WP5.2-1: large-scale fields of low-mass stars Observations

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Outline

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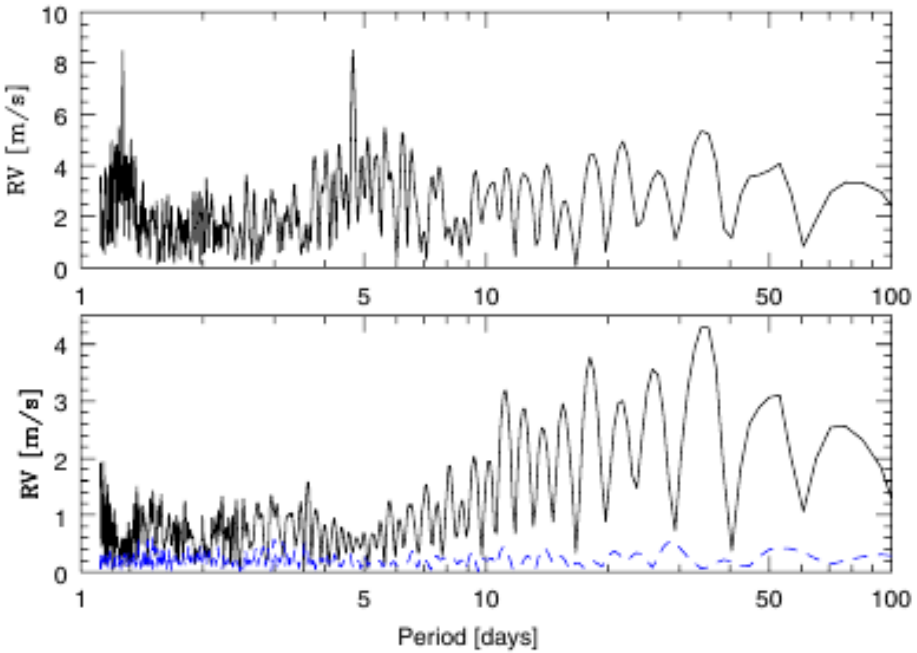
Main aims of WP5.2

- SPIRou goal 1: studying Earth-mass planets around M dwarfs (WP1,2)
- Map large-scale fields of M dwarfs (Zeeman-Doppler Imaging)
  - Planet detection (activity jitter)
  - WP4.2

  ➥ Rotation period
  - Planetary environment
  - WP4.4/4.5

  ➥ "Magnetic HZ"
- SPIRou goal 2: studying star/planetary systems formation (WP3)



Harmonic filtering – GJ 674

Boisse et al. (2011)

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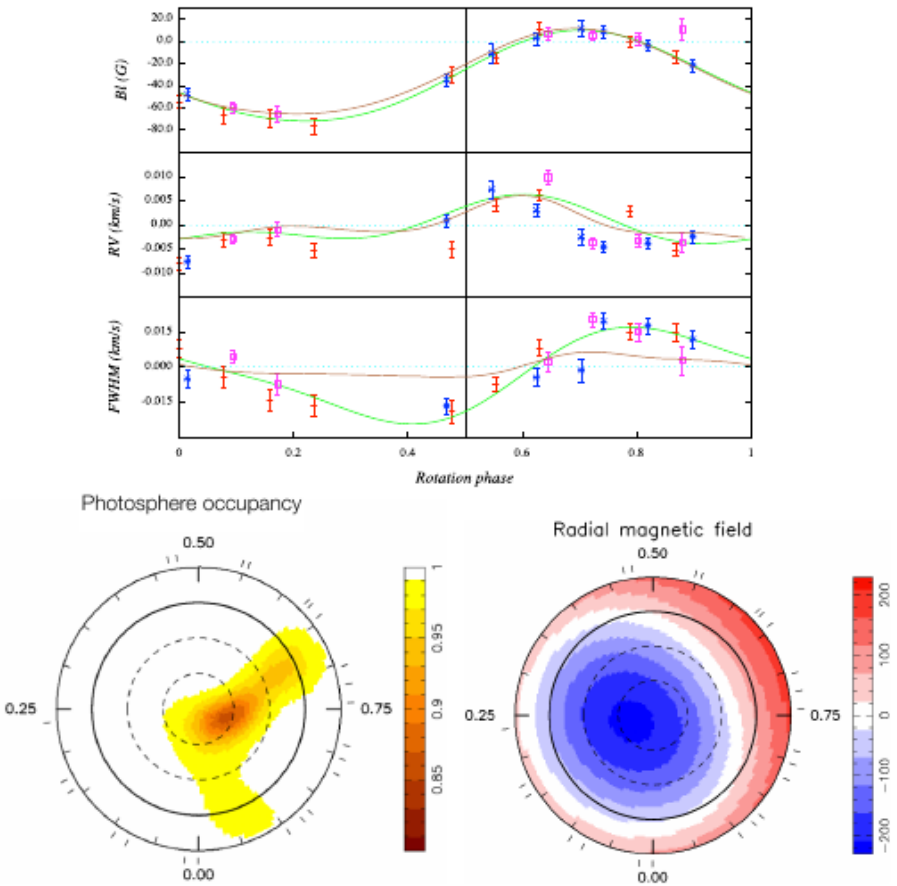

