

# Observing magnetic cycles on Solar-type stars

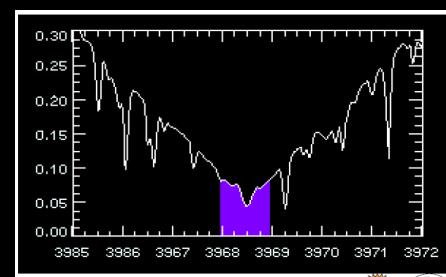
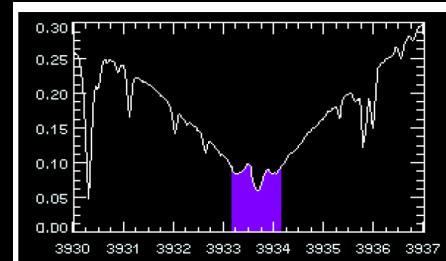
Sandra Jeffers and Sudeshna Boro Saikia  
and BCool collaboration

Institute for Astrophysics  
Göttingen

# Observing magnetic cycles

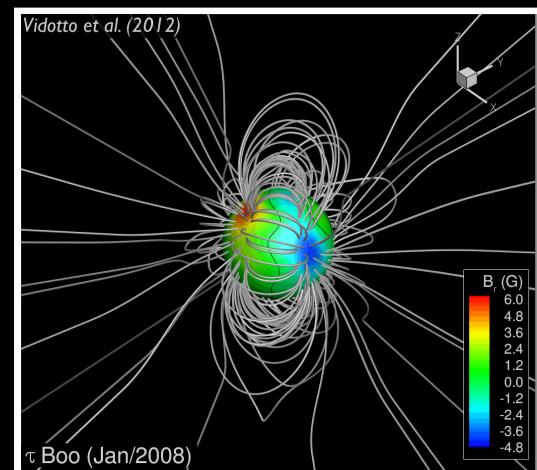
- Unpolarised spectroscopy

- Chromospheric activity indicators  
(S index, H $\alpha$ , Ca II IRT)



