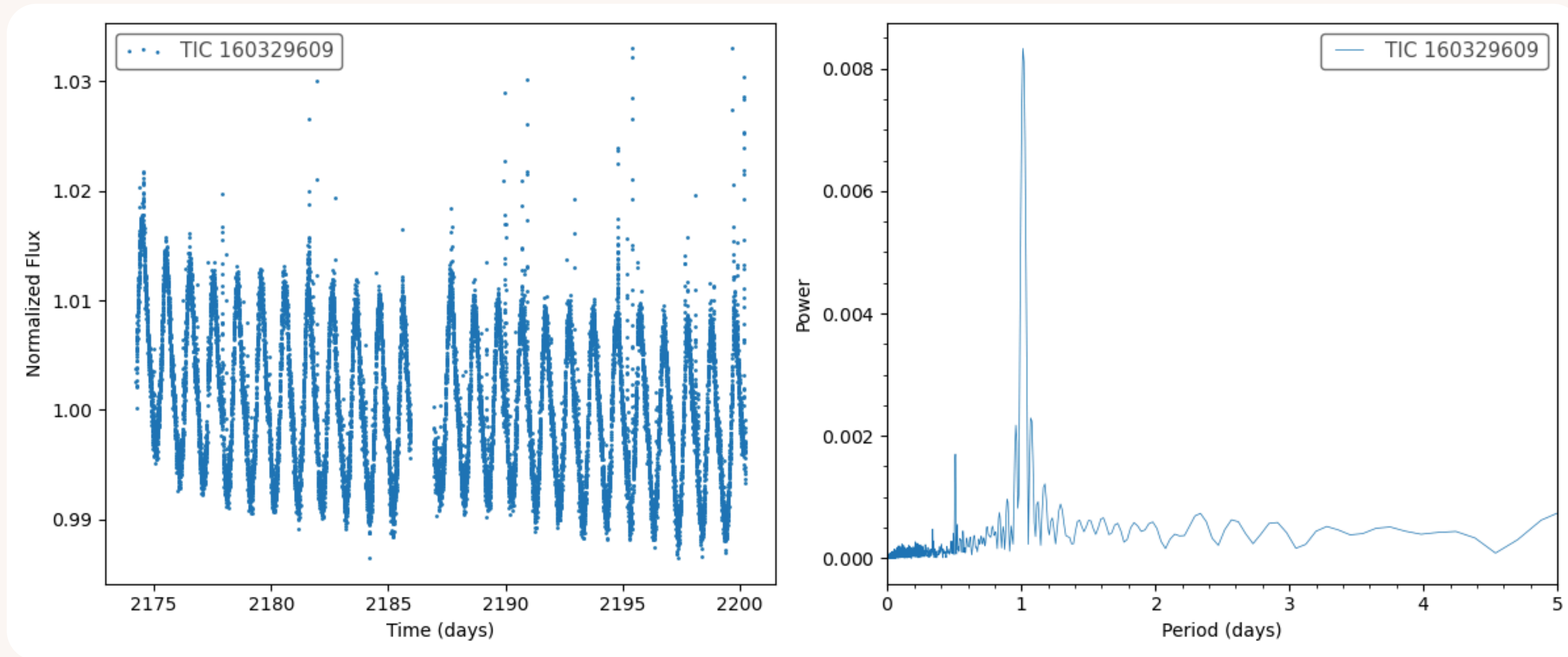
- Fundamental parameters from the Gaia DR3 catalog (activity level)
- Light curves from the TESS mission

ID	SpT	Mass (M_{\odot})	Prot ZDI [d]
AP Col	M5	0.26	0.9940 ± 0.0009
CD-35 2213	M4	0.40	1.9441 ± 0.0072
CD-26 4156	M1	0.55	1.3287 ± 0.0014
CD-35 2722	M1	0.55	1.7220 ± 0.0050
CD-29 4446	M1	0.64	1.6357 ± 0.0031
PM J05408-3323	M2	0.60	16.5 ± 1.4

The 6 M Dwarfs in this sample: 1) Identifier 2) spectral type 3) Mass 4) Rotation period

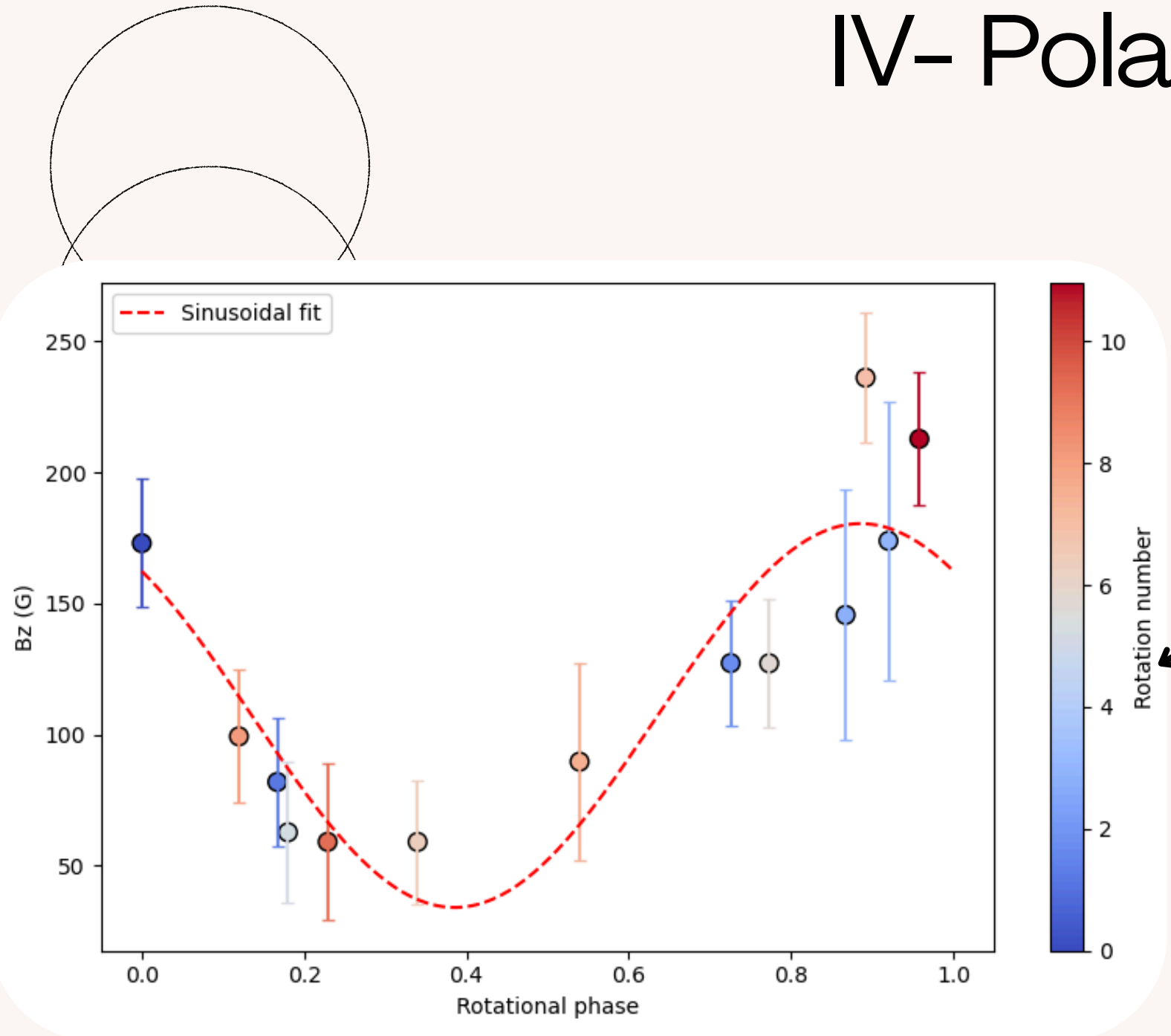
III- Activity and rotation

Light curve and periodogram for AP Col, M dwarf target in the southern PLATO field



Rotation period for AP Col : 1.0158 d

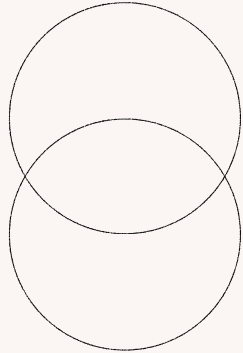
IV- Polarimetric analysis



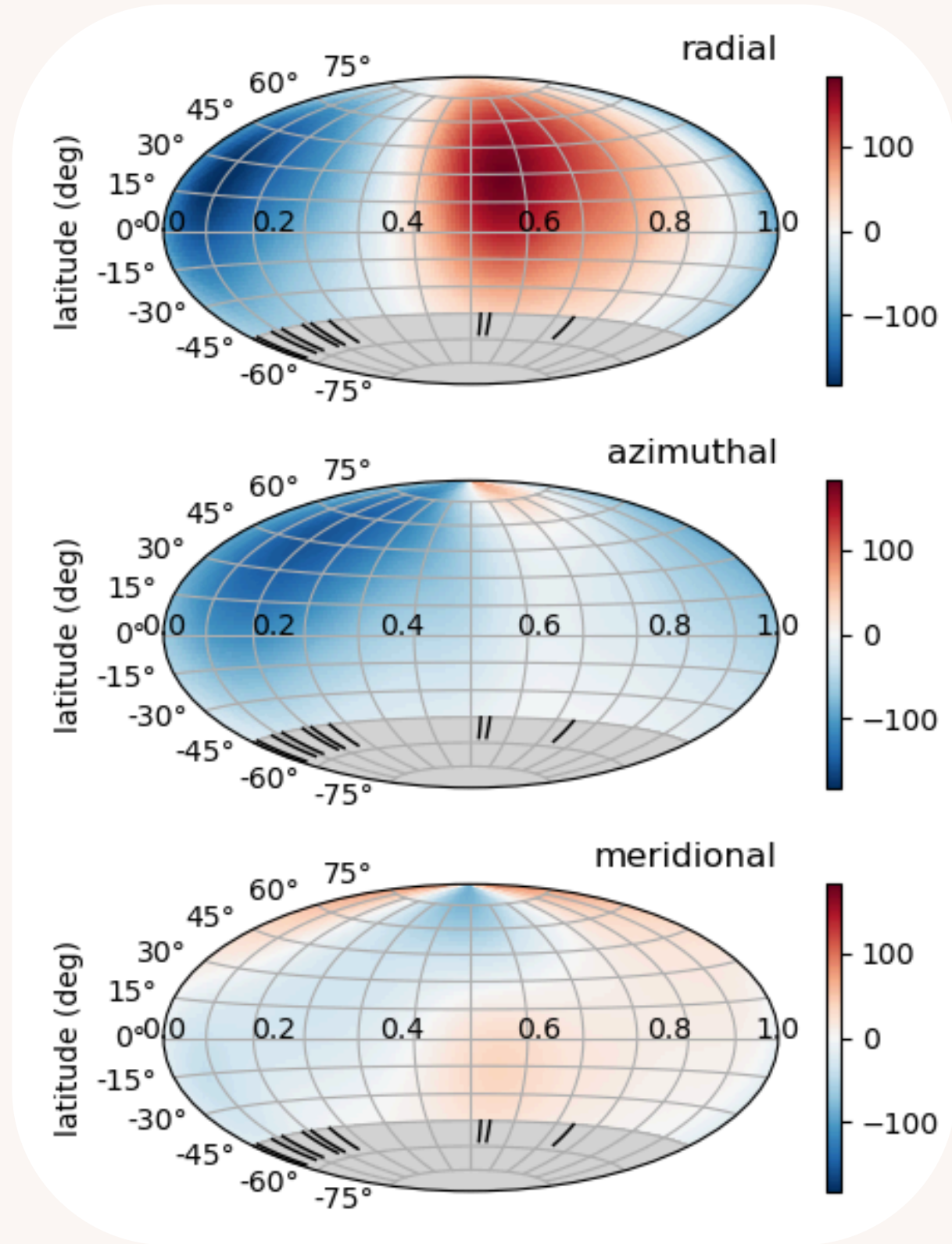
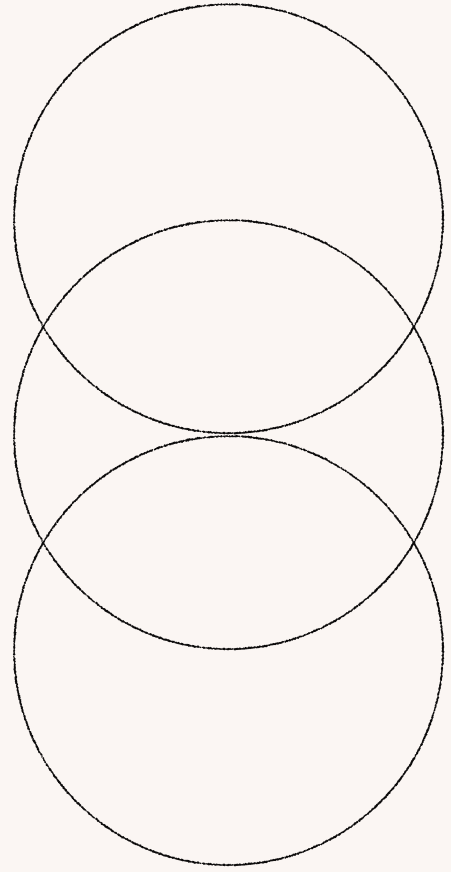
M dwarfs

ID	N_{obs}		N_{definite}		N_{marginal}		$\langle B_l \rangle$ [G]		$\text{std}(B_l)$ [G]		$\langle u(B_l) \rangle$ [G]	
	24B	25B	24B	25B	24B	25B	24B	25B	24B	25B	24B	25B
AP COL	19	7	16	7	0	0	356	408	67	61	56	54
CD-35 2213	13	9	5	1	2	2	128	67	146	86	39	39
CD-26 4156	14	4	5	4	4	0	64	72	49	20	32	20
CD-35 2722	13	5	7	3	1	1	127	114	59	57	30	30
CD-29 4446	23	4	7	0	7	0	64	59	39	20	30	22
PM J05408-3323	12	3	0	0	0	0	6	10	9	3	10	7