DI modelling – GJ 358

Hébrard et al. (2016)

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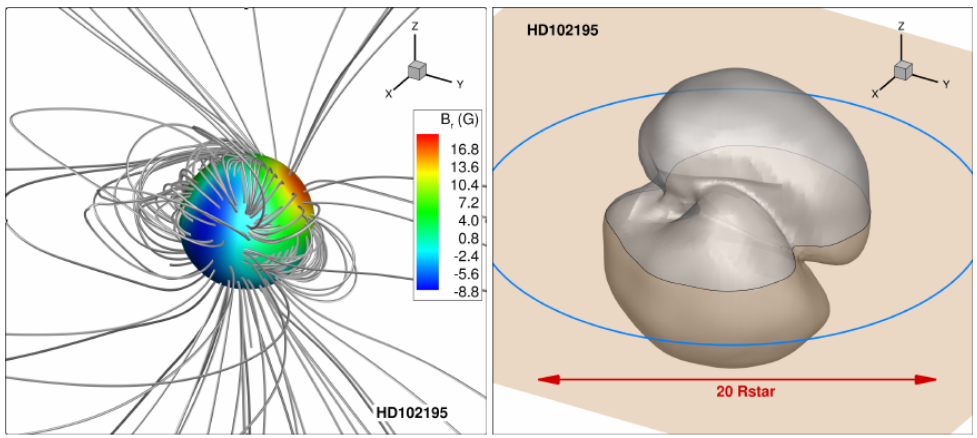

Wind modelling – HD 102195

Vidotto et al. (2015)

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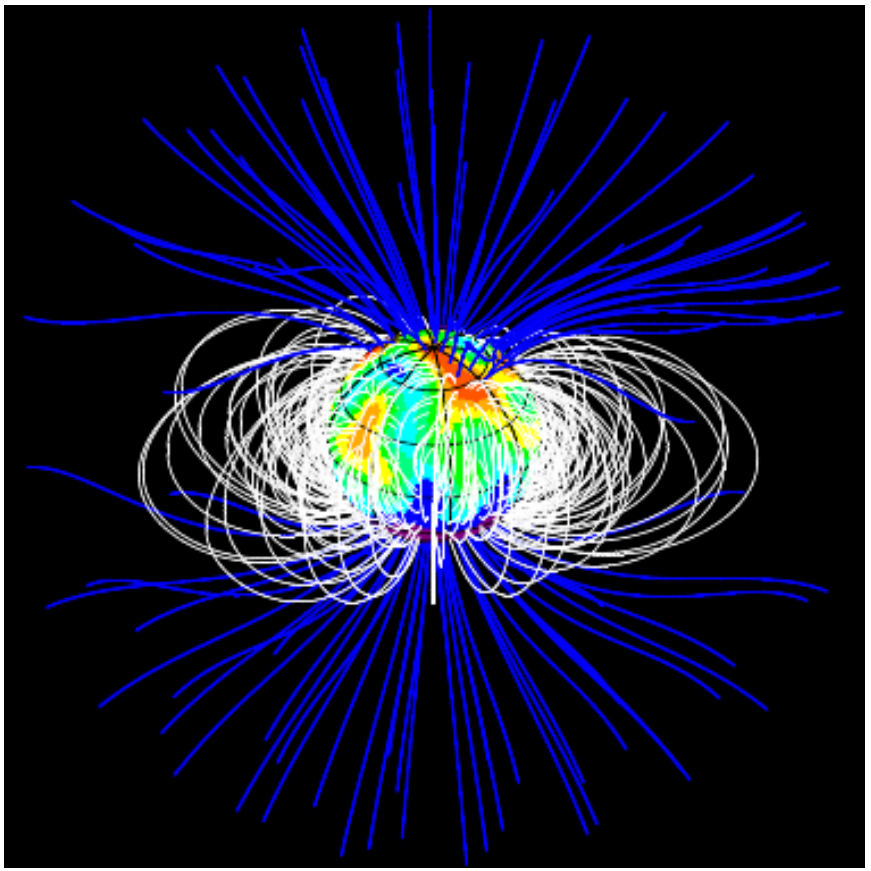