- Polarised spectroscopy

- Large-scale magnetic field topology
  - Look for polarity reversals

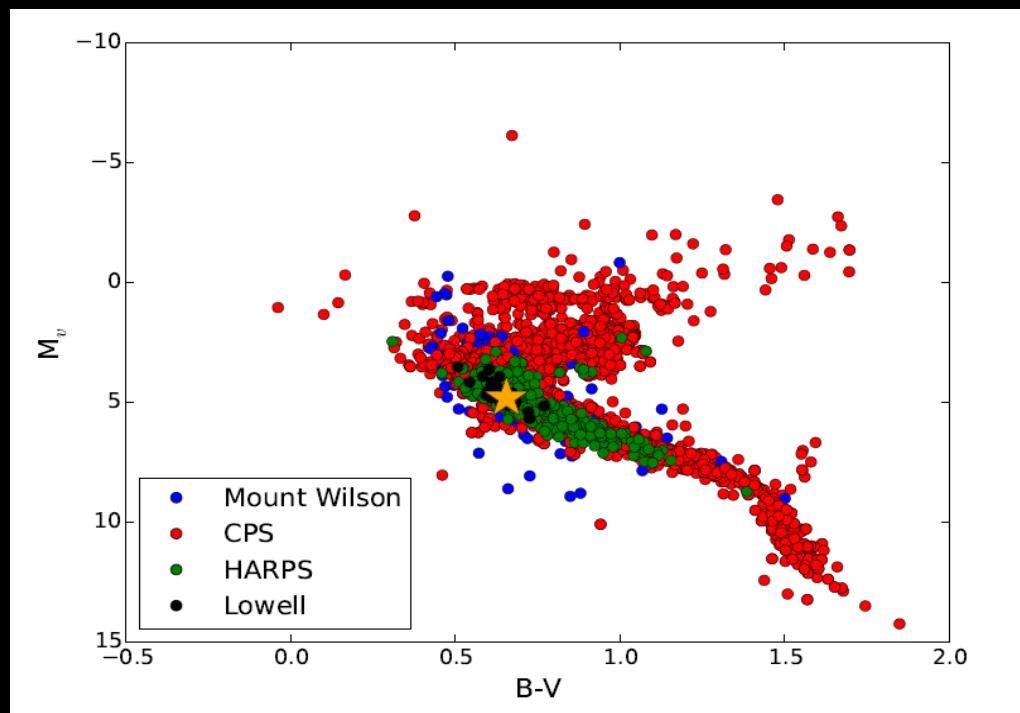


# Unpolarised spectroscopy

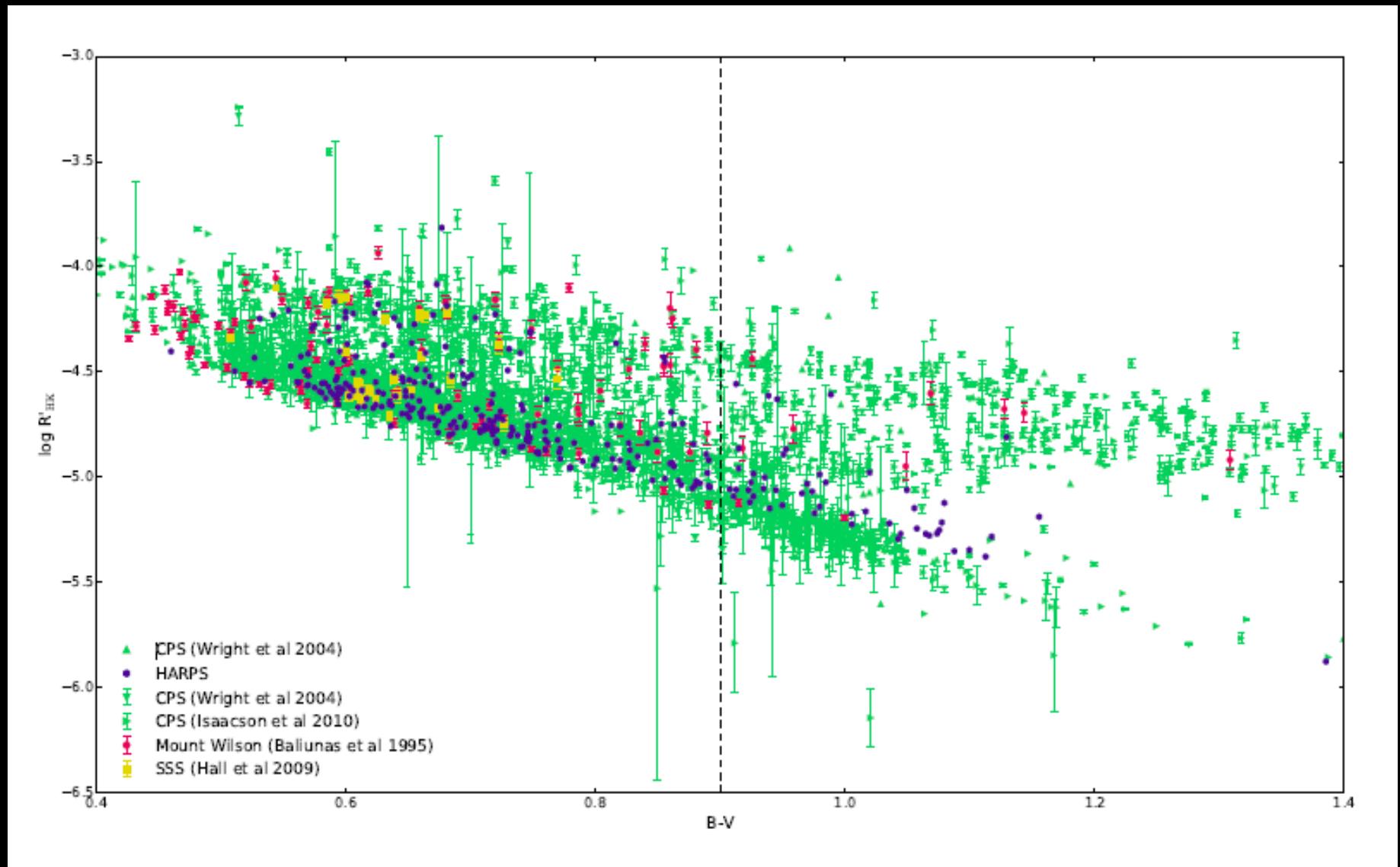
# Catalogue of Ca II H & K

- ~ 4000 F, G, K stars
- Mount Wilson S index
- California Planet Survey
- HARPS spectra
- Lowell observatory

