

The BRITE spectropolarimetric survey

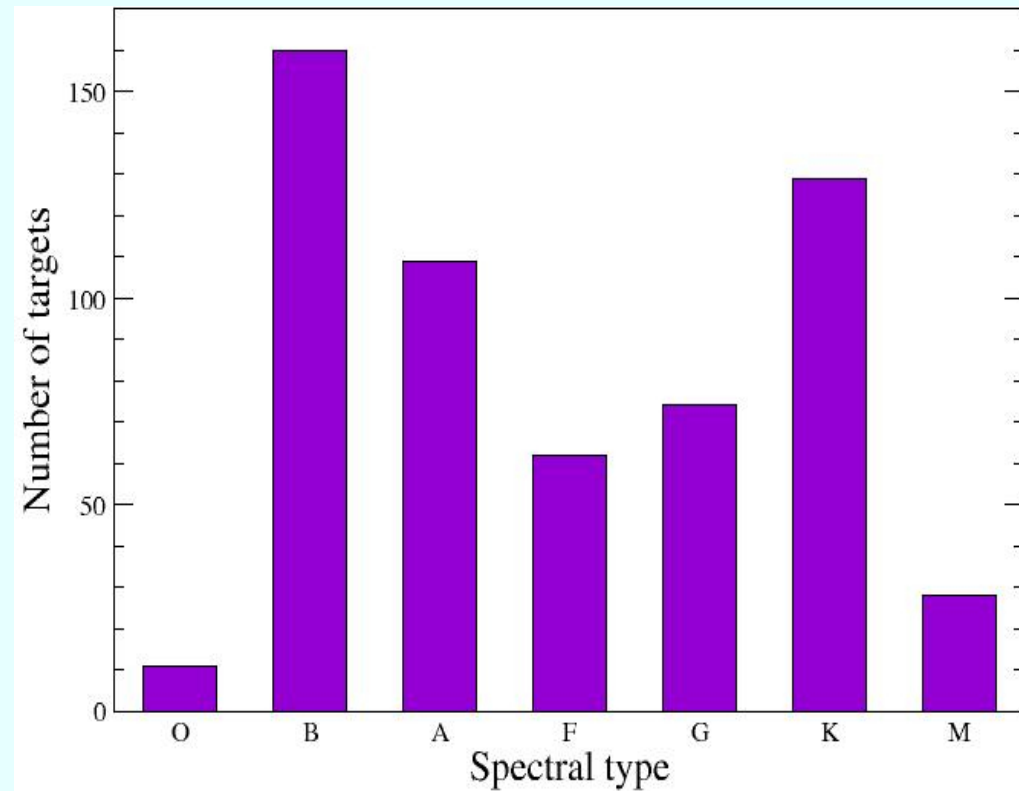
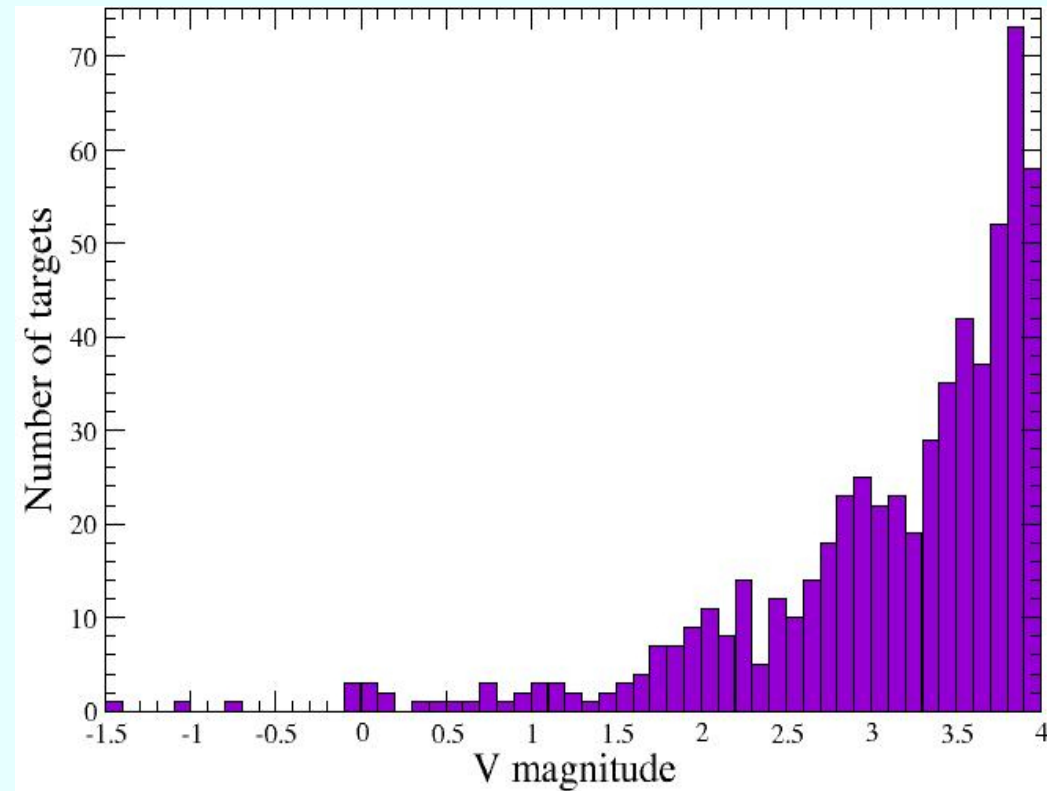
Coralie Neiner

LESIA, Paris Observatory, France

with inputs from A. Blazère, A. Lèbre, J. Morin, G. Wade

Spectropolarimetric survey: targets

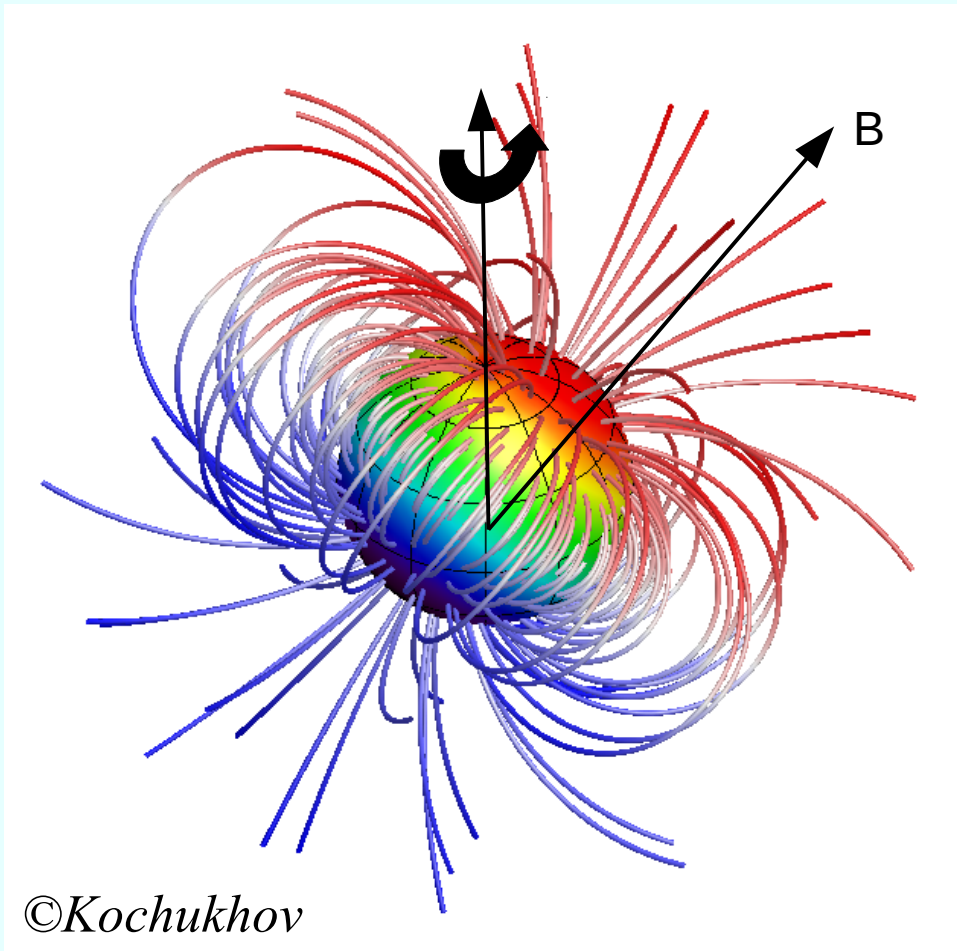
~600 stars with $V < 4$: ~100 already in spectropolarimetric archives
~500 to be observed