wTTS mapping

Donati et al. (2015)

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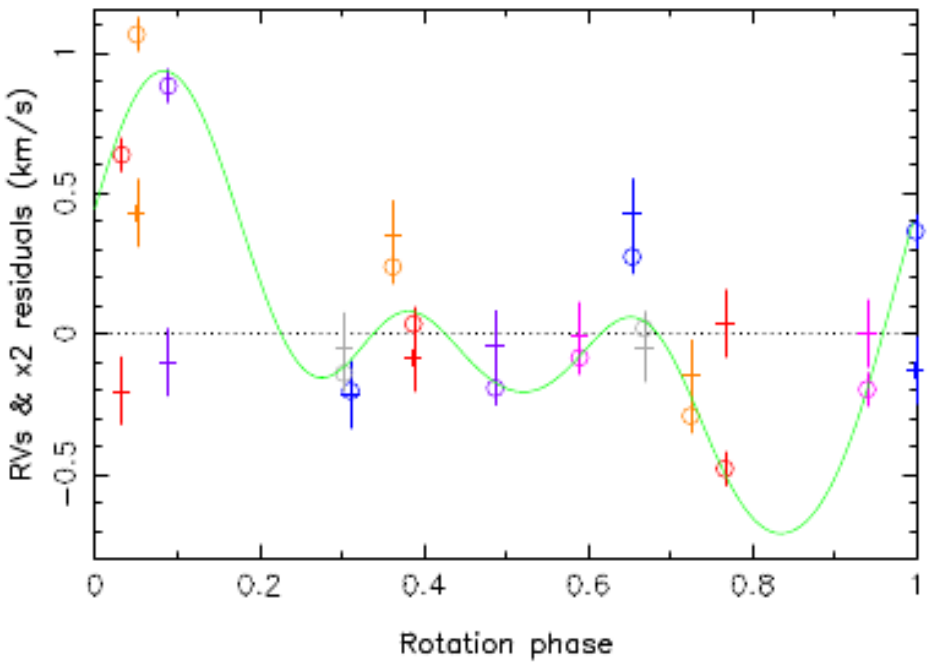


wTTS jitter filtering

Donati et al. (2015)