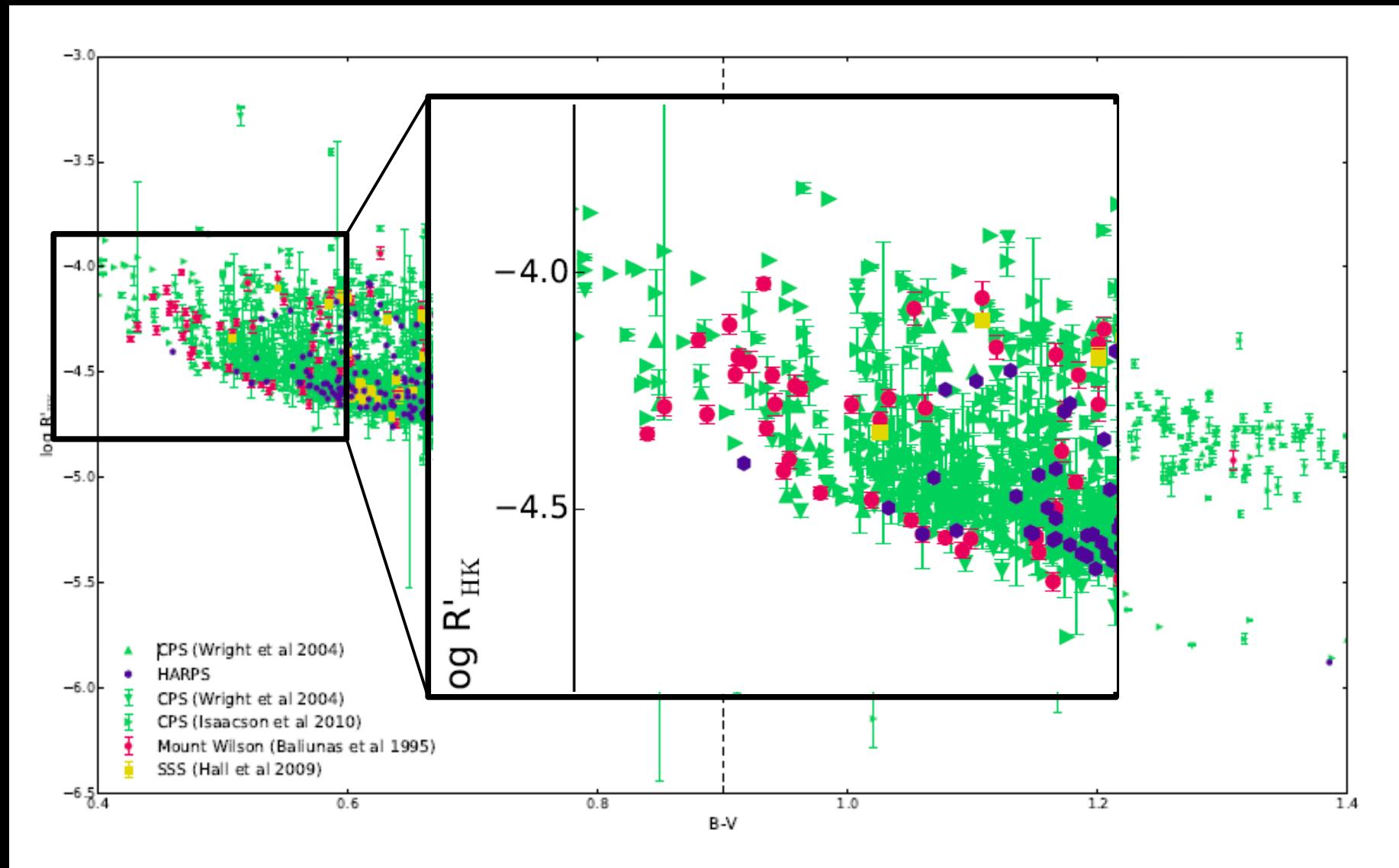
HR diagram



# Current status



# Current status

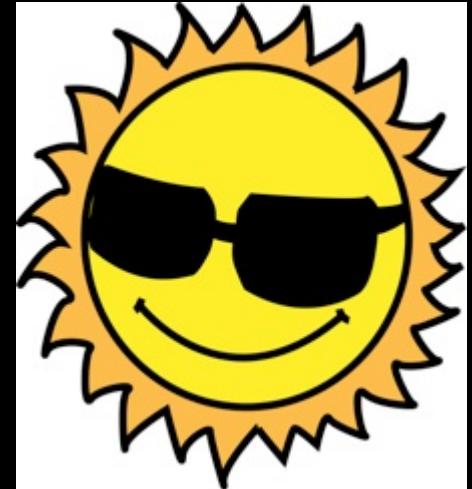


# Polarised spectroscopy

# The BCool Collaboration

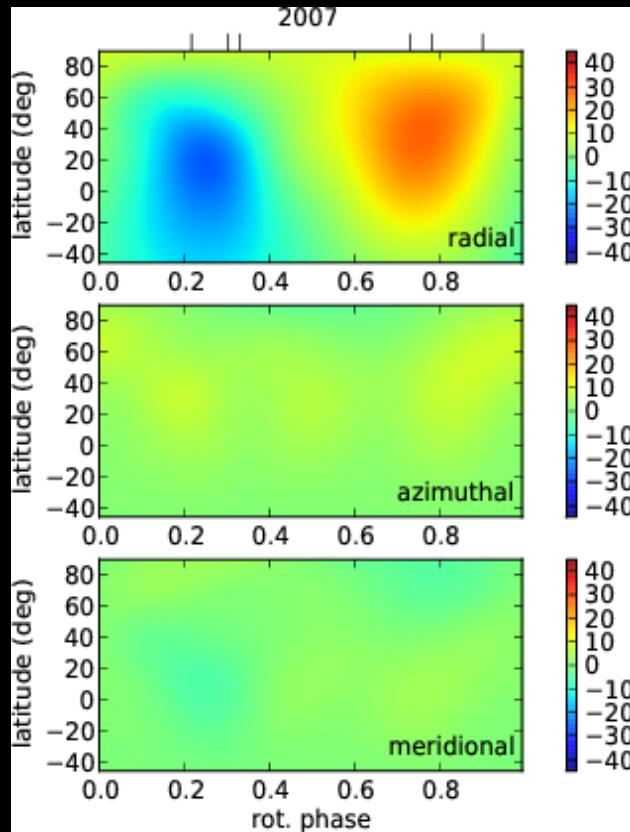
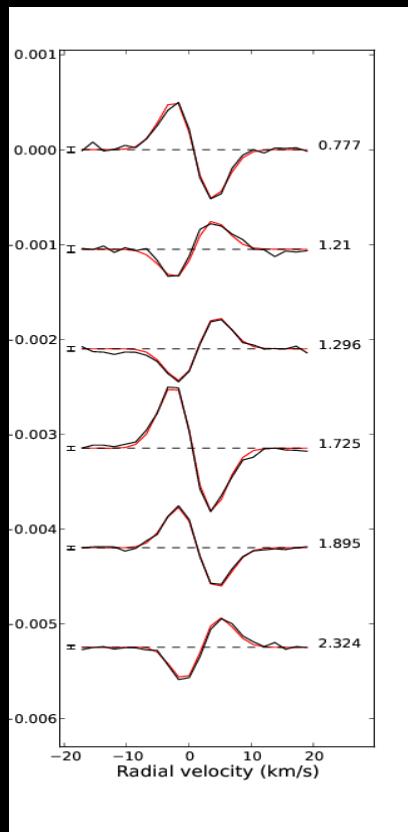
- An international collaboration to study the generation of magnetic fields in cool stars