~50% hot stars + ~50% evolved cool stars

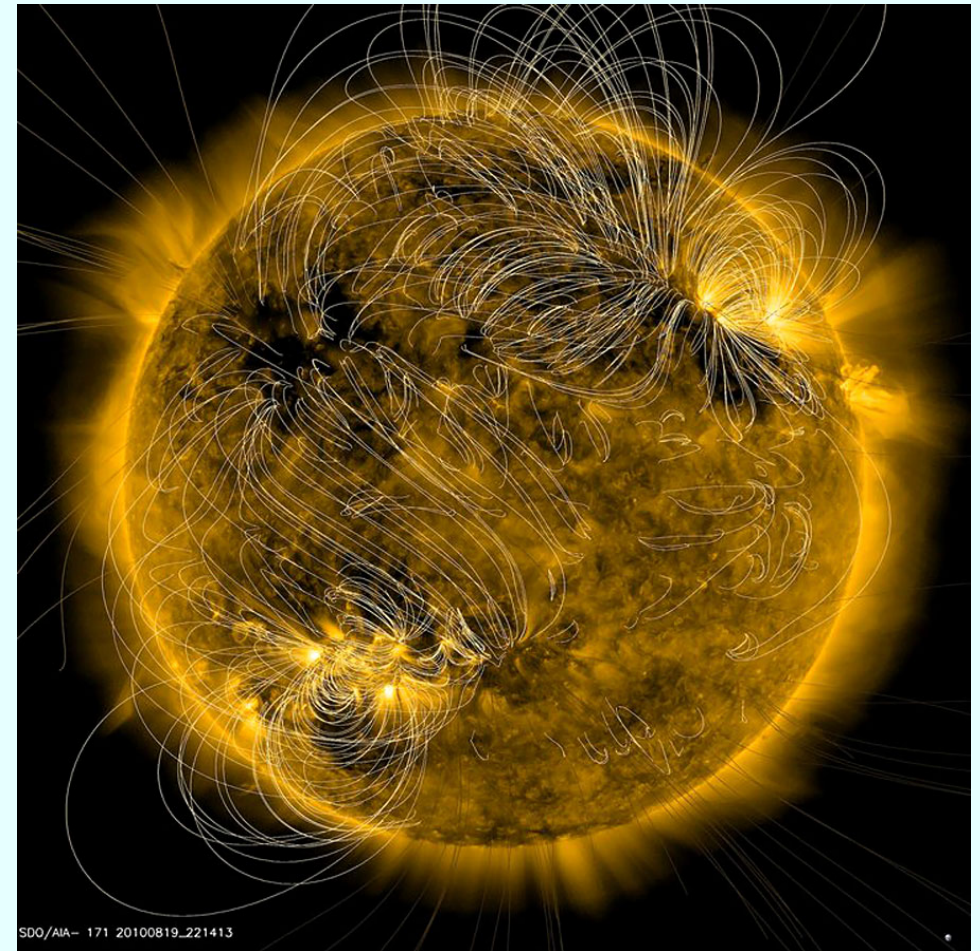
Dynamo vs Fossil fields

Hot stars (O \rightarrow F5)



\rightarrow **Fossil** fields, simple, stable, rotationally modulated

Cool stars (F5 \rightarrow M)



\rightarrow **Dynamo** fields, produced contemporaneously, variable

Spectropolarimetric observations

High-resolution spectropolarimetry with:

- Narval at TBL PI C. Neiner 93 hours + C-time
- ESPaDOnS at CFHT PI G. Wade 56 hours
- HarpsPol at ESO PI C. Neiner 18 nights (=156 hours)

Circular polarisation (Stokes V)

High quality spectra: **SNR>1000**

- 1 measurement per star + 1 confirmation if magnetic detection
- Follow-up of the most interesting targets for full field characterisation
- Final goal: magnetism to constrain seismic models



Status of the survey

| Instrument | # spectra | # stars | Completion | Declination |
|------------|-----------|----------------|------------|----------------------------------|
| Narval | 845 | 205 out of 255 | 80% | $\delta > -20^\circ$ |
| ESPaDOnS | 741 | 89 out of 121 | 74% | $-45^\circ < \delta < -20^\circ$ |
| HarpsPol | 553 | 91 out of 121 | 75% | $\delta < -45^\circ$ |

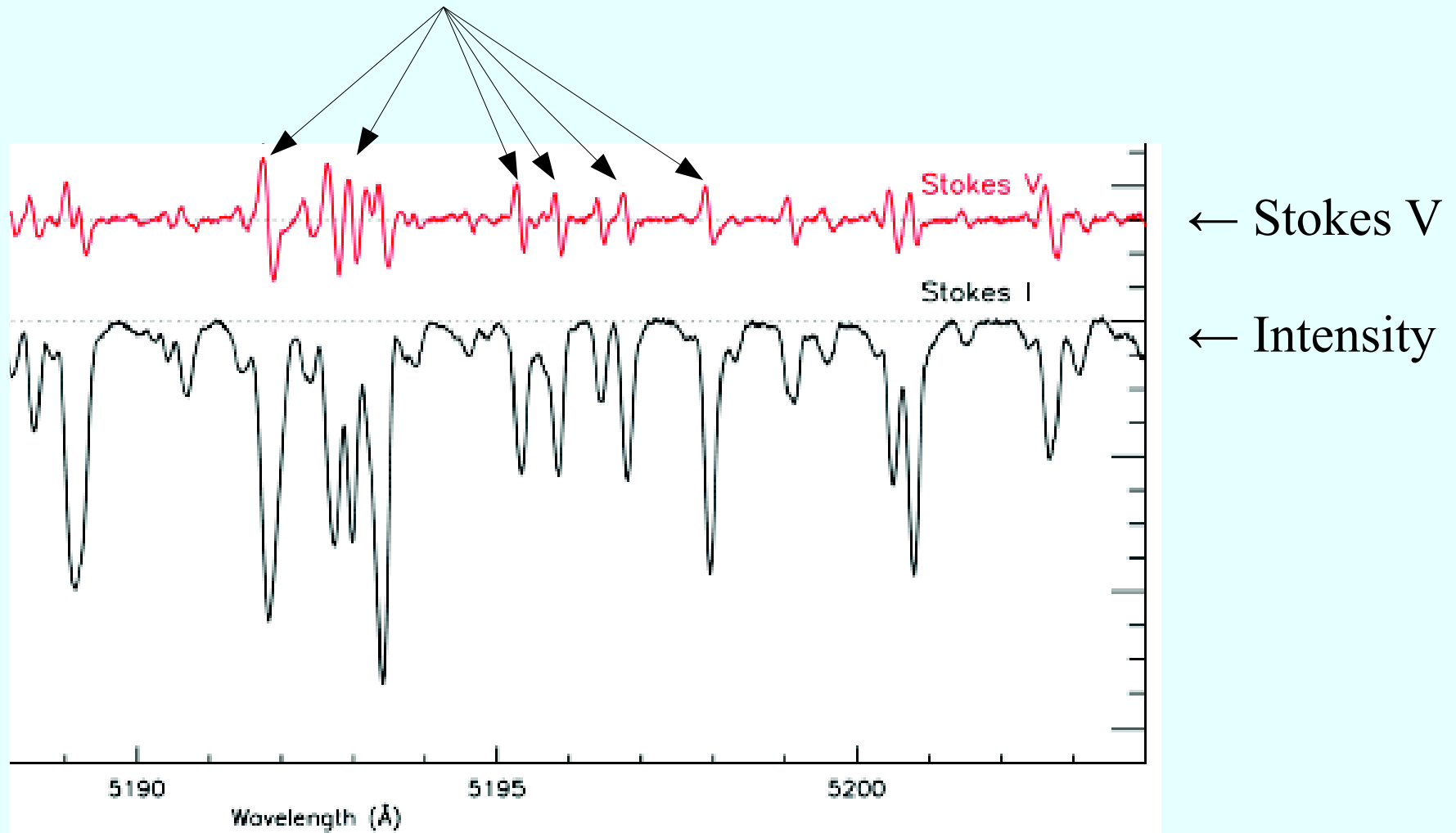
- ~77% completion (+ archives)
- 100% in February 2016

Magnetic detections:

- 46 stars (~12%) found to be magnetic!