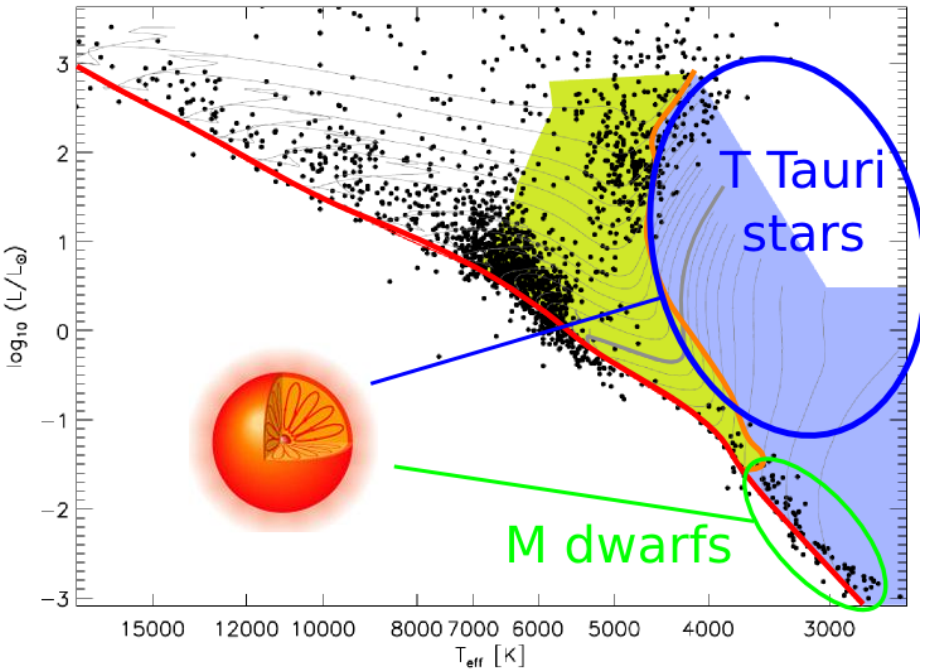
Additional aims / by-products of WP5.2

- SPIRou survey : spectropol time-series for $\sim$ 380 M dwarfs
- Map large-scale fields of M dwarfs (Zeeman-Doppler Imaging)
- At least "snapshot-like" detections
  - Stellar dynamos
  - WP5.2-2 talk by L. Jouve

  ➔ Fully-convective transition

  ➔ MS M dwarfs $\leftrightarrow$ TTS
  - Rotational evolution
  - Rotation-B-activity

  ➥ Moderate activity regime



PMS and MS fully-convective stars in the HRD
Adapted from Reiners (2008)
Evolutionary tracks from
Siess et al. (2002)

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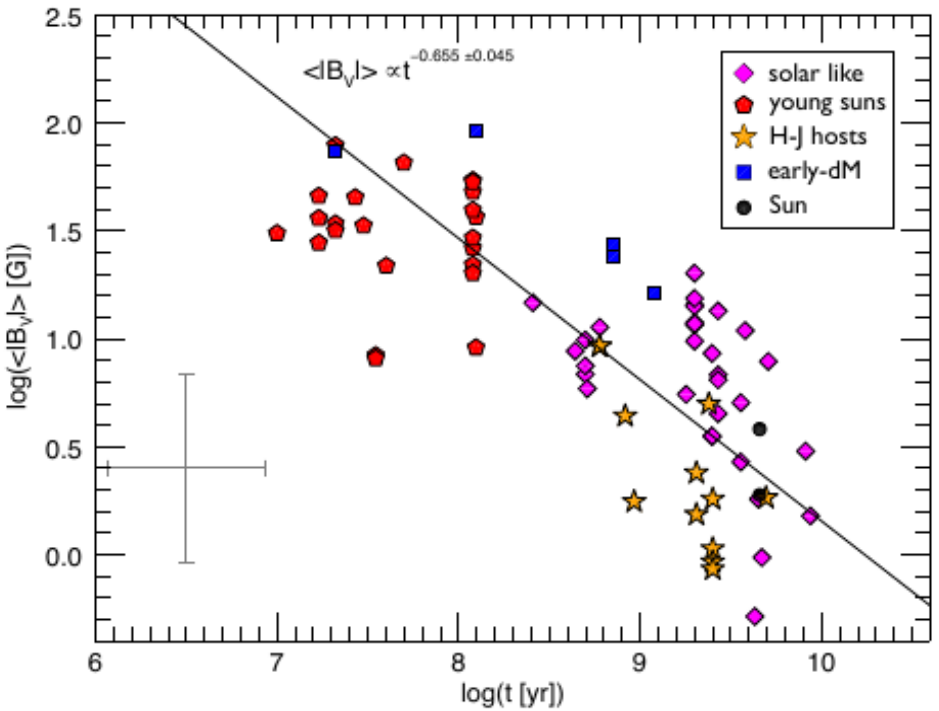


Vidotto et al. (2015)

Outline

Spectral line lists (1/2)