- AIM is to understand how magnetic activity depends on basic stellar parameters such as rotation rate and mass
- Long-term program using NARVAL @ 2.2m TBL started in 2007
- More than 70 team members

<http://bcool.ast.obs-mip.fr/Bcool>



# Zeeman-Doppler Imaging: Epsilon Eridani

↓ Rotational Phase



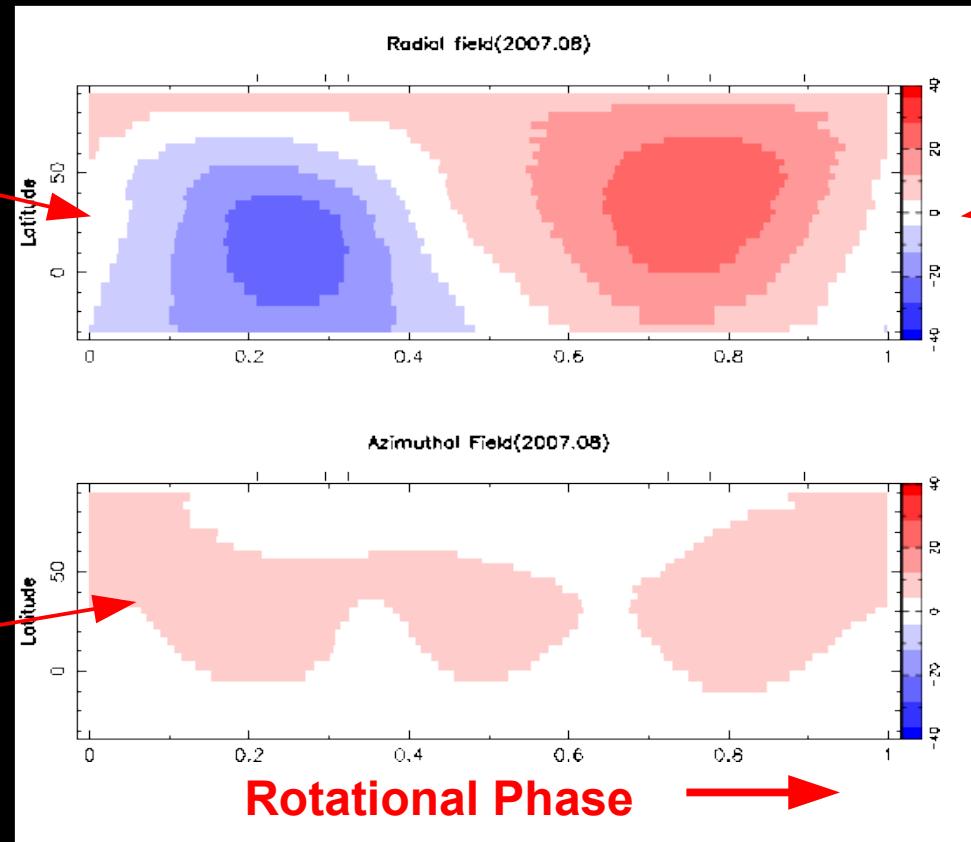
Rotational Phase →

M<sub>v</sub> = 3.7 : V<sub>sin*i*</sub> = 2.4 km/s : K2V : period = 11.68 days : inc = 46 degrees