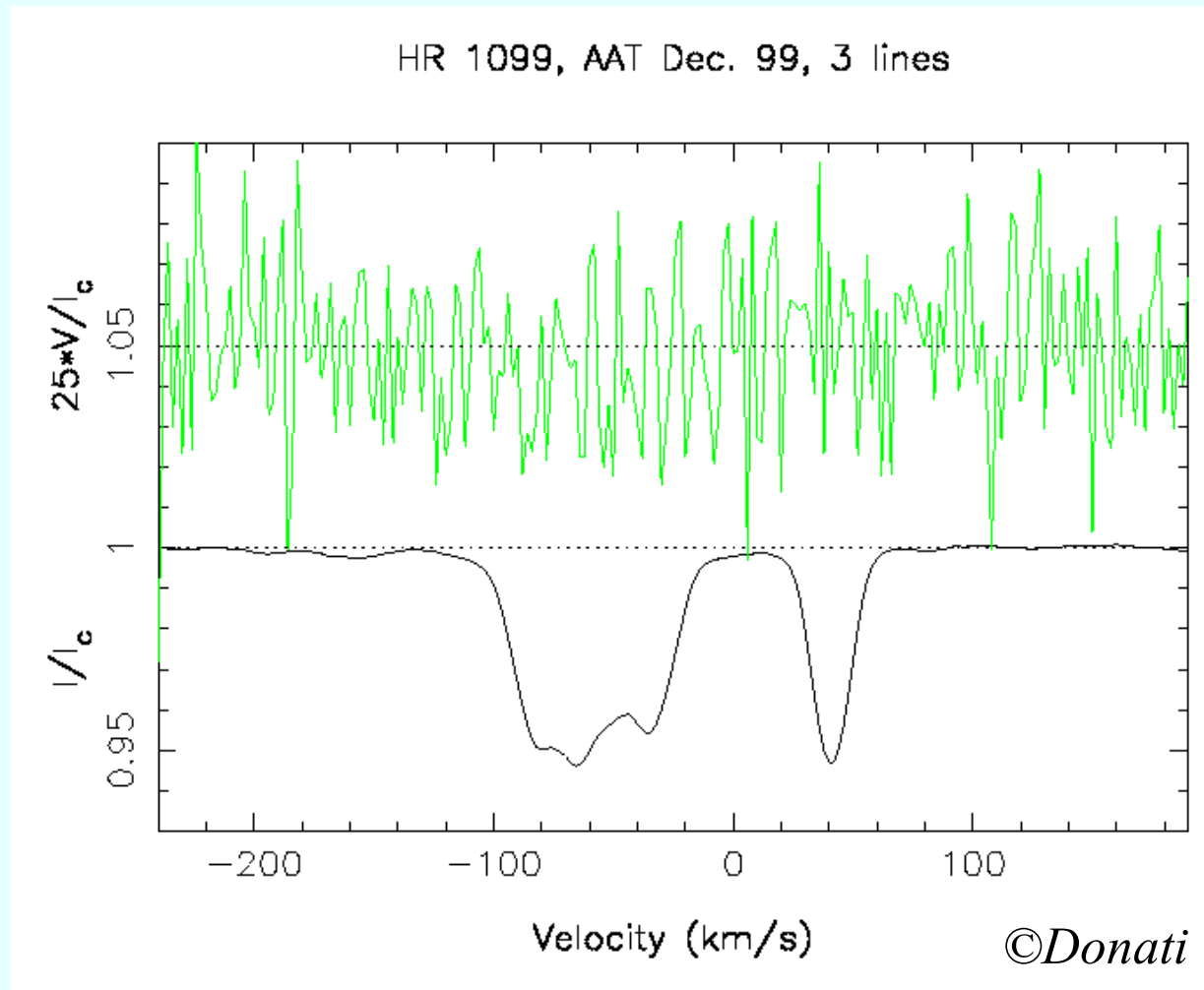
Magnetic measurement: Stokes V spectra

Zeeman signature of a magnetic field in each line



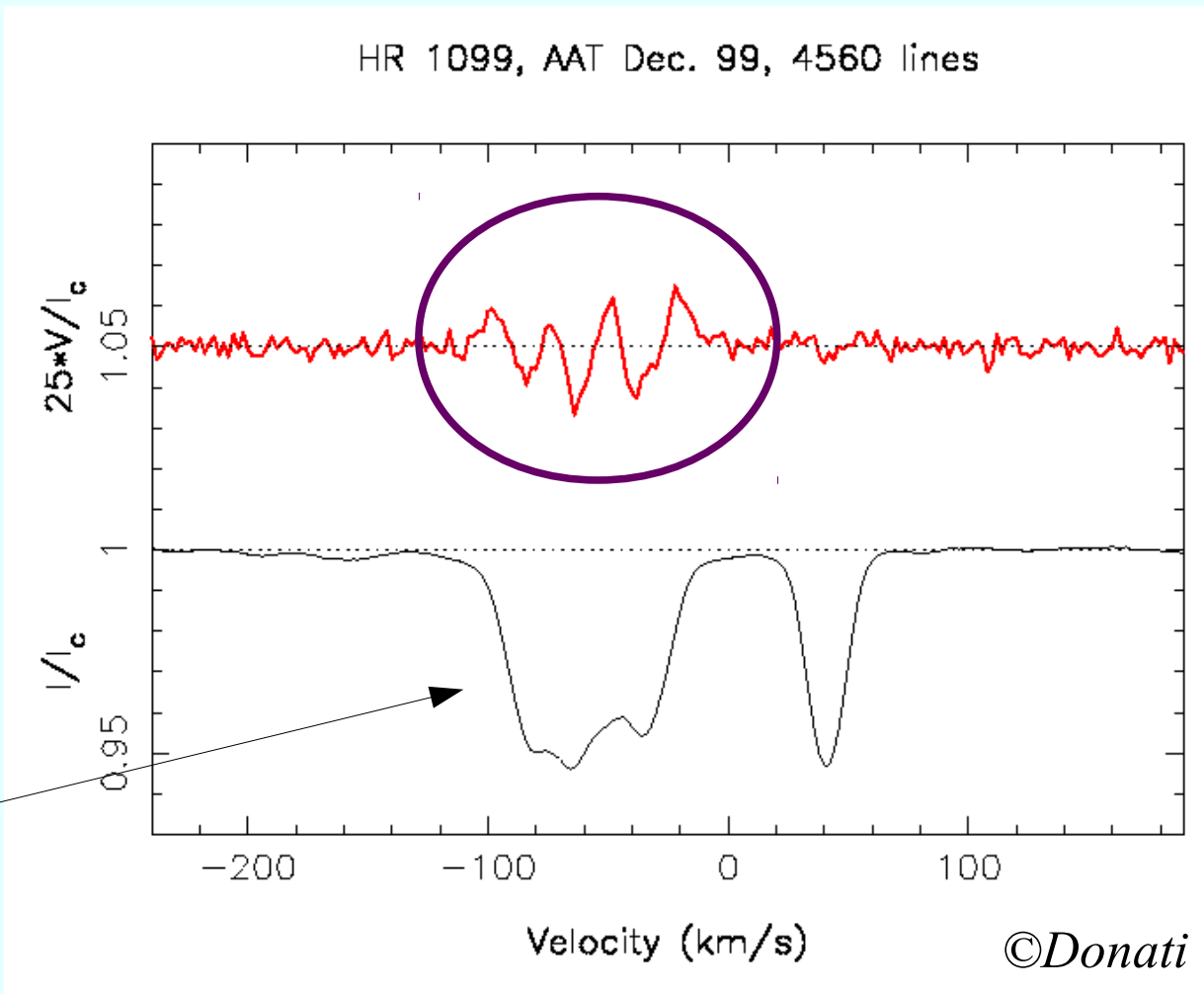
Magnetic measurement: LSD

Spectropolarimetric observation of **1 line** of a binary star