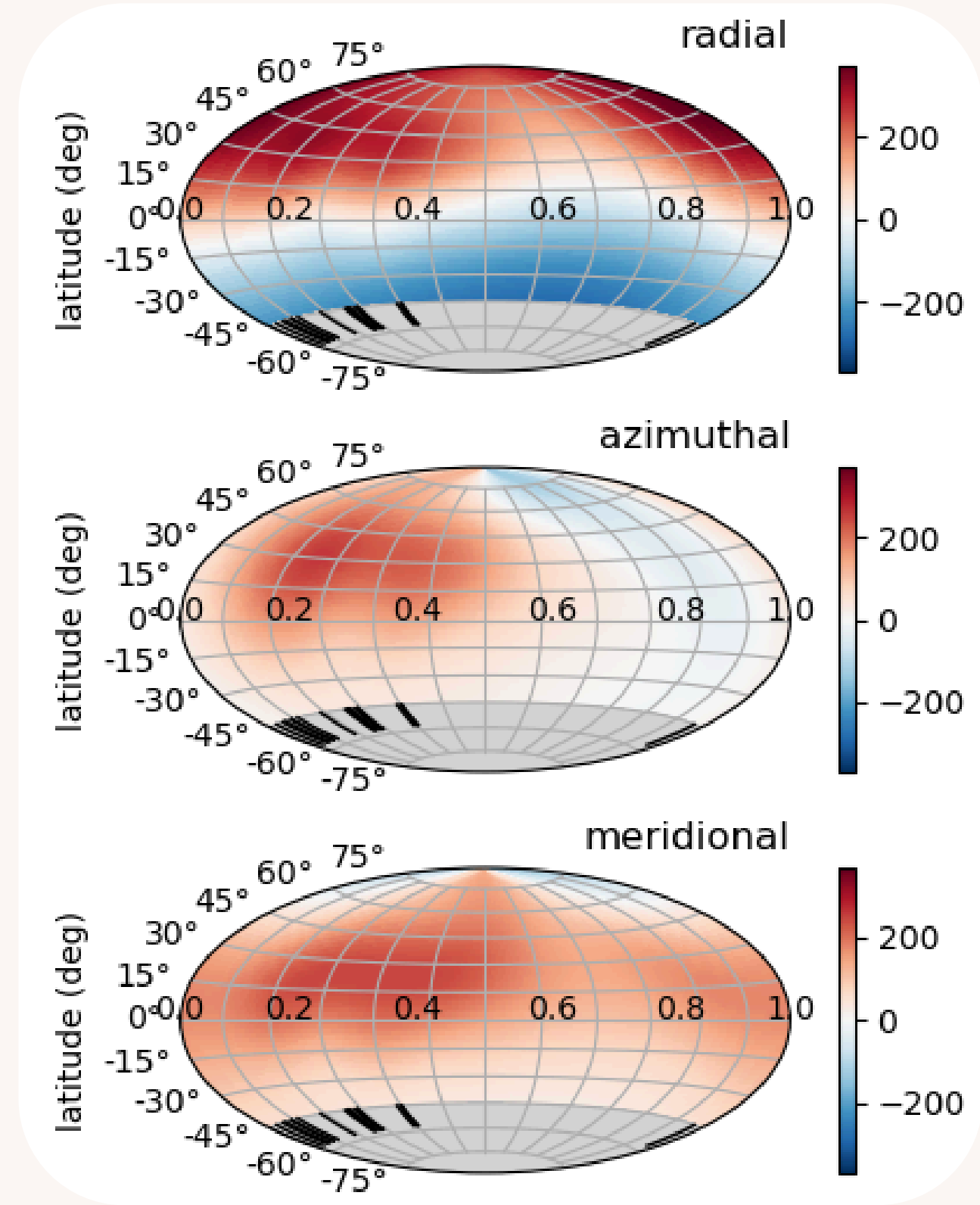
Summary of observations in 2024B and 2025B : 1) Identifier 2) Number of observations 3) Number of definite detection ($f_{\text{ap}} < 10^{-5}$), 4) Number of marginal detection ($f_{\text{ap}} < 10^{-3}$), 5) Average absolute value of longitudinal magnetic field B_l , 6) Dispersion of B_l values, 7) Average uncertainty of B_l .



IV- Polarimetric analysis



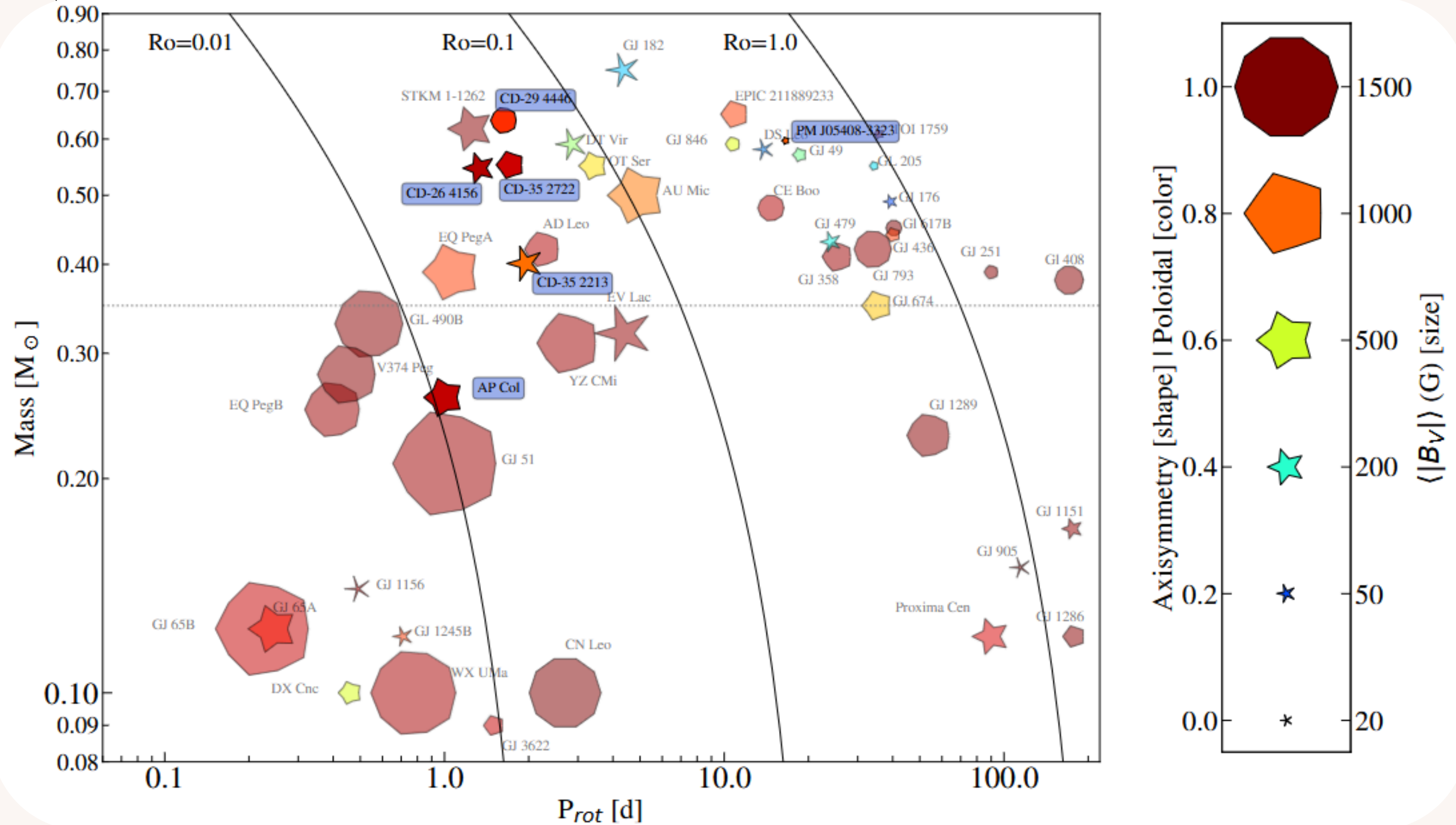
CD-35 2213: Mass: $0.4 M_{\odot}$, spectral type: M4,
Prot : 1.94 days.



AP Col: Mass: $0.26 M_{\odot}$, spectral type: M5,
Prot : 0.99 days.



IV- Polarimetric analysis



Plot showing the magnetic properties of cool, single, main-sequence stars, derived from Zeeman-Doppler Imaging (ZDI). The axes represent the stellar rotation period (horizontal) and stellar mass (vertical) (Diez et al. 2026).

V- Perspectives

- Feasibility demonstrated
 - Long-term monitoring of M dwarfs
 - WENAOKEAO
- Publication
 - Diez et al. 2026, *A&A*, 709, A273

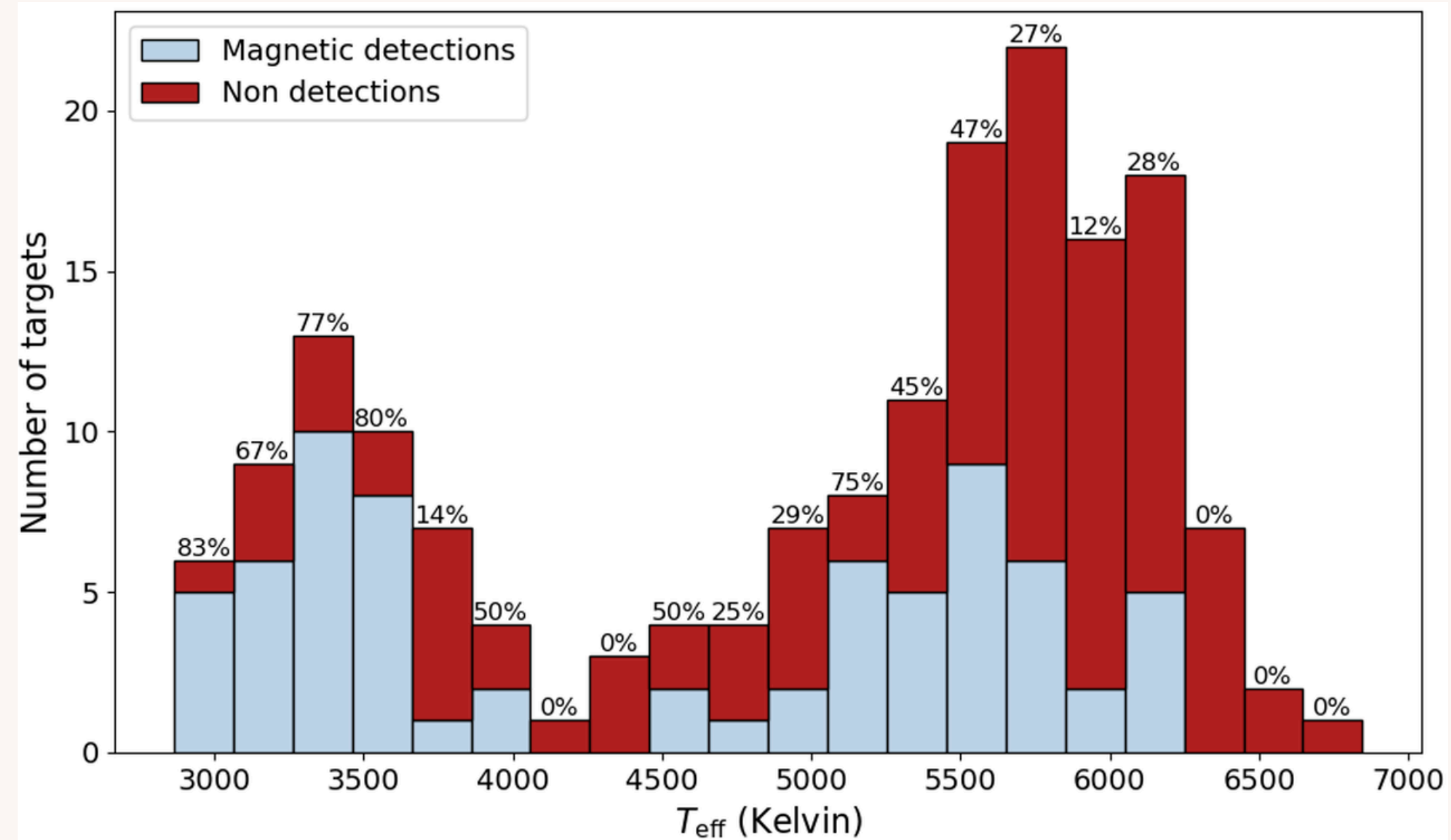
Scan for paper



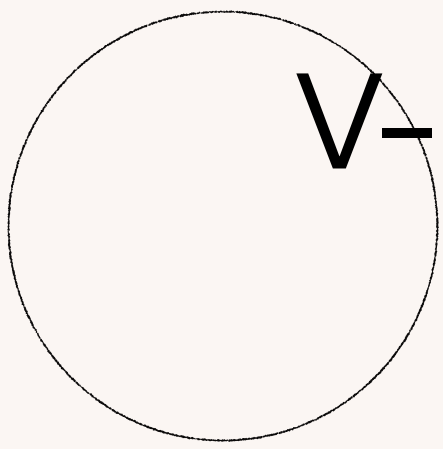
V- Perspectives

FGK dwarfs

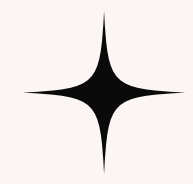
- Additional spectropolarimetric proposals for FGK stars
- Using PolarBase archival data
- Construction of a reference catalogue for PLATO targets with Stokes V observations
- Publication in preparation



Histogram of the number of targets in our sample as a function of effective temperature (K), together with the detection rate. Red bars indicate non-detections, while blue bars indicate magnetic detections.