Jeffers et al. 2014

# Epsilon Eridani: ~ yearly epochs 2007-2013

Varies from  
dipolar  
to monopolar



Varies from  
non existent  
to dominating  
magnetic energy

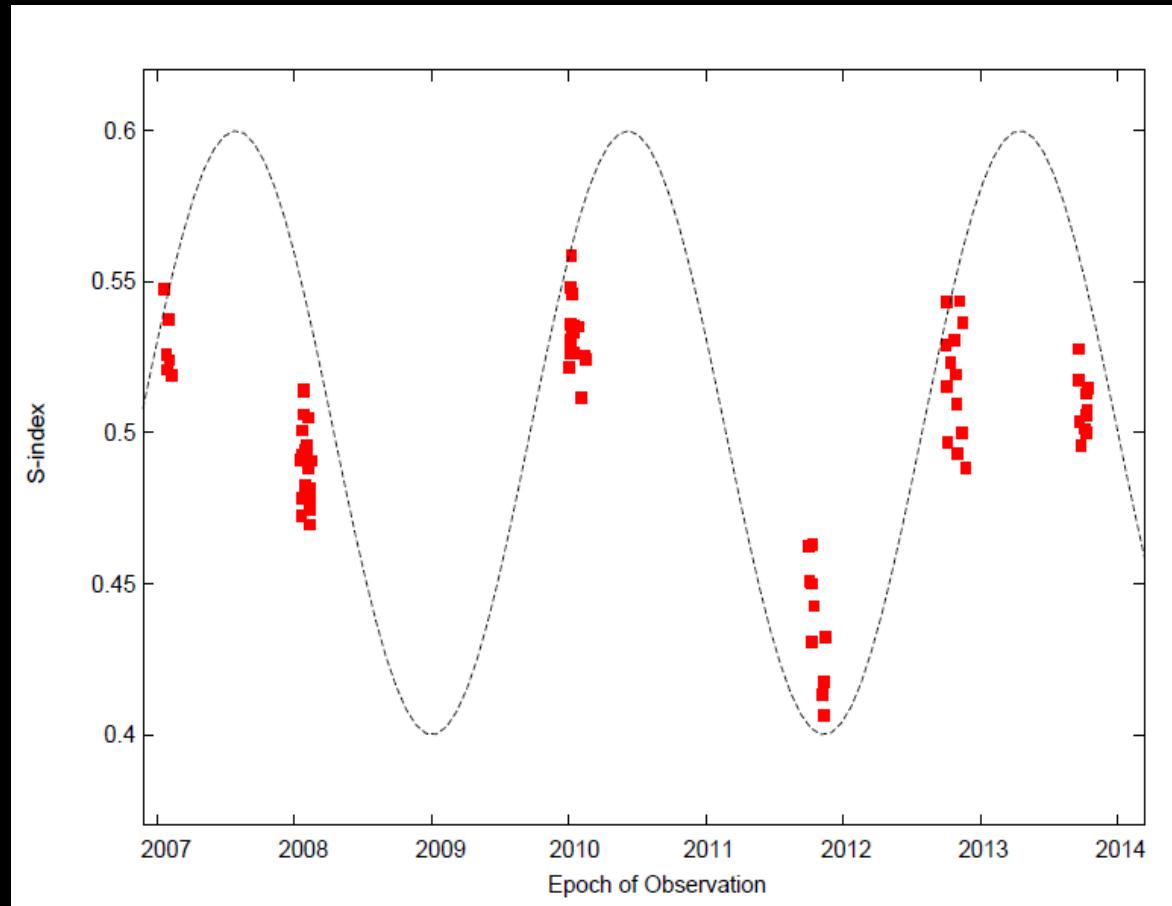
Potential cycle!

No correlation  
with S-index

$M_v = 3.7$  :  $V_{\text{sin} i} = 2.4 \text{ km/s}$  : K2V : period = 11.68 days : age = 400 Myr