Magnetic measurement: LSD

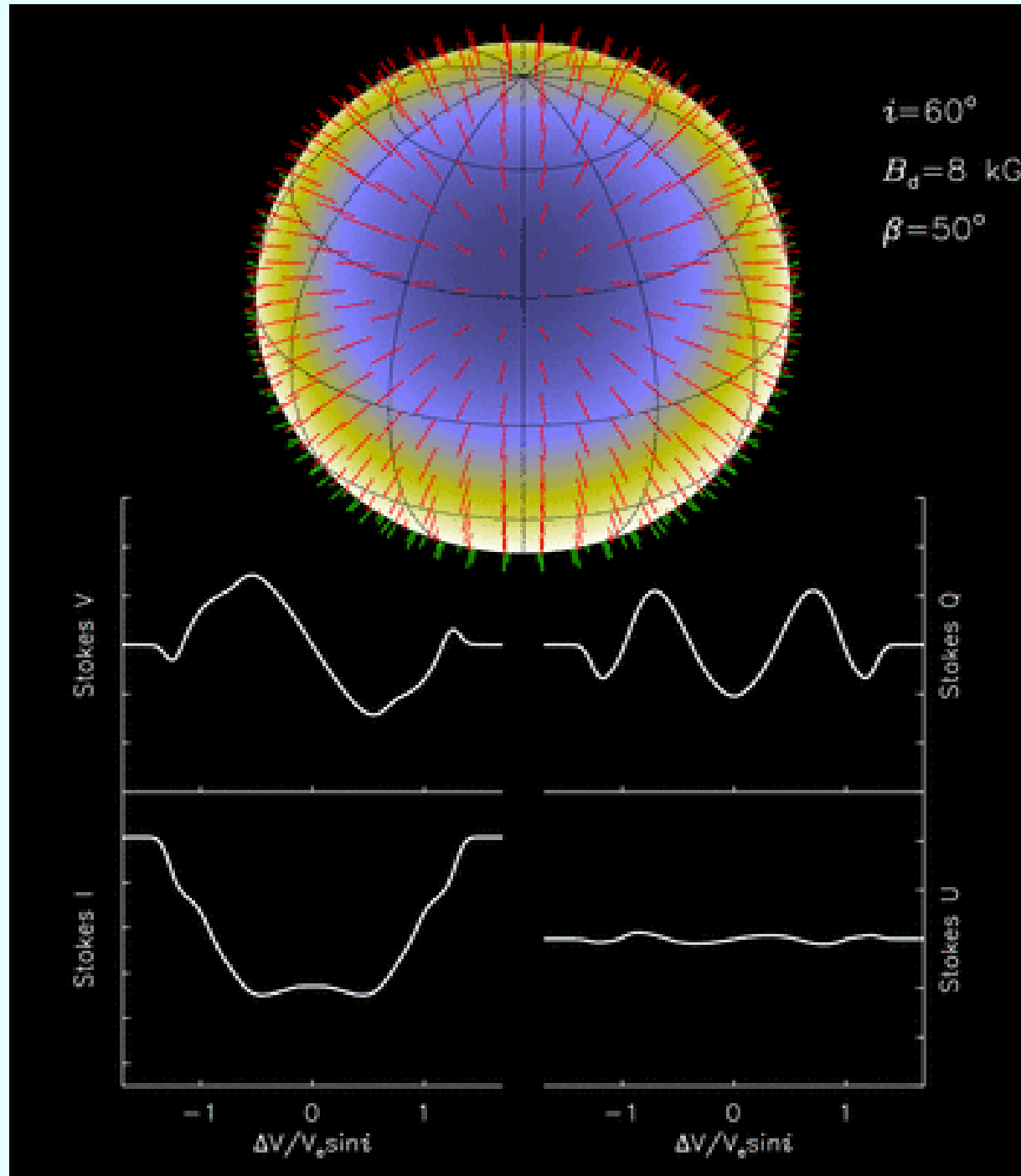
Averaged spectropolarimetric observation of **all lines** of a binary star



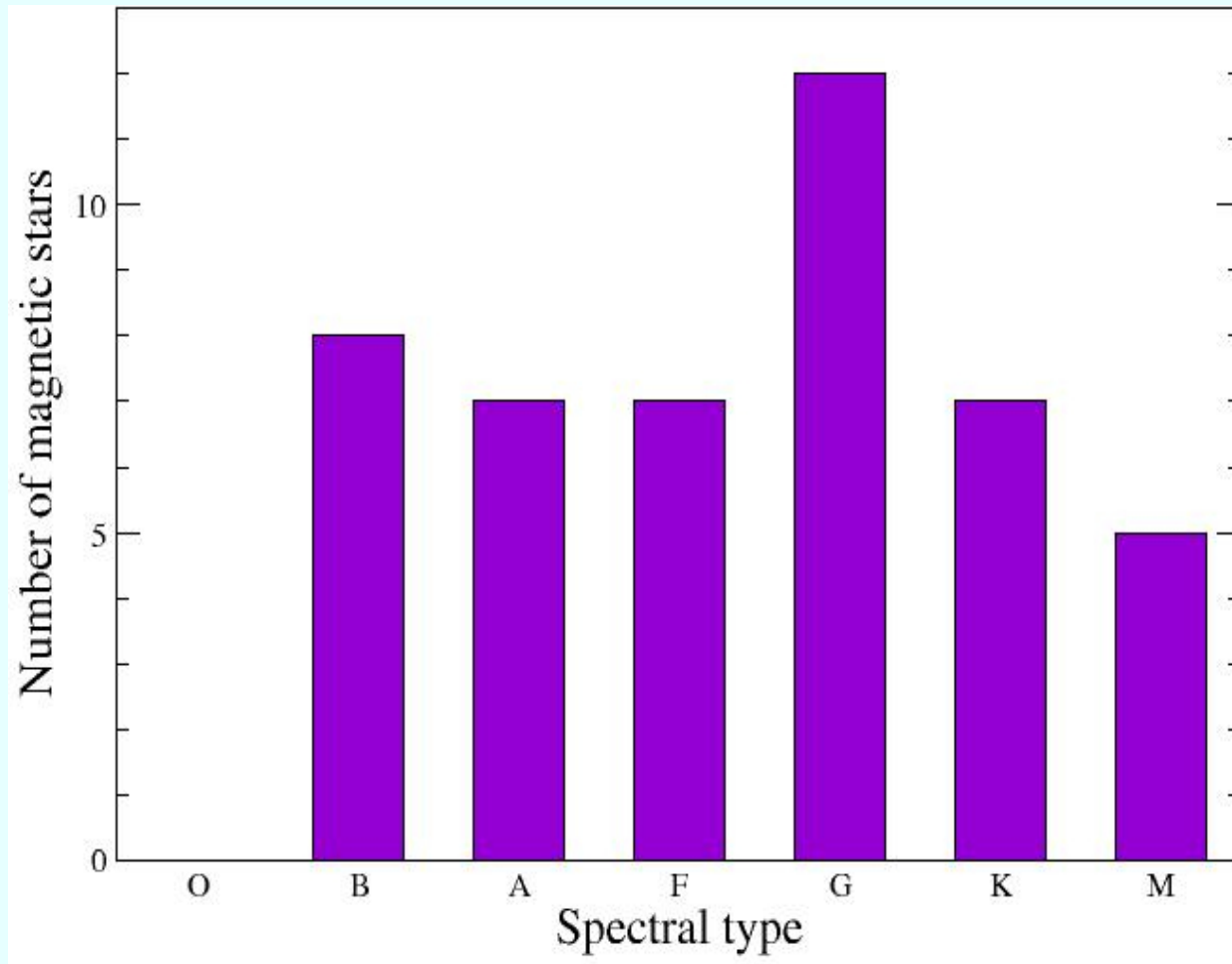
This star is magnetic!