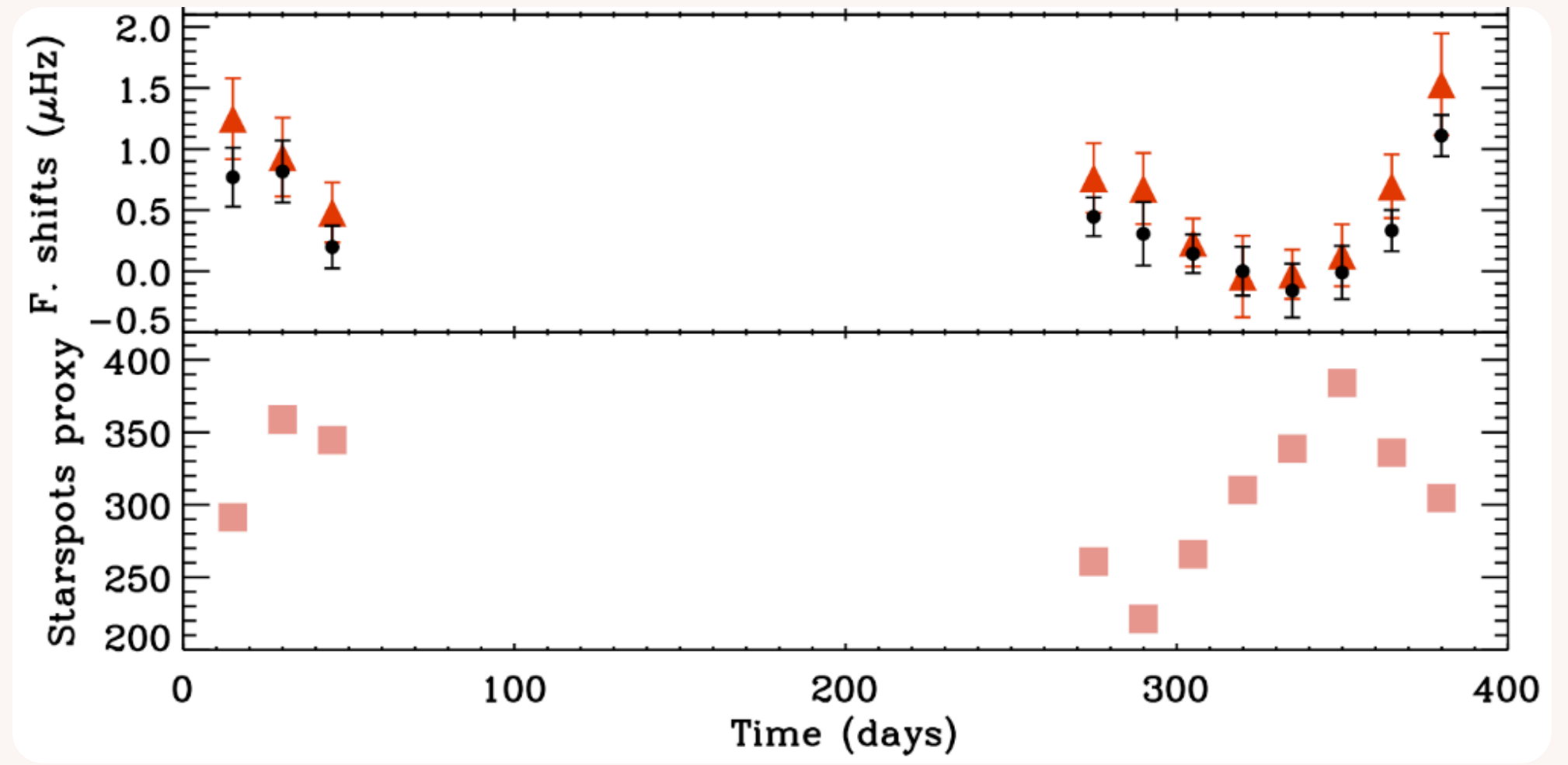


V- Perspectives

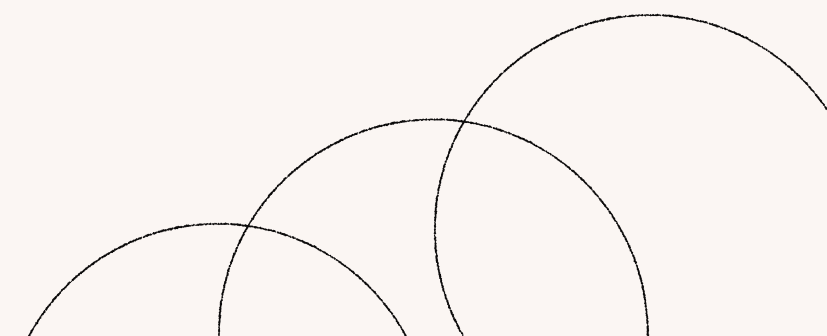
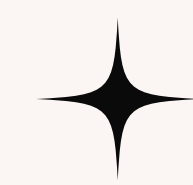


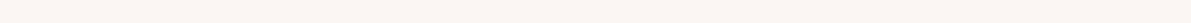
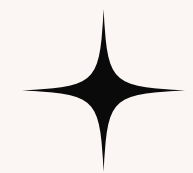
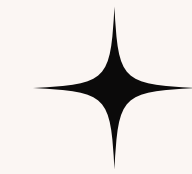
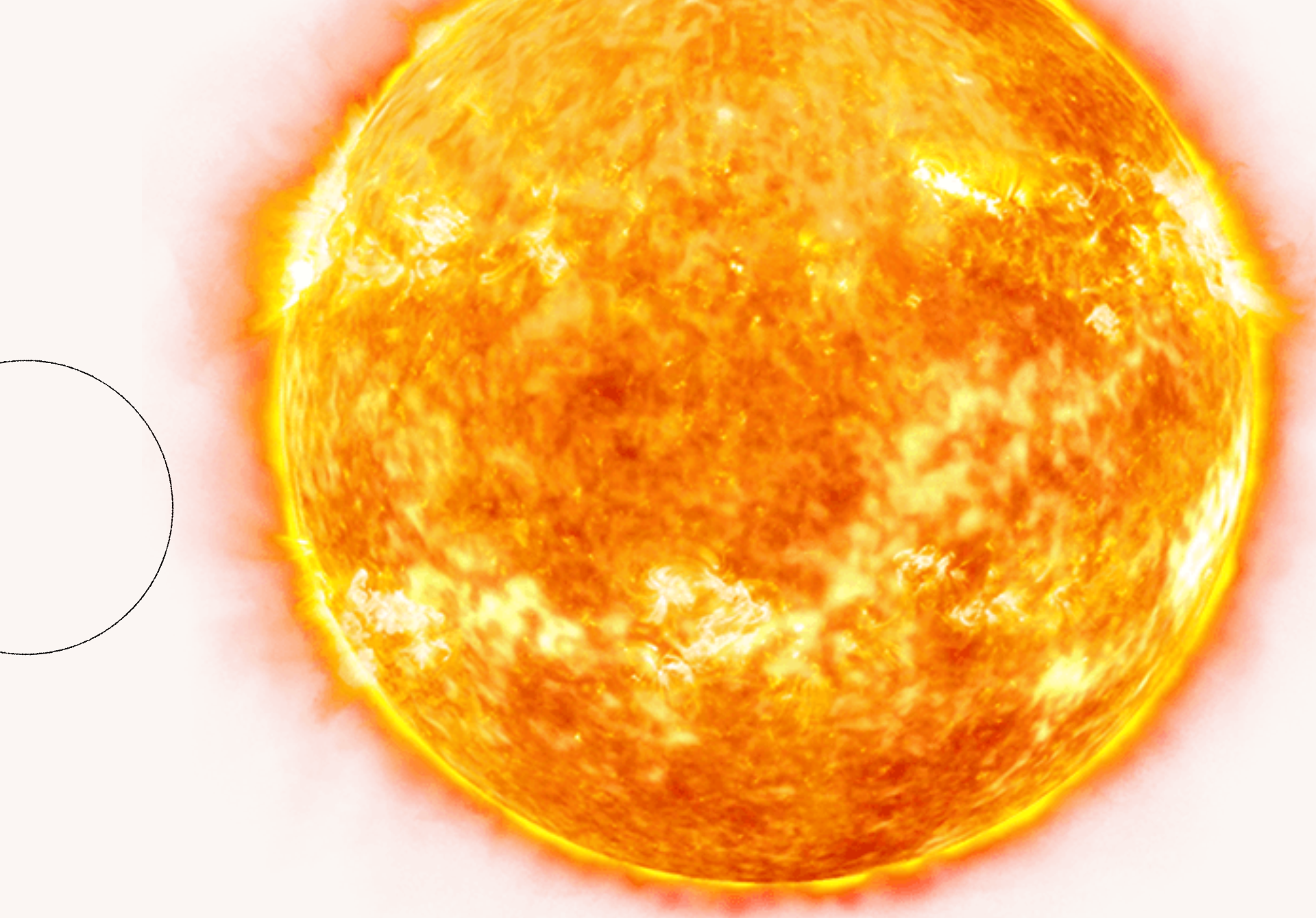
FGK dwarfs

Relate spectropolarimetric magnetic cycles (Bellotti et al. 2025) to indirect seismic signatures (Garcia et al. 2010)

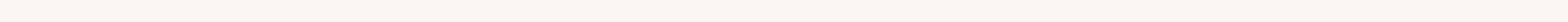
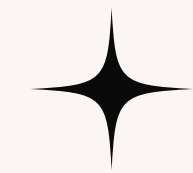
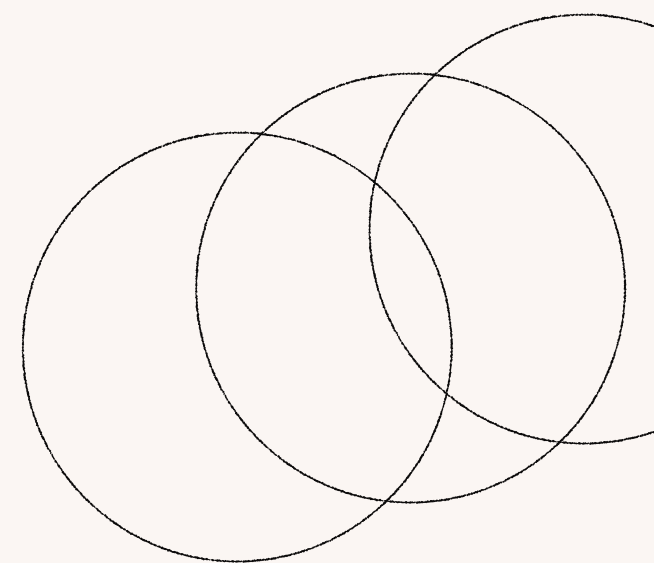


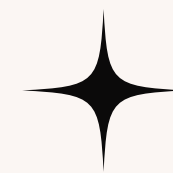
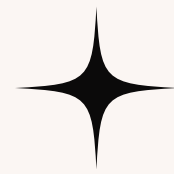
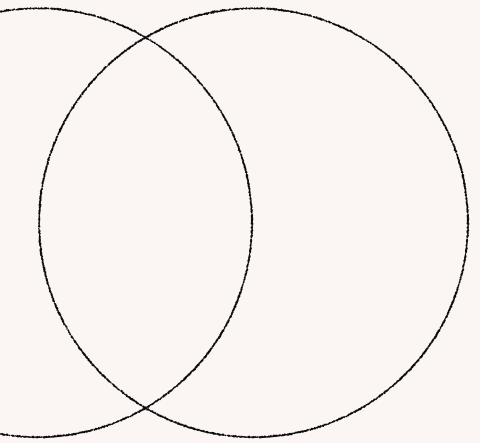
(Garcia et al. 2010)





Thank You
for your attention





Appendix

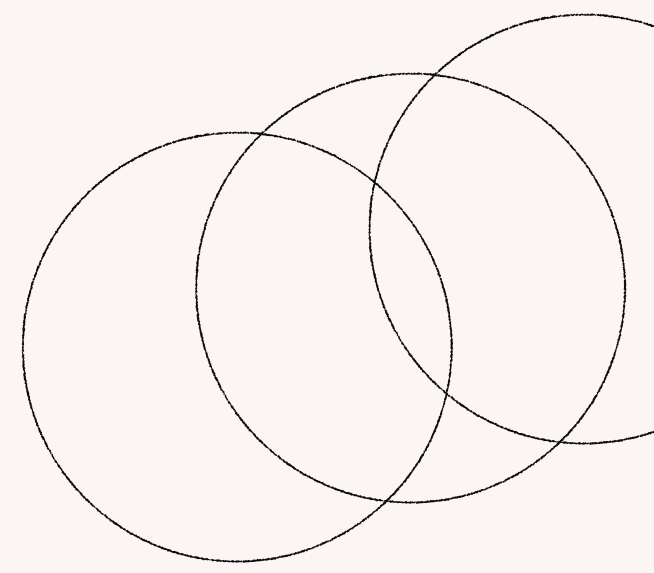
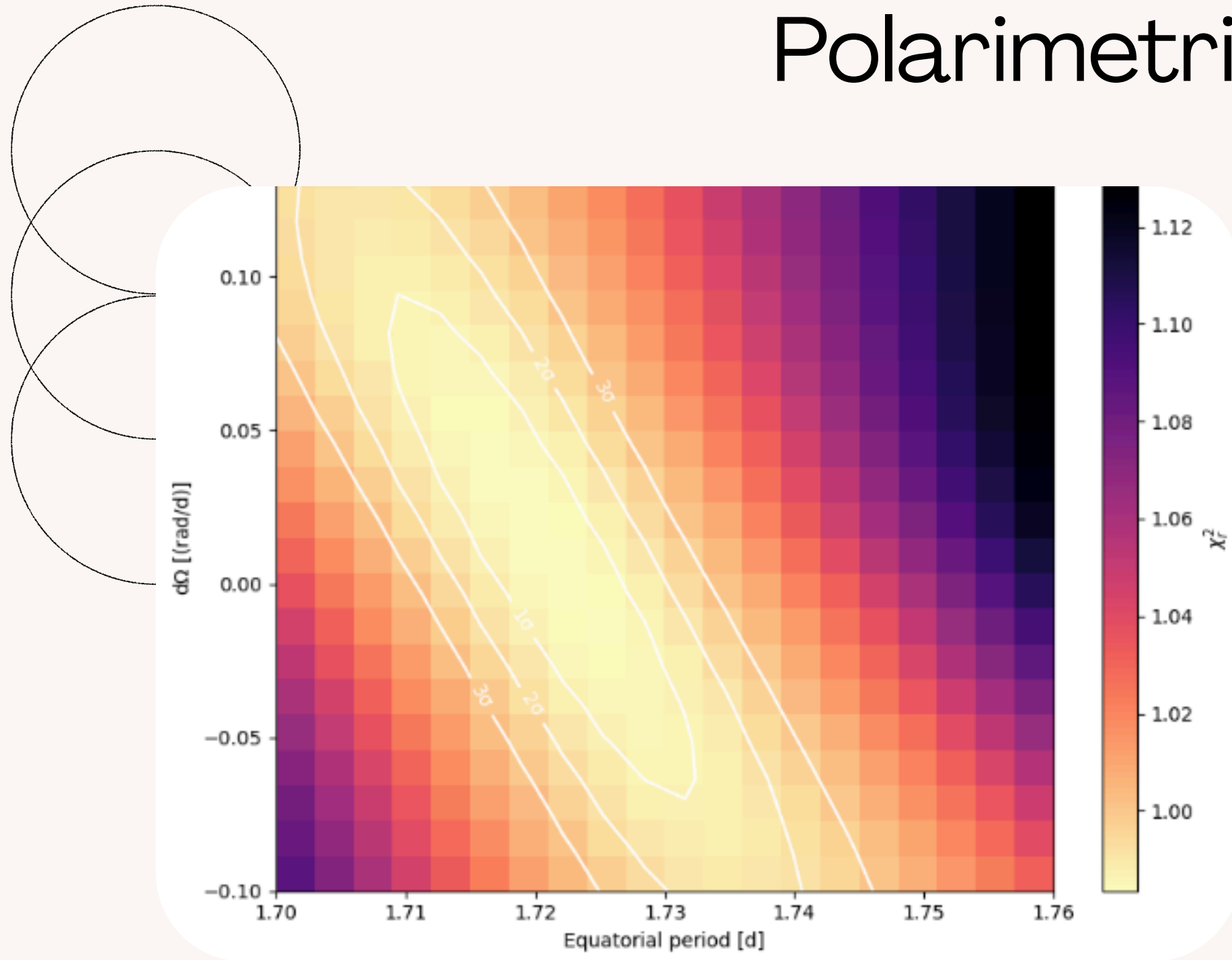