Jeffers et al. 2014

# Epsilon Eridani: ~ yearly epochs 2007-2013



No correlation  
with S-index

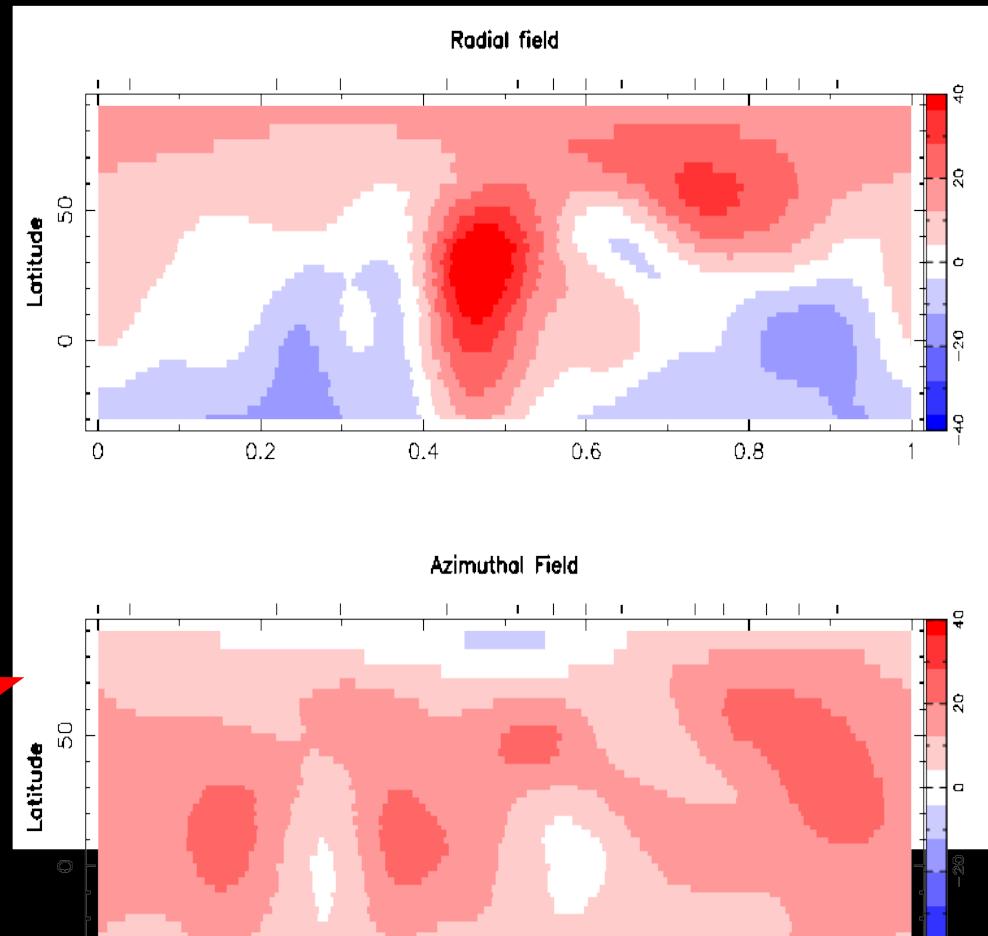
$M_v = 3.7$  :  $V_{\text{sin}i} = 2.4 \text{ km/s}$  : K2V : period = 11.68 days : age = 400 Myr