LSD allows to gain **a factor 3 to 30 in SNR**

Magnetic measurement: rotational modulation



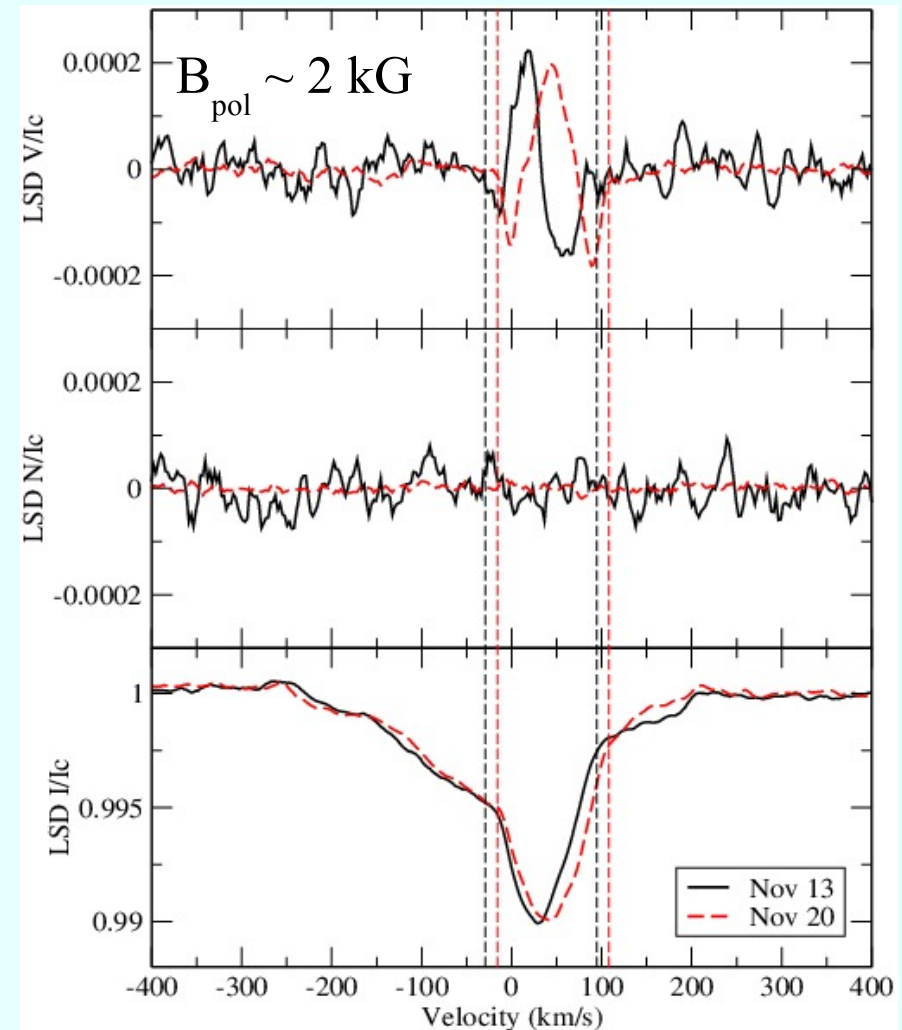
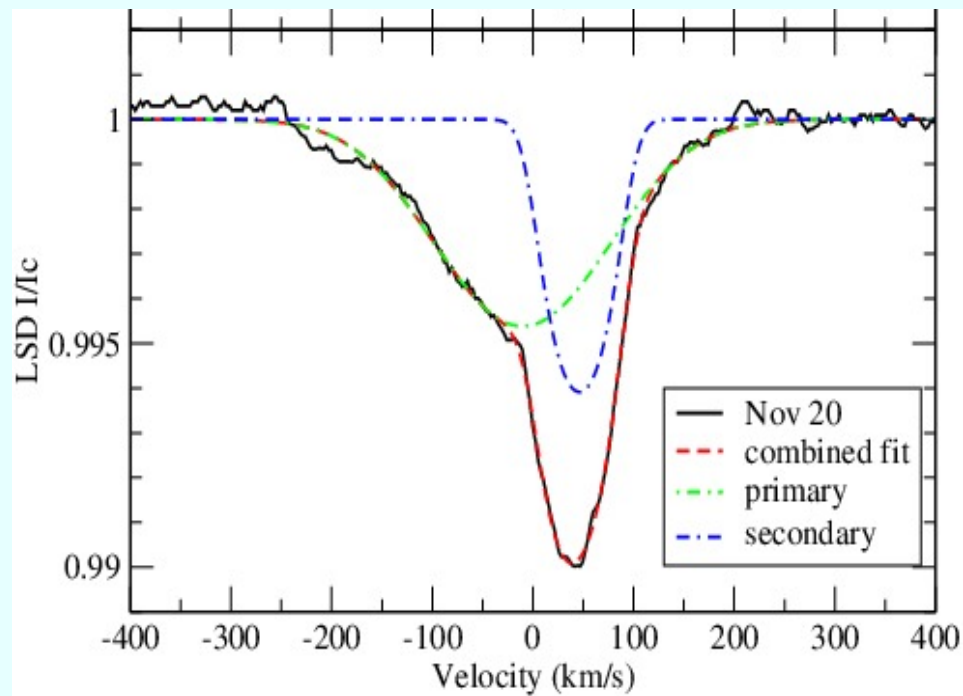
Magnetic detections in the BRITe survey



46 magnetic detections:

- 3 BA supergiants
- 12 other BA stars
- 8 FGK dwarfs/subdwarfs
- 18 FGK giants/supergiants
- 5 M giants