Table 1. Fundamental parameters and rotation periods of the six M dwarf targets observed during semester 2024.

Name	AP Col	CD-35 2213	CD-26 4156	CD-35 2722	CD-29 4446	PM J05408-3323
Spectral Type (SpT)	M5	M4	M1	M1	M1	M2
Mass (M_{\odot}) ^a	0.263 ± 0.022	0.401 ± 0.021	0.546 ± 0.021	0.552 ± 0.021	0.637 ± 0.021	0.597 ± 0.021
T_{eff} [K] ^b	3035 ± 30	3291 ± 30	3606 ± 30	3707 ± 30	3651 ± 30	3783 ± 30
$\log(g)$ [dex] ^b	4.37 ± 0.05	4.79 ± 0.05	4.57 ± 0.05	4.61 ± 0.05	4.71 ± 0.05	4.75 ± 0.05
[M/H] [dex] ^b	-0.01 ± 0.10	0.12 ± 0.10	0.25 ± 0.10	0.14 ± 0.10	0.21 ± 0.10	0.06 ± 0.10
Inclination i_{zdi} ^c	60°	60°	60°	45°	60°	60°
$v \sin(i)$ [km/s] ^b	15.94 ± 0.09	20.27 ± 0.15	21.77 ± 0.13	12.42 ± 0.04	21.56 ± 0.31	3.70 ± 0.05
$\log(L_X/L_{\text{bol}})$ ^d	–	–	–3.22	–3.25	–2.96	–4.40
P_{rot} (lit.) [d]	1.01^e	1.93 ± 0.009^f	1.33^g	1.71^f	1.64 ± 0.090^h	–
P_{TESS} [d] ⁱ	1.013 ± 0.011	1.937 ± 0.057	1.326 ± 0.020	1.719 ± 0.030	1.642 ± 0.056	17.0 ± 2.6
P_{ZDI} [d] ^j	0.9940 ± 0.0009	1.9441 ± 0.0072	1.3287 ± 0.0014	1.7220 ± 0.0050	1.6357 ± 0.0031	16.5 ± 1.4

Polarimetric analysis



Reduced χ^2 map obtained from the ZDI analysis of CD-35 2722, as a function of the equatorial rotation period P_{eq} and the differential rotation $d\Omega$. The contours indicate the 1 σ , 2 σ , and 3 σ confidence levels around the minimum. The minimum reduced χ^2 is located near $d\Omega \approx 0$, indicating no detectable differential rotation and allowing a revision of the adopted rotation period.

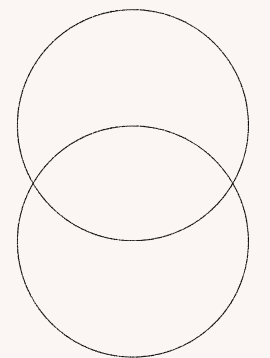
Revision of rotation periods

CD-35 2722

TESS : 1.7192 ± 0.0304 days



ZDI : 1.7220 ± 0.0048 days

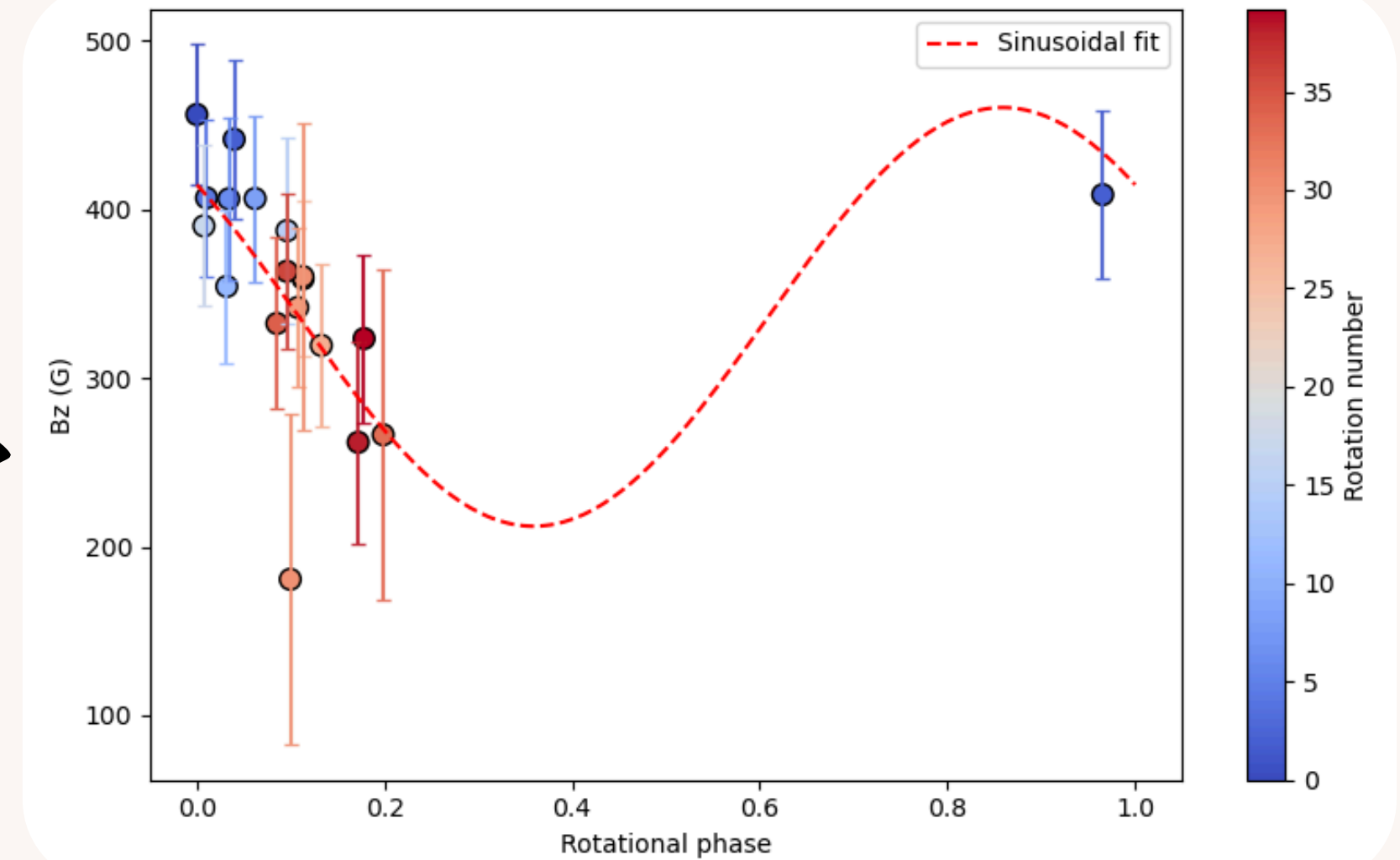
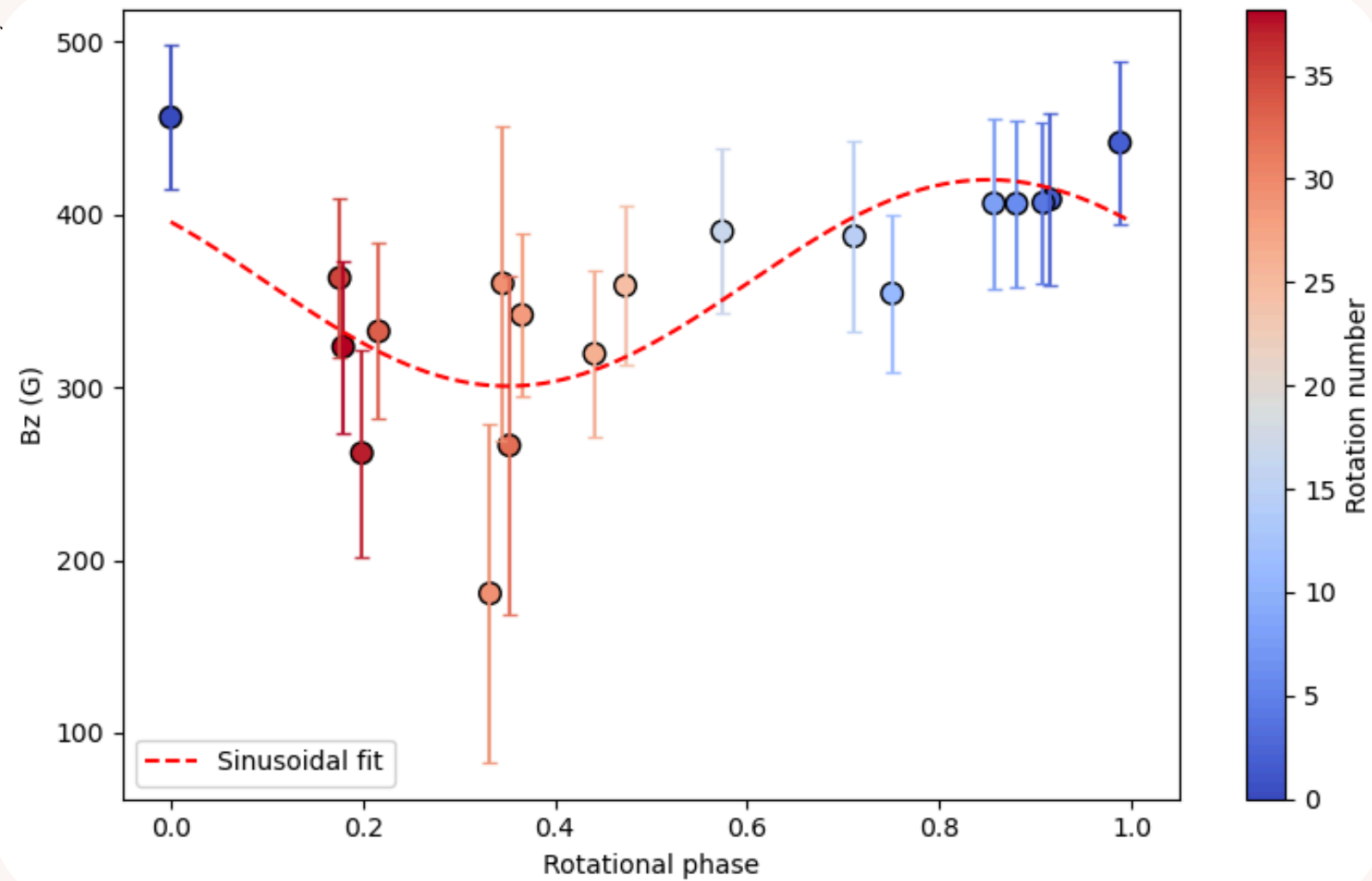