Jeffers et al. 2014

# HN Peg: ~ yearly epochs 2007-2013

Stable +ve  
polarity at  
all epochs

Strongly  
variable:  
disappears  
and  
reappears

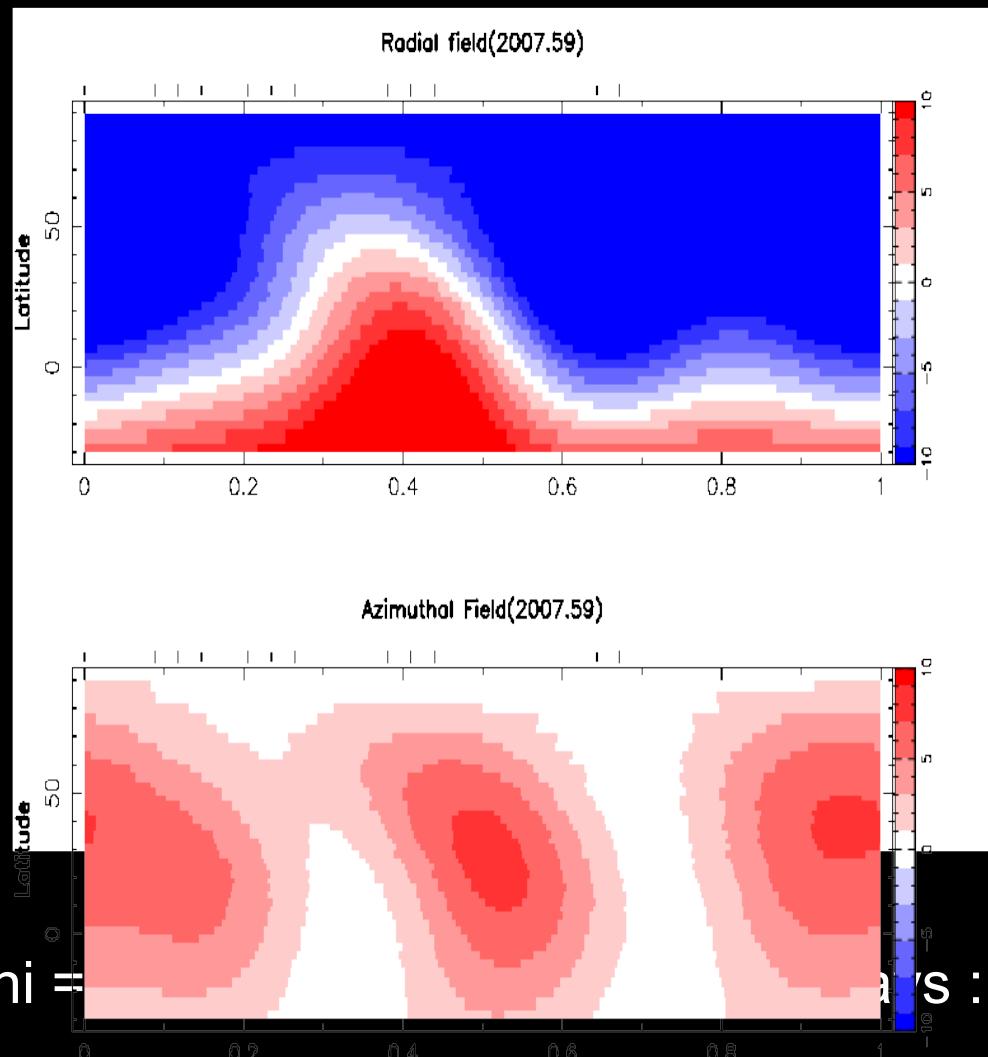


M<sub>v</sub> = 5.9 : V<sub>sini</sub> = 10.6 km/s : G0V : period = 4.6 days : age = 200 Myr

Boro Saikia et al. 2015

# 61 Cyg A: ~ yearly epochs 2007-2014

Polarity reversals  
in all three  
components!



Correlation  
with S-index!

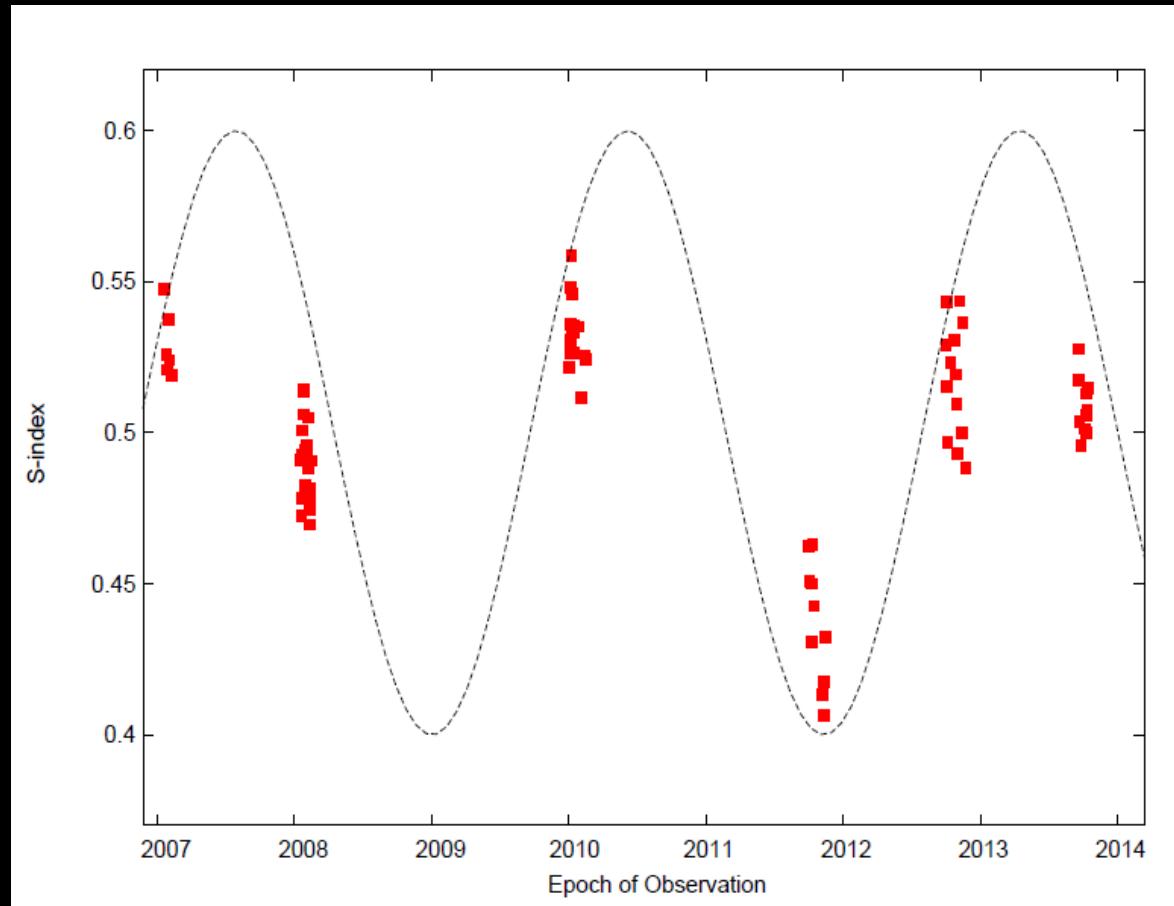
M<sub>v</sub> = 5.21 : V<sub>sin i</sub> = ? : S : Age = 2-3 Gyr