- Magnetometry: LSD
- RV: jitter filtering
- Stellar parameters

➥ Accurate line parameters

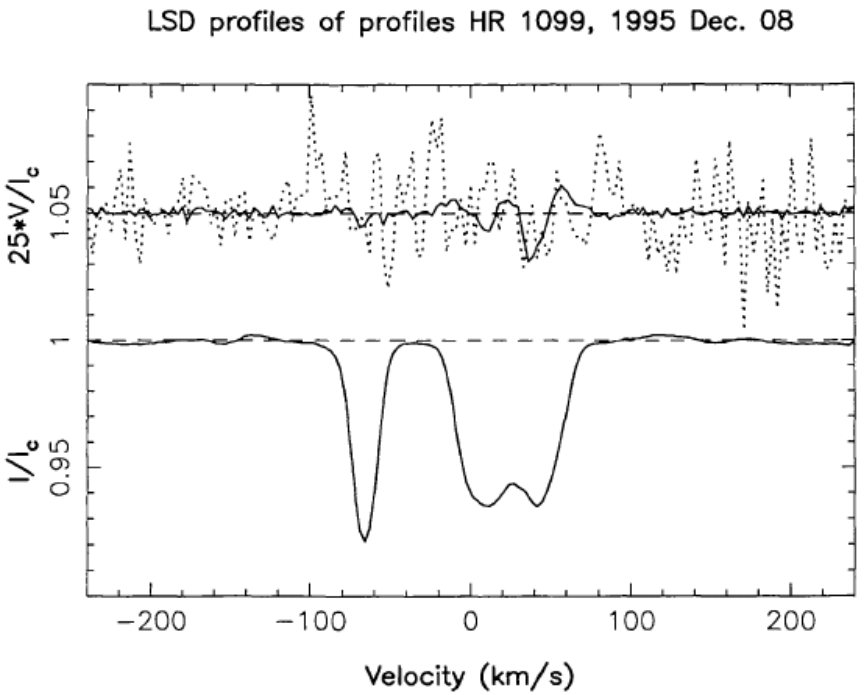
- positions
- depths
- Landé factors

- Present situation

- Atomic lines only
- Kurucz Atlas9 models

➥ Limitations at low Teff

➥ $\mathrm{Teff}_{\mathrm{min}} = 3\,500$ K



LSD Donati et al. (1997)

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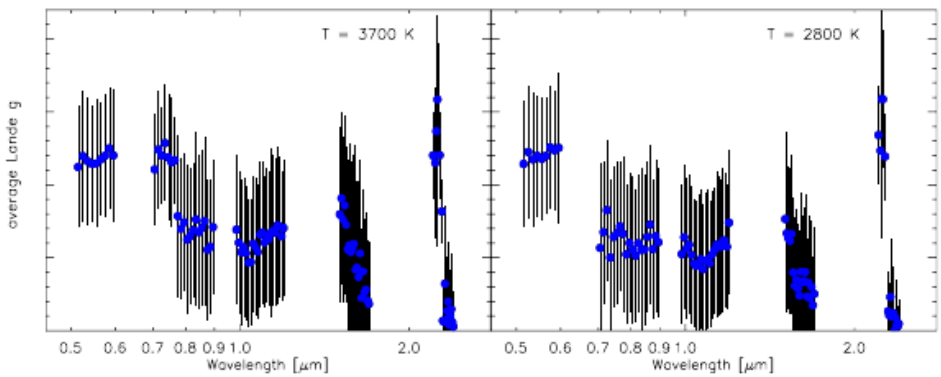
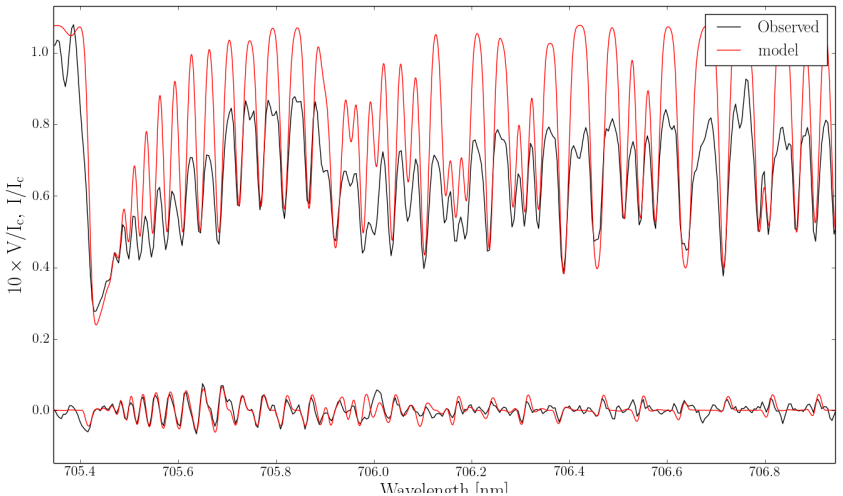