Example: the binary B8V+B8III star Atlas

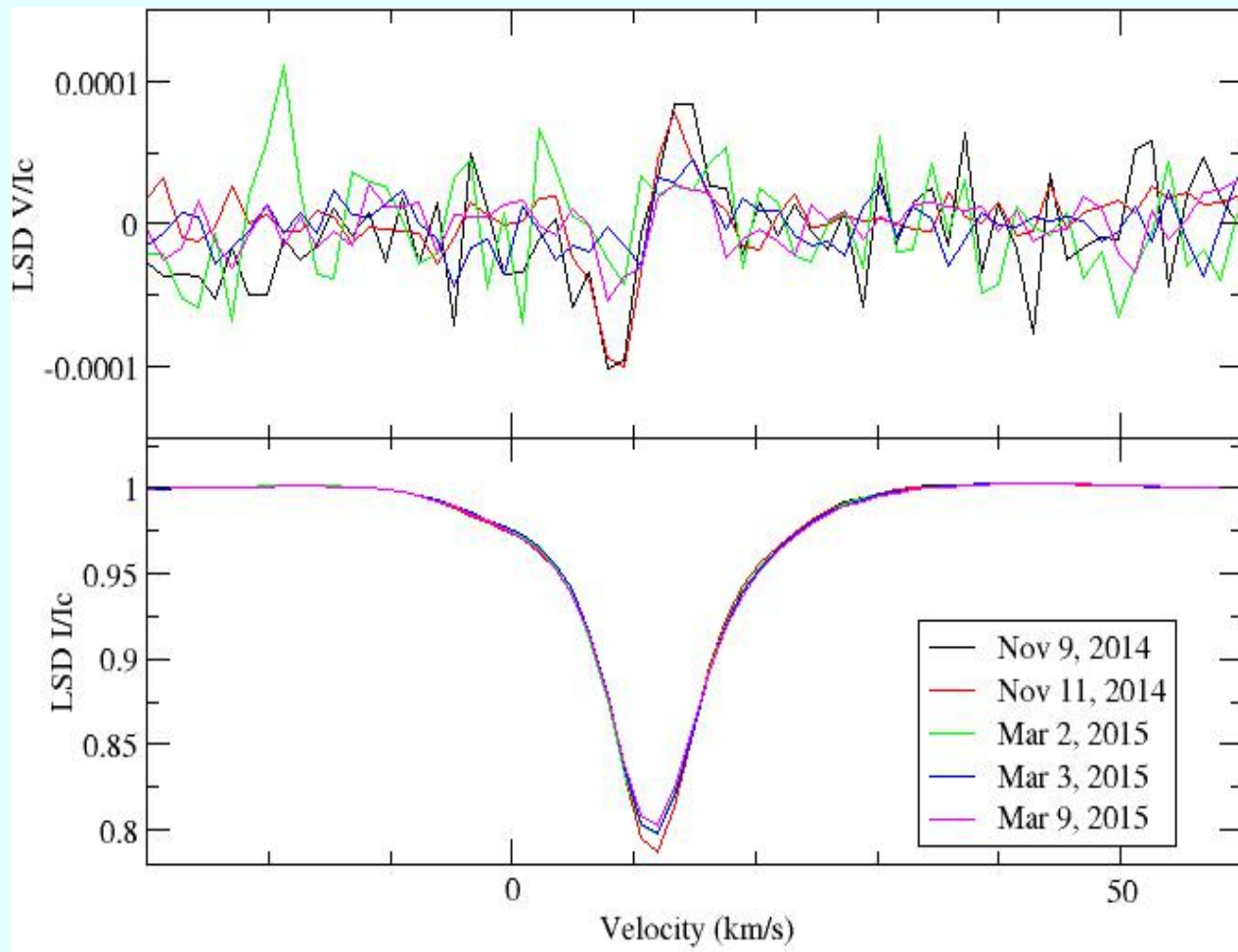


Pleiades → known distance and age

Neiner+ 2015

- binaries require the separation of the components to extract the field strength
- Atlas has been observed by Kepler2
- for detailed analysis of B stars, see talks by B. Buysschaert and by G. Wade

Example: hot supergiant stars



$B_{\text{pol}} \sim 15 \text{ G}$
slow rotation

Neiner+ in prep

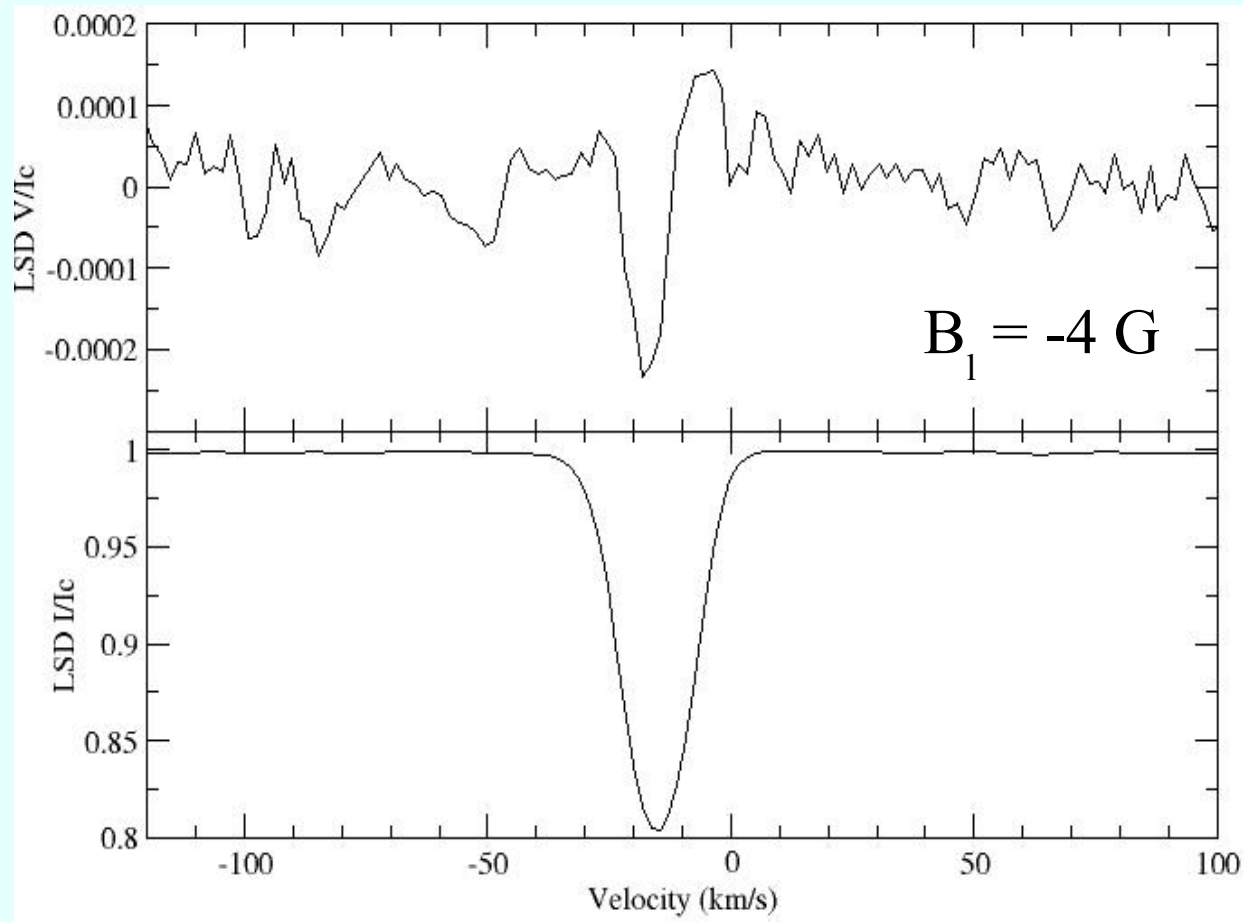
- 3 magnetic hot supergiants discovered!
- Weak fields ($B_{\text{pol}} \sim 5\text{-}15 \text{ G}$)
- magnetic flux conservation during stellar evolution: field on MS was $\sim 5 \text{ kG}$

Example: a magnetic Am star

Am stars were not known to be magnetic until recently:

Sirius (*Petit+ 2011*), β UMa and θ Leo (*Blazère+ to be submitted*)