Polarimetric analysis

Revision of rotation periods of AP Col

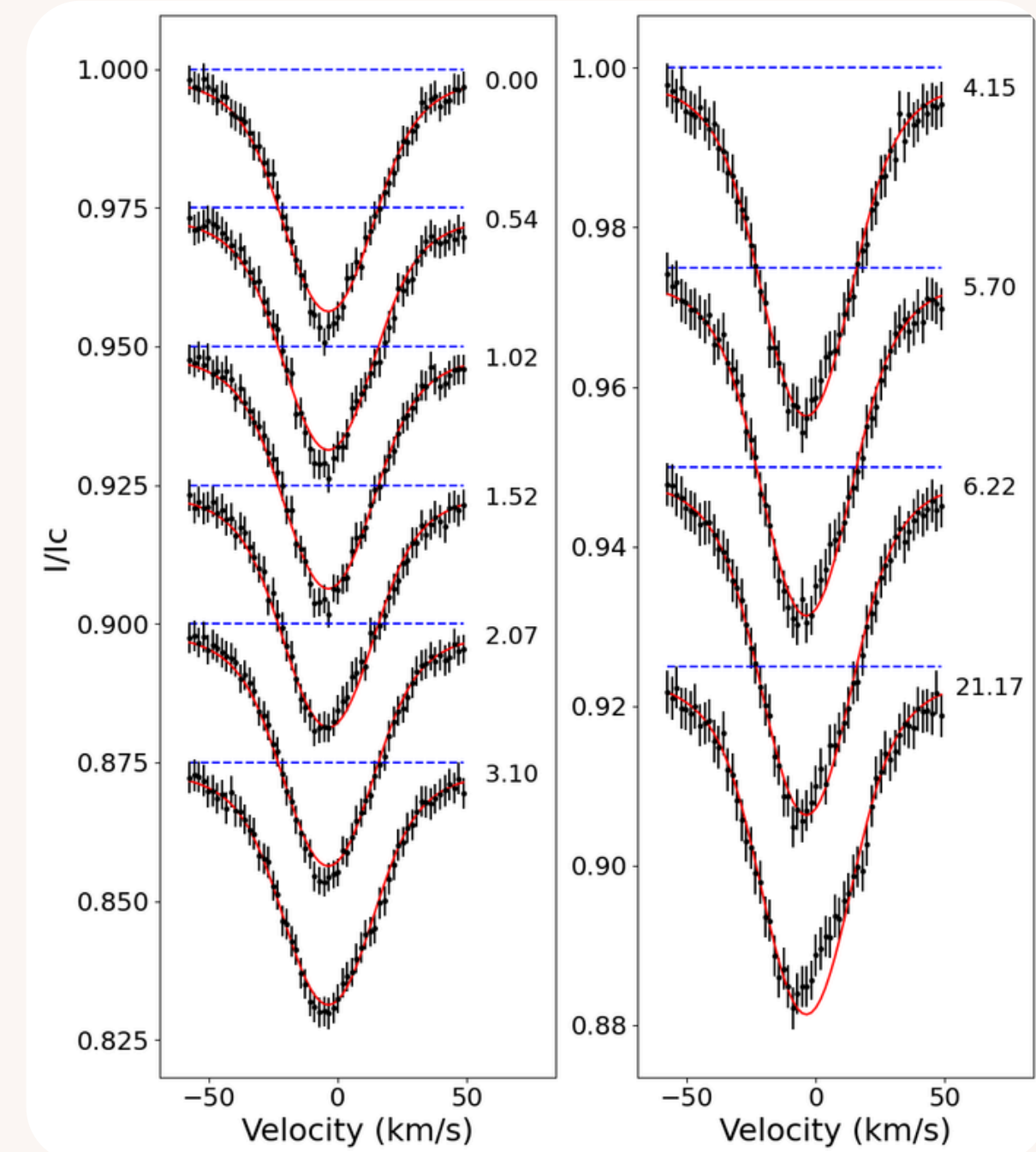
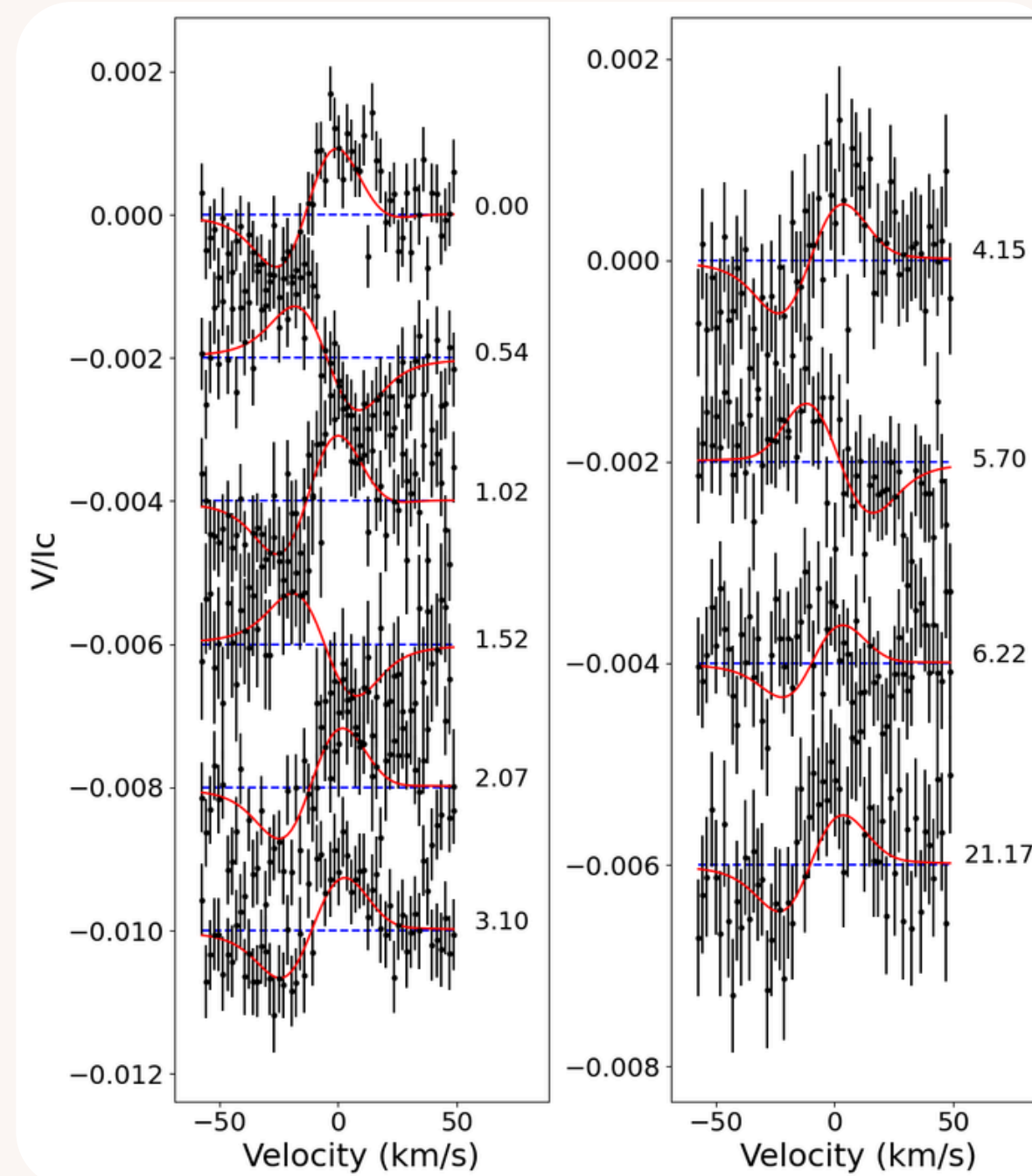
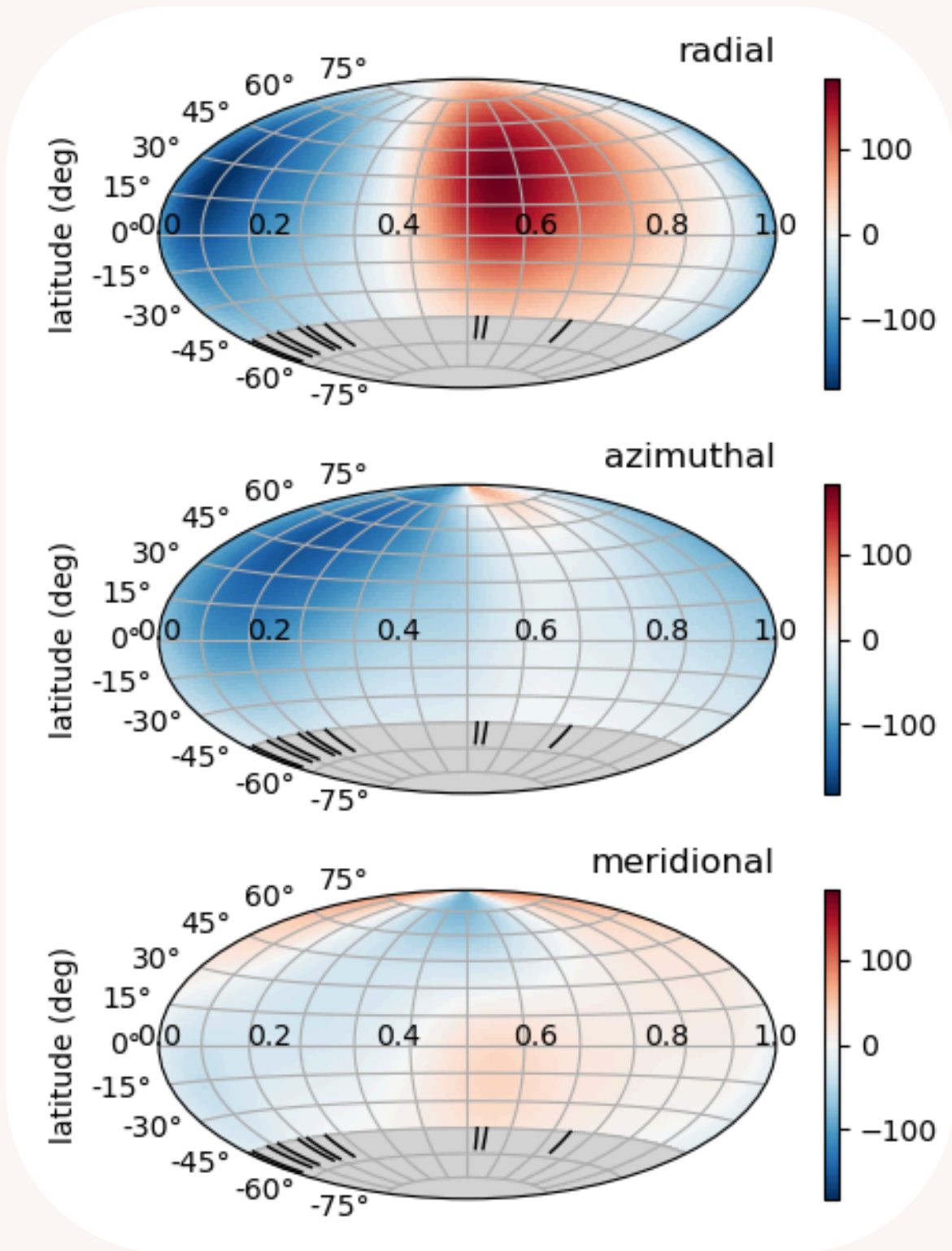
TESS : 1.0129 ± 0.00114 days