Boro Saikia et al. 2015b

# Summary of BCool targets with long-term monitoring

BCool target	Spectral type	V <sub>sin</sub> i Km/s	Mass M <sub>sun</sub>	Age (Gyr)	Period (d)	Magnetic cycle
HN Peg	G0	10.6	1.085	0.2	4.6	No
ε Eri	K2	2.4	0.70	0.44	11.6	Maybe
61 Cyg A	K5	4.7	0.66	2-6	35.4	Maybe
HD190771	G2	4.3	0.96	2.7	8.8	Maybe
HD78366	G0	3.9	1.34	2.5	11.4	Yes
Tau Boo	F7	15	1.42	1.3	3.3	Yes
ξ Boo A	G7	3	0.85	0.22	6.4	No

# Epsilon Eridani: ~ yearly epochs 2007-2013

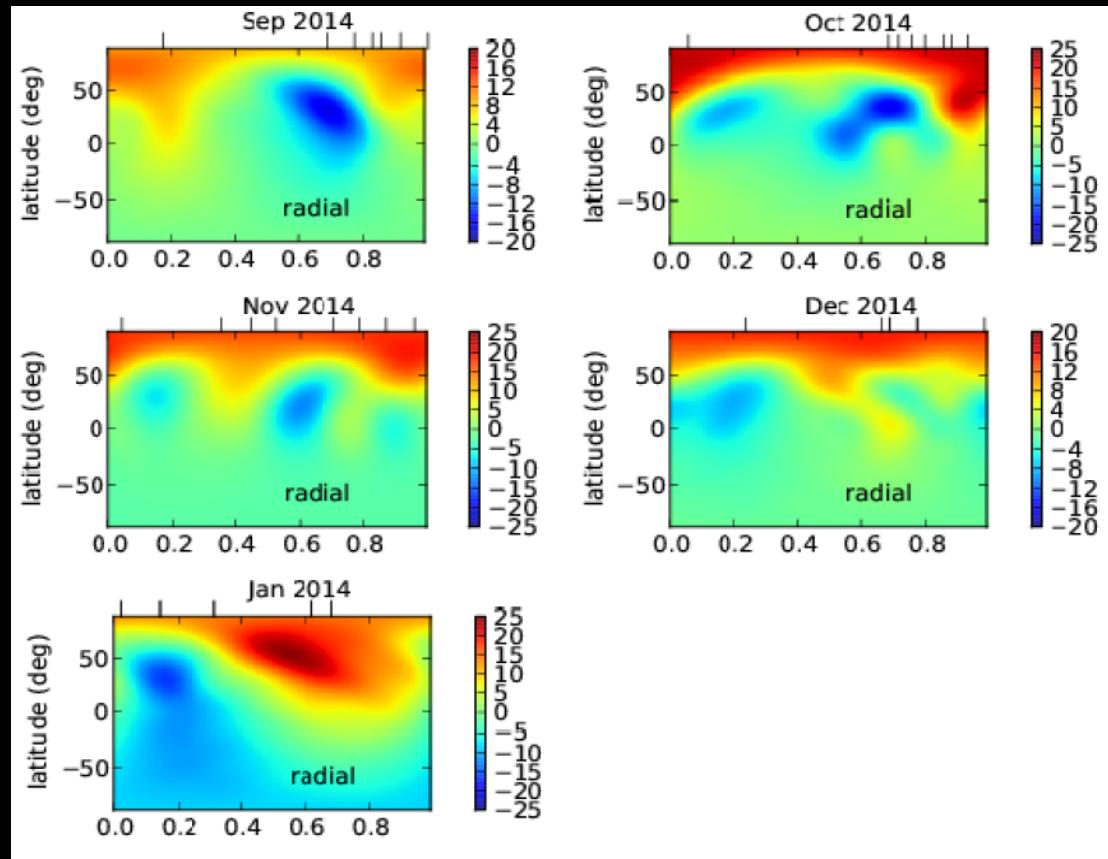


No correlation  
with S-index

$M_v = 3.7$  :  $V_{\text{sin} i} = 2.4 \text{ km/s}$  : K2V : period = 11.68 days : age = 400 Myr

Jeffers et al. 2014

# Epsilon Eridani: ~ monthly epochs 10/2014-01/2015



$M_v = 3.7$  :  $V_{\text{sin} i} = 2.4 \text{ km/s}$  : K2V : period = 11.68 days : age = 400 Myr

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