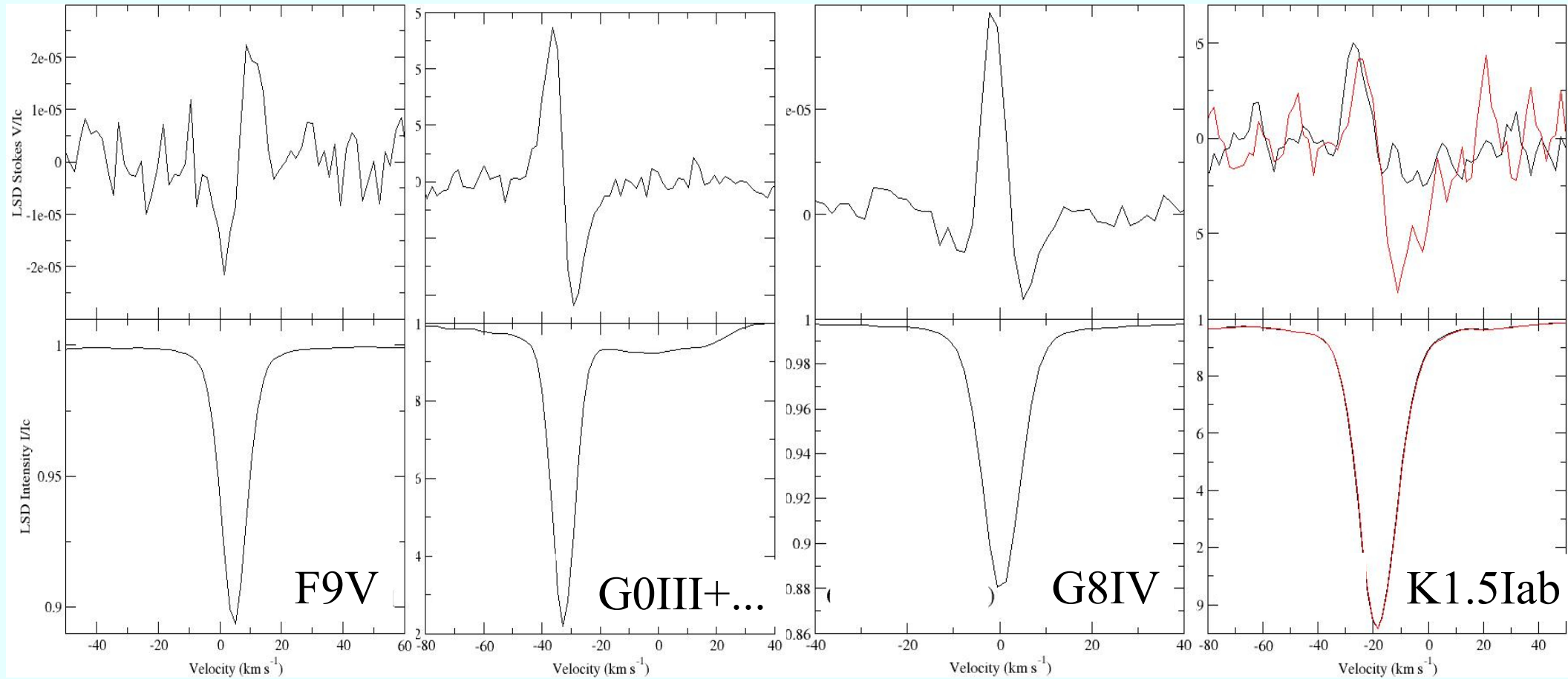
→ ultra weak fields with $B_1 \sim 0.5$ G, with atypical signatures



Blazère+ in prep

→ This star has a stronger polar field ($B_{\text{pol}} \sim 15$ G) with a more classical signature

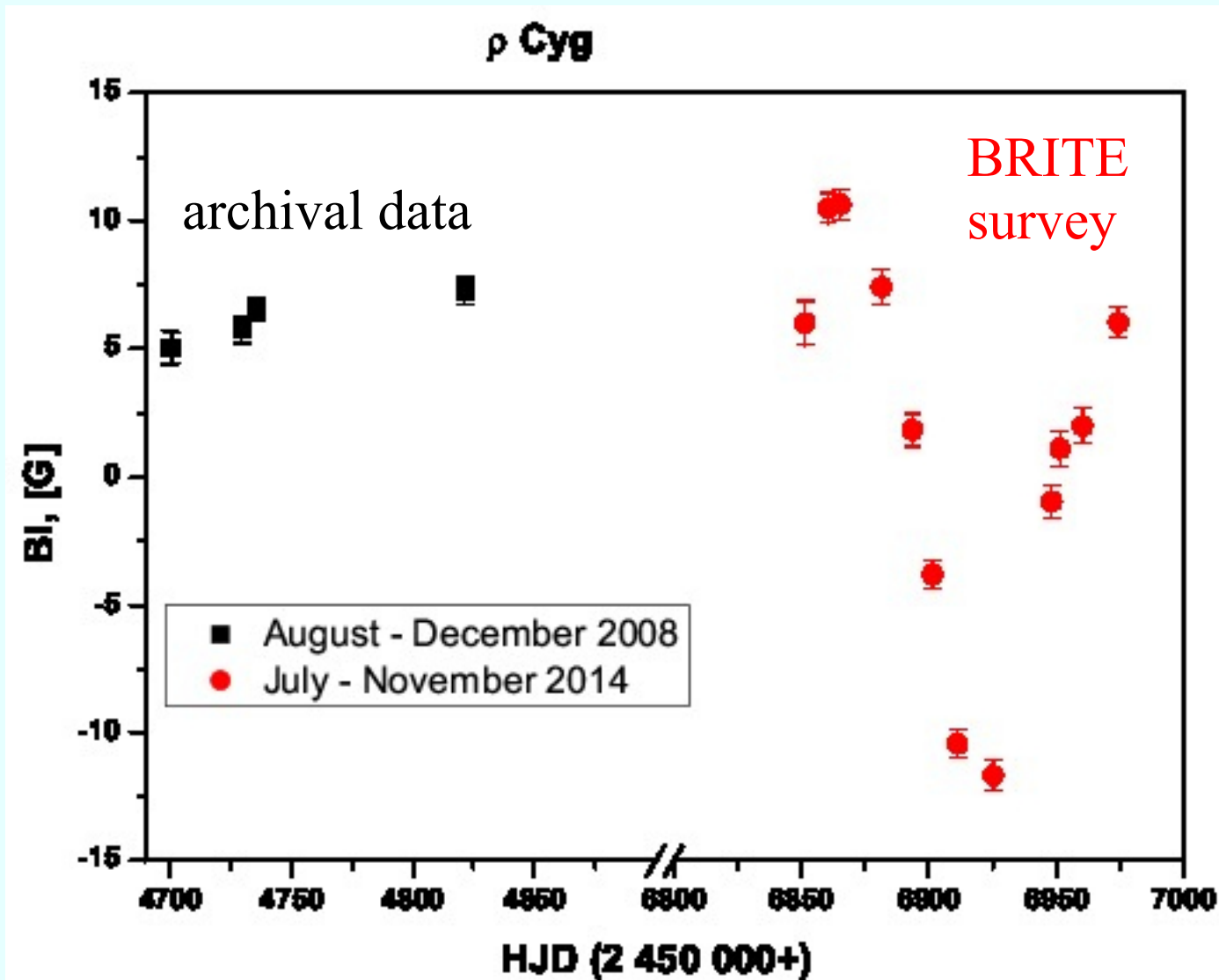
Example: FGK stars



- Many magnetic FGK stars found, but not as many as expected...
- Fields strength of a few G

Lèbre+ in prep

Example: follow up of ρ Cyg (G5III)