ZDI : 0.9940 ± 0.0009 days

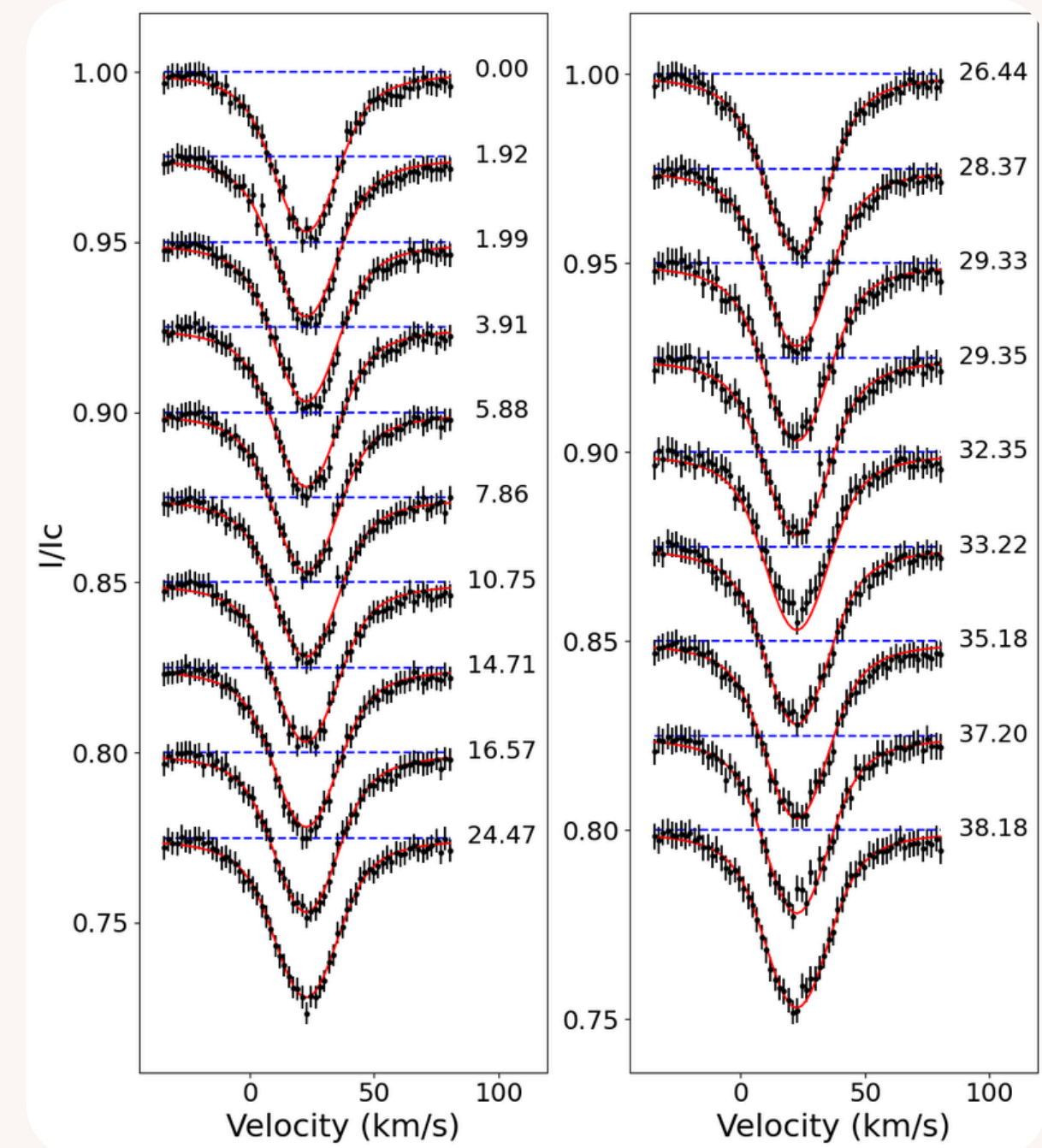
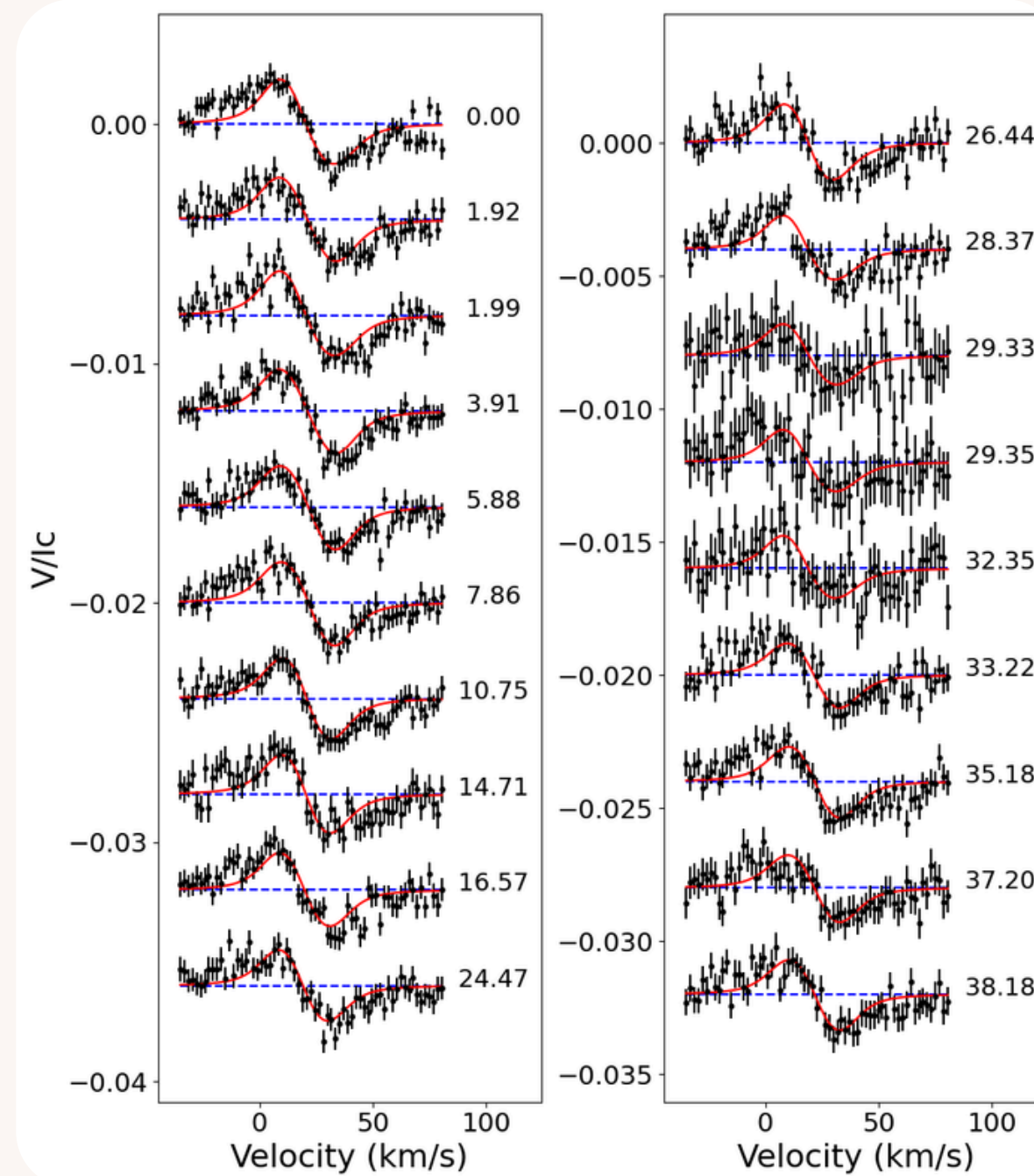
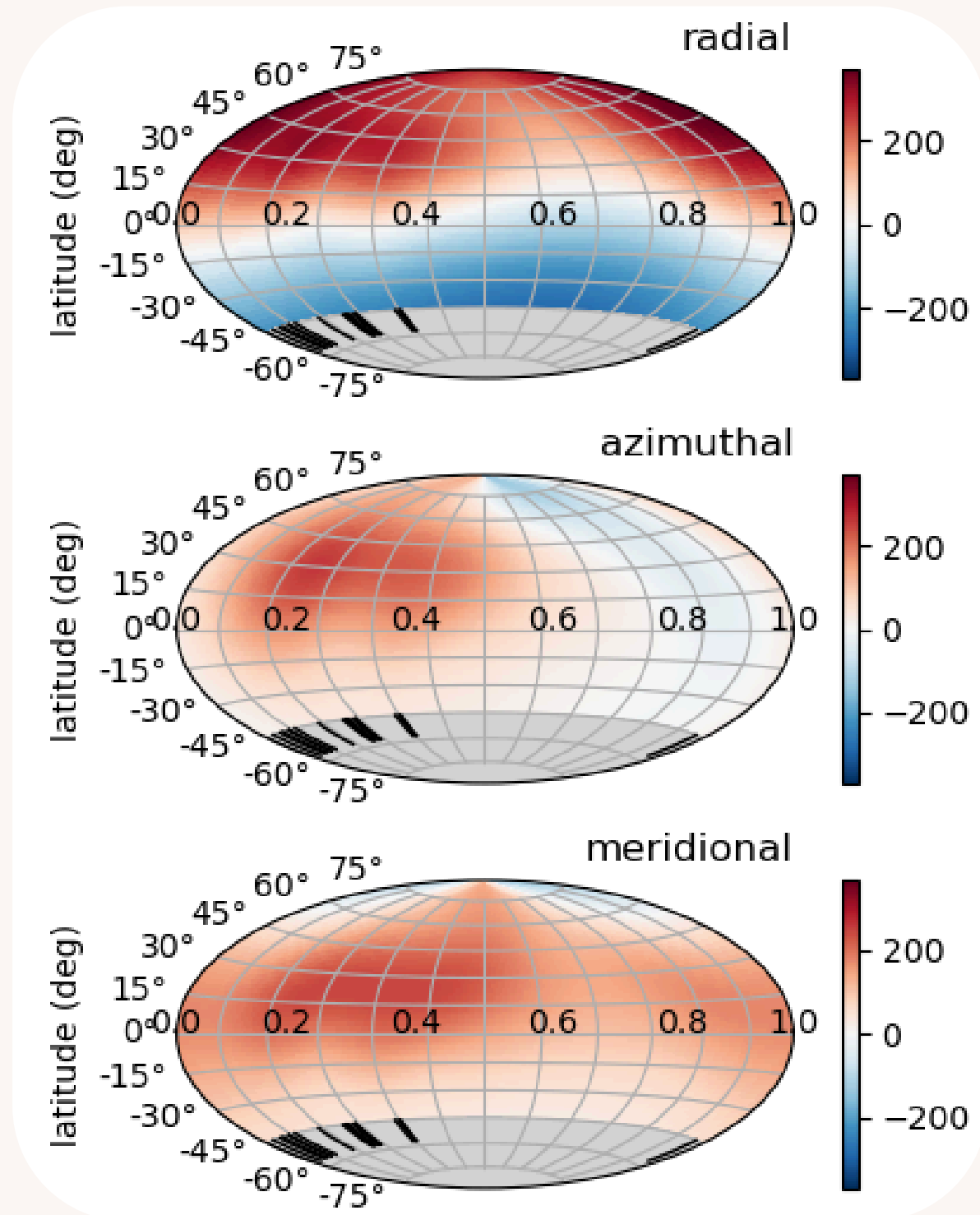


Longitudinal magnetic field B_z as a function of rotational phase for the star AP Col. The color bar indicates the number of rotations.

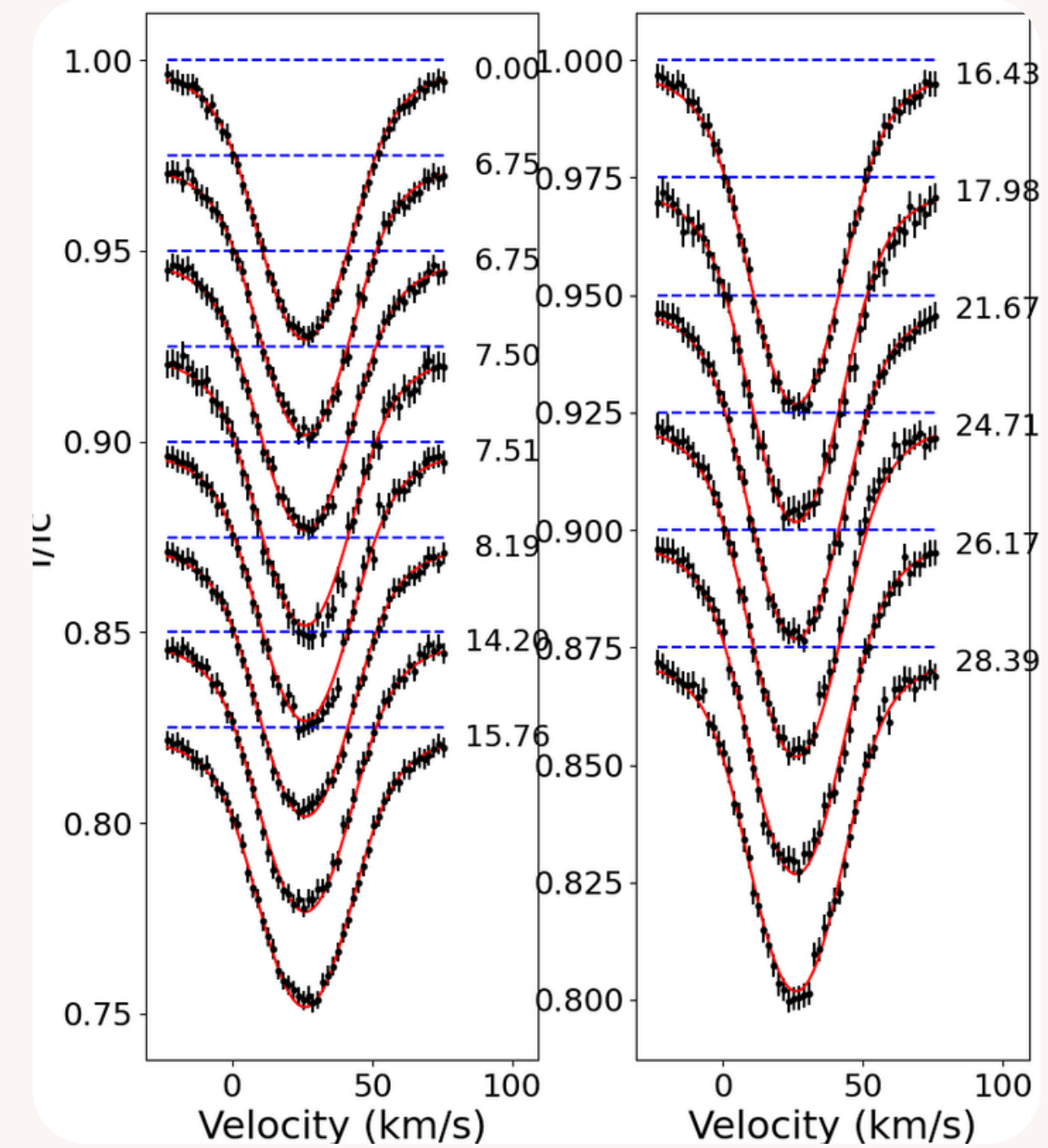
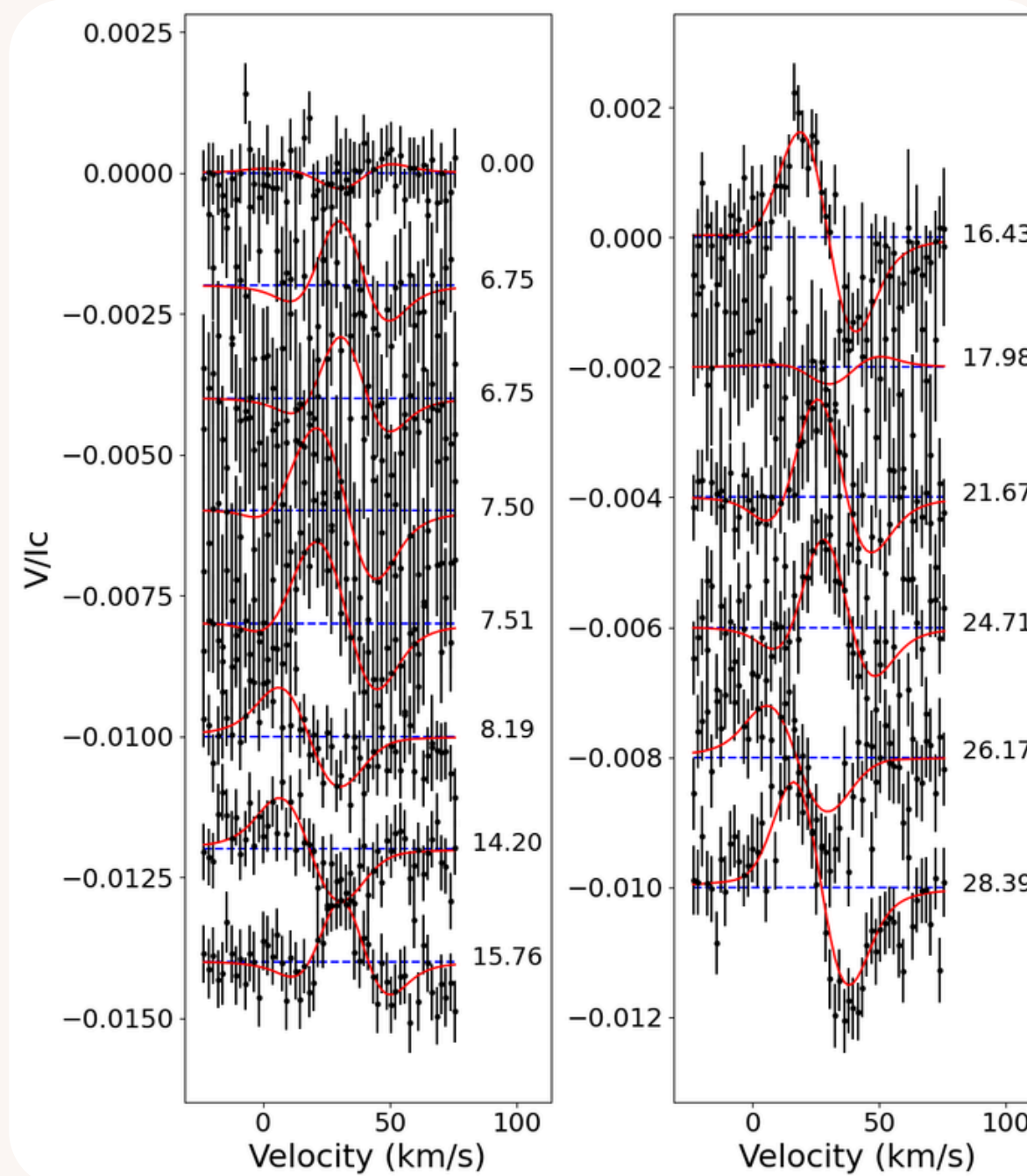
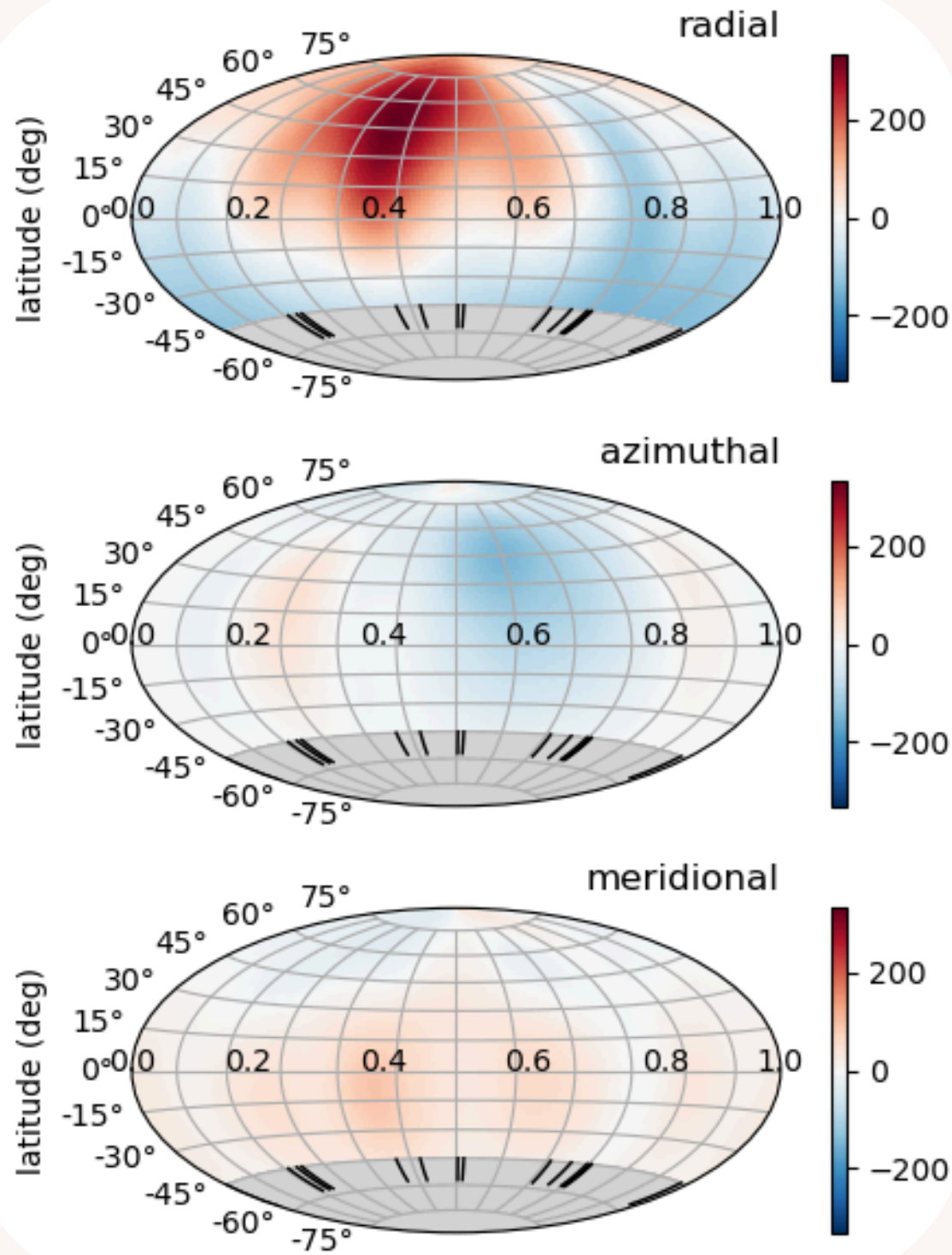
CD-35 2213: Mass: $0.4 M_{\odot}$, spectral type: M4, $Prot$: 1.94 days.



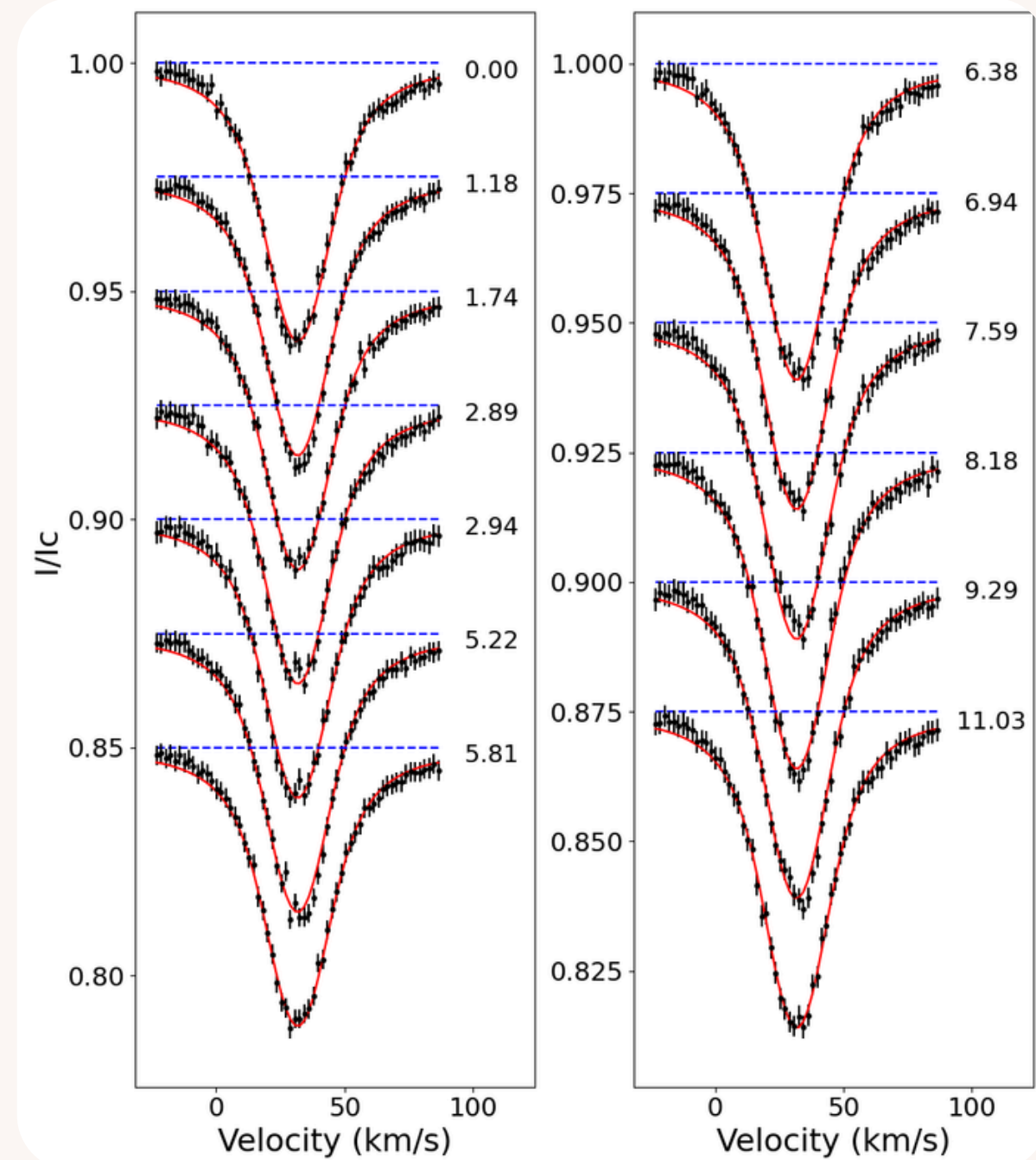
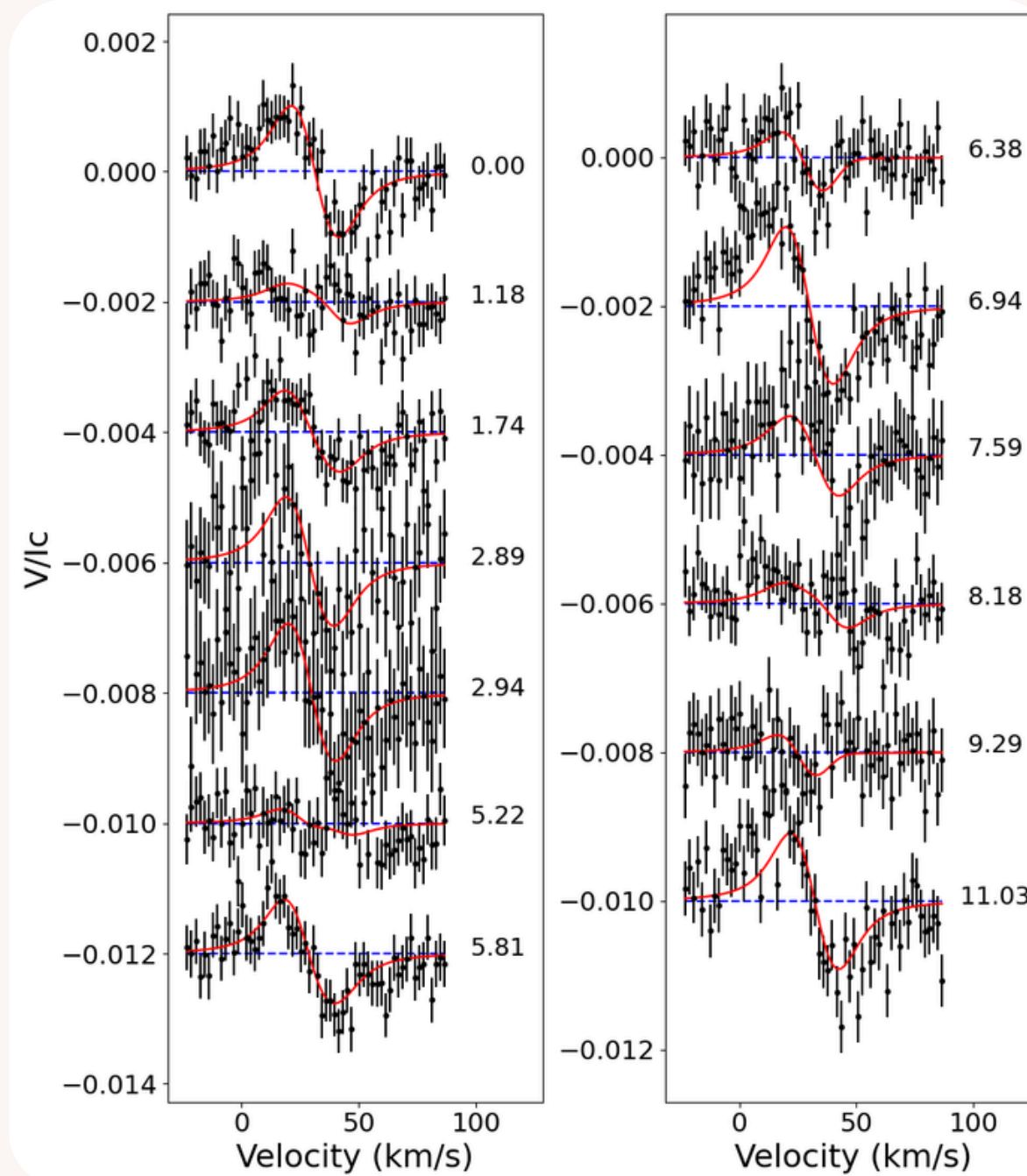
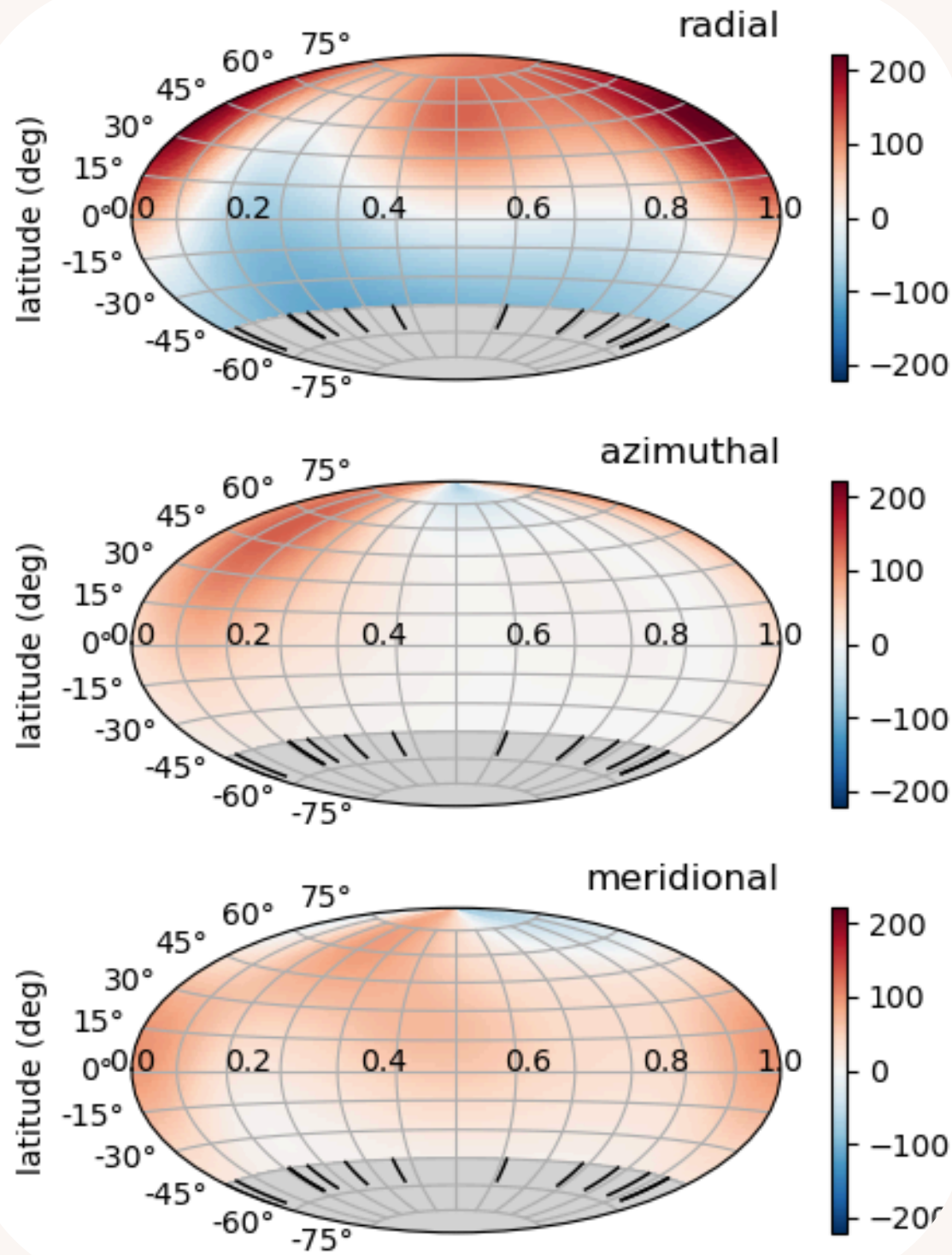
AP Col: Mass: $0.26 M_{\odot}$, spectral type: M5, P_{rot} : 0.99 days.