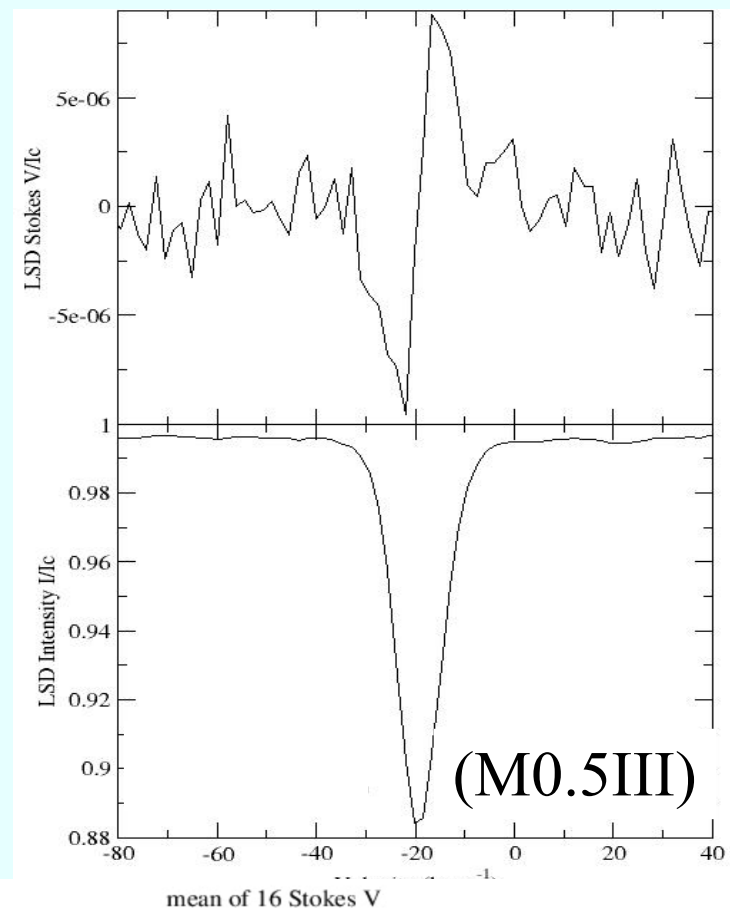
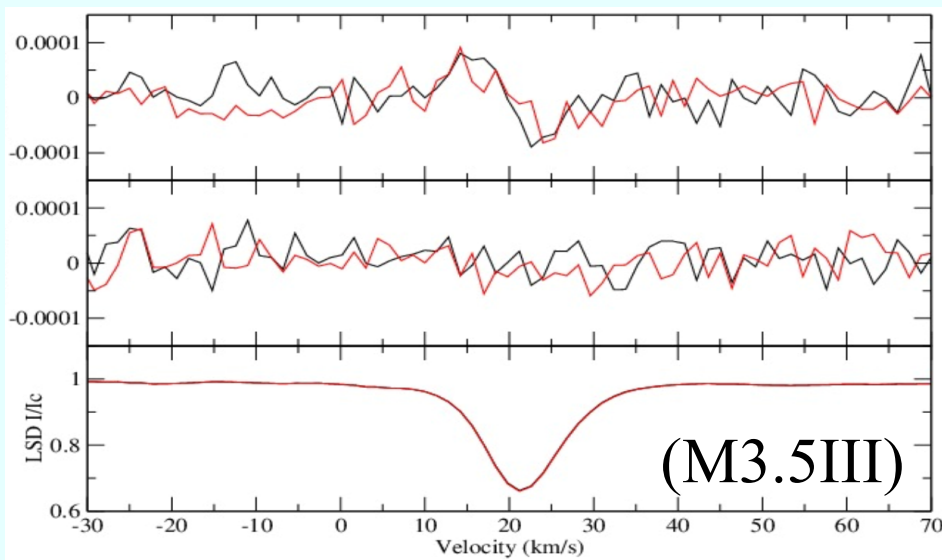
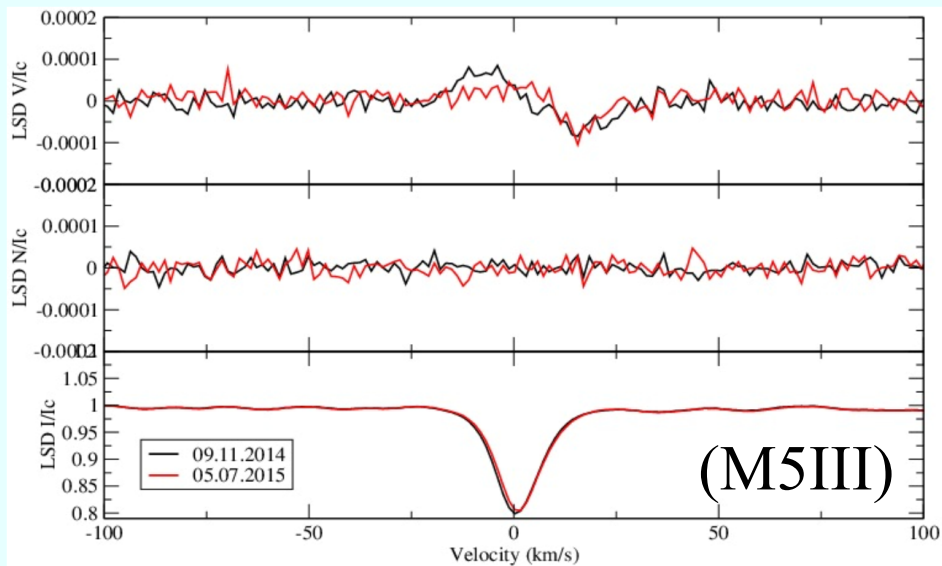
Spectropolarimetry
simultaneous with
BRITE
observations

$P_{\text{rot}} \geq 200 \text{ d} ?$
(Percy+ 2001)

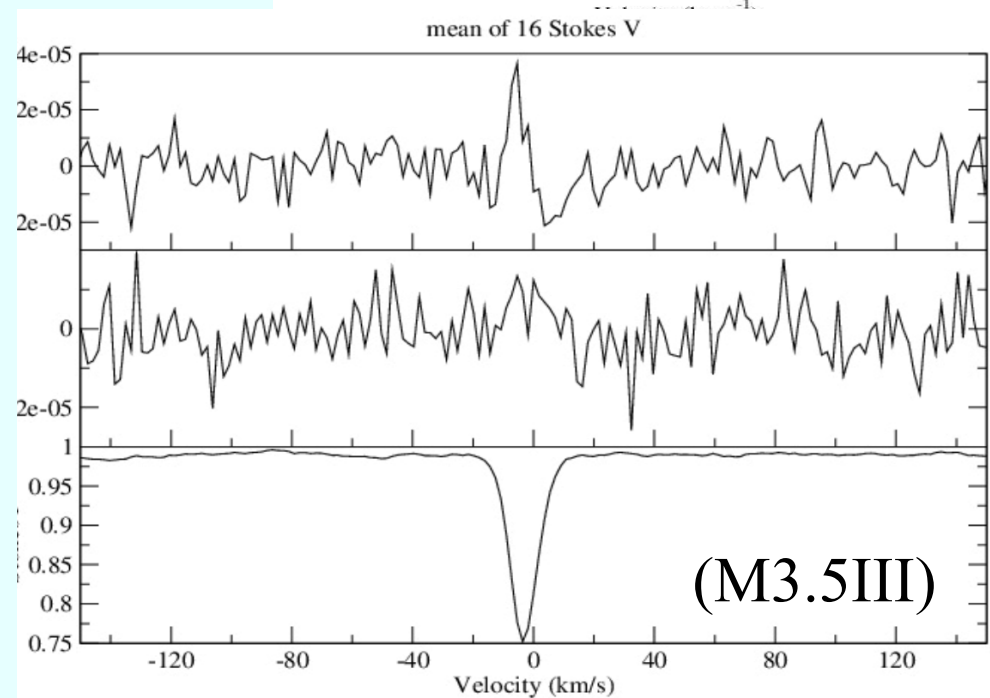
→ probably a
descendant of an
Ap star

Konstantinova+ in prep

Example: M giants



Morin+ in prep



→ Fields in M giants come and go...

Combining magnetic+seismic studies

Knowing that the star is magnetic is important!

- rotational modulation → rotation period
- mapping of surface spots
- magnetic splitting, amplitude change of modes → mode identification
- magnetism modifies/inhibits mixing → constraint on internal mixing

Knowing that the star is pulsating is important too!

- impact of pulsations on Stokes profiles → strength and configuration of the field (see talks by B. Buysschaert and S. Hubrig)

→ Combining spectropolarimetry with BRITE seismology is very powerful
→ BRITE should observe the magnetic stars!

Conclusions

- Spectropolarimetric survey soon completed
- 1 high resolution, high quality spectrum for each target with $V < 4$
- 46 magnetic detections
- Follow-up for magnetic characterisation has started for selected targets
- Combined seismic + magnetic analysis is very powerful

→ contact me if you want to use the spectra / spectropolarimetric data
if you want to know if your favourite star is magnetic

→ contact the WG leaders if you are interested in a particular type of targets:

| | | | |
|----------|------------|-----------------|------------|
| O stars | G. Wade | FGK MS | P. Petit |
| B stars | C. Neiner | FGK giants | A. Lèbre |
| Be stars | M. Oksala | FGK supergiants | J. Grunhut |
| A stars | L. Fossati | M stars | J. Morin |



britepol: BRITE spectropolarimetric survey Workshop
26-30 Oct 2015 Meudon (France)

October 26-30 at the Meudon Observatory (France)

<http://britepol.sciencesconf.org>