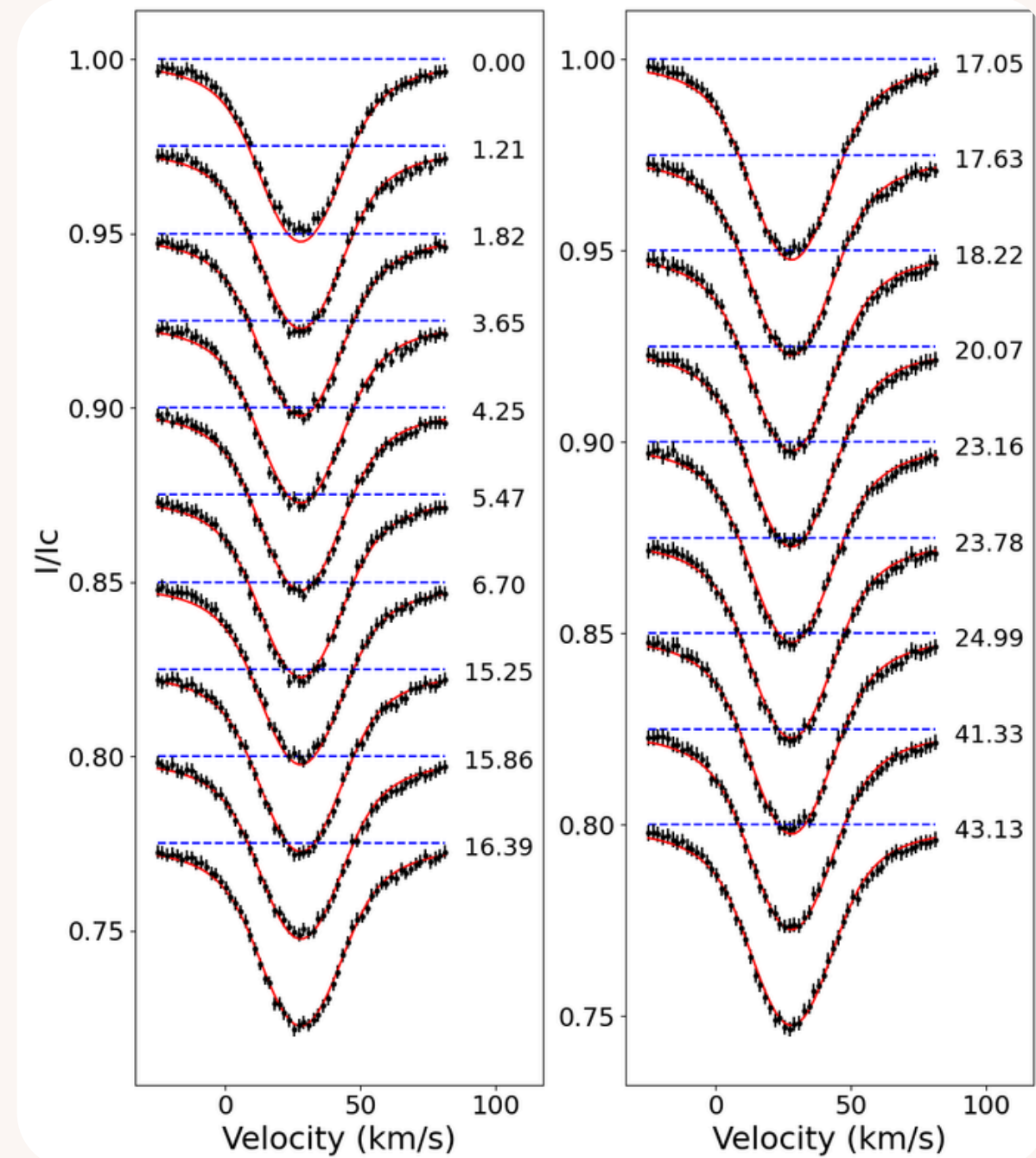
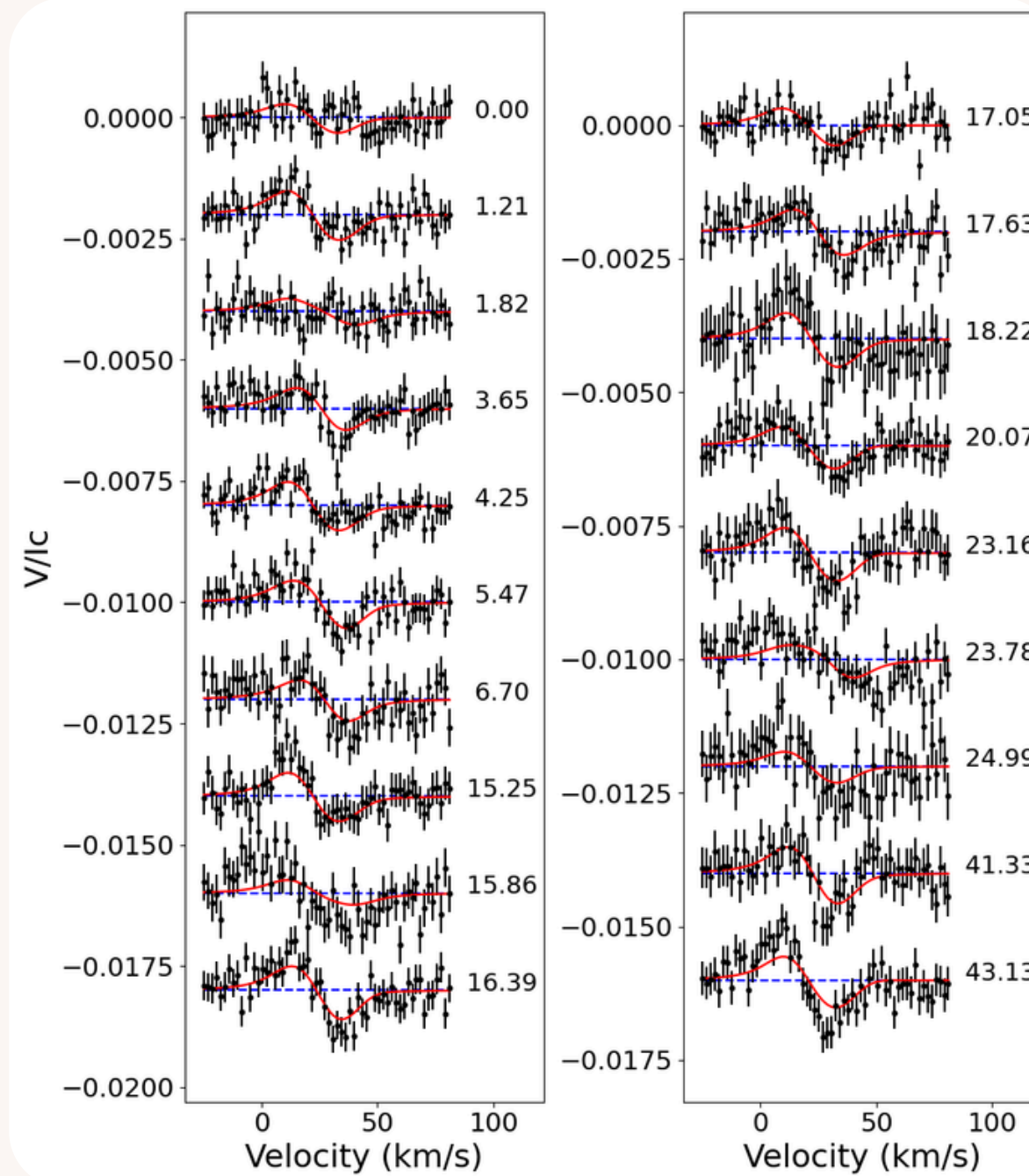
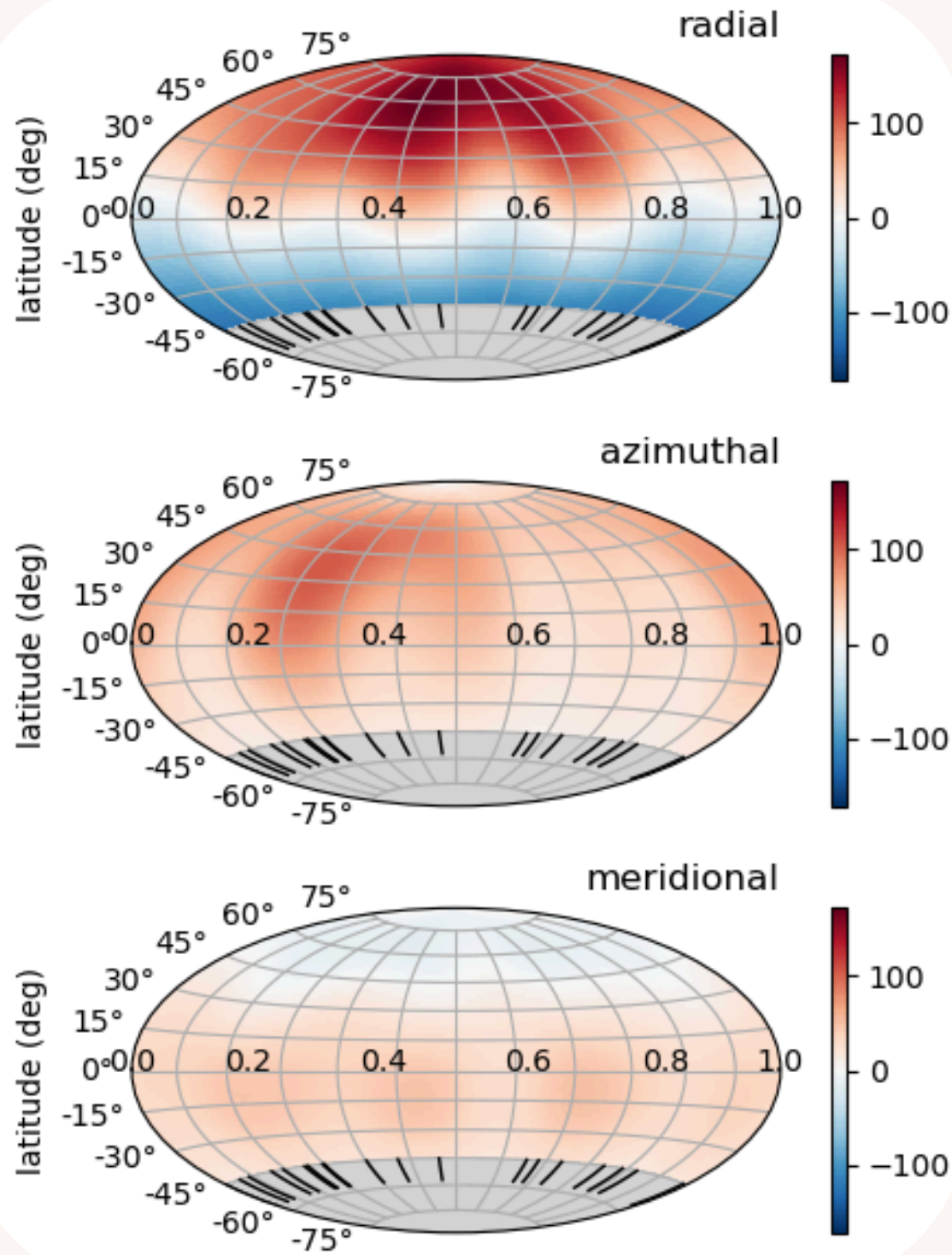
CD-26 4156: Mass: $0.55 M_{\odot}$, spectral type: M1, P_{rot} : 1.33 days.



CD-35 2722: Mass: $0.55 M_{\odot}$, spectral type: M1, P_{rot} : 1.72 days.



CD-29 4446: Mass: $0.64 M_{\odot}$, spectral type: M1, P_{rot} : 1.63 days.



PM J05408-3323: Mass: $0.60 M_{\odot}$, spectral type: M2, P_{rot} : 16.5 days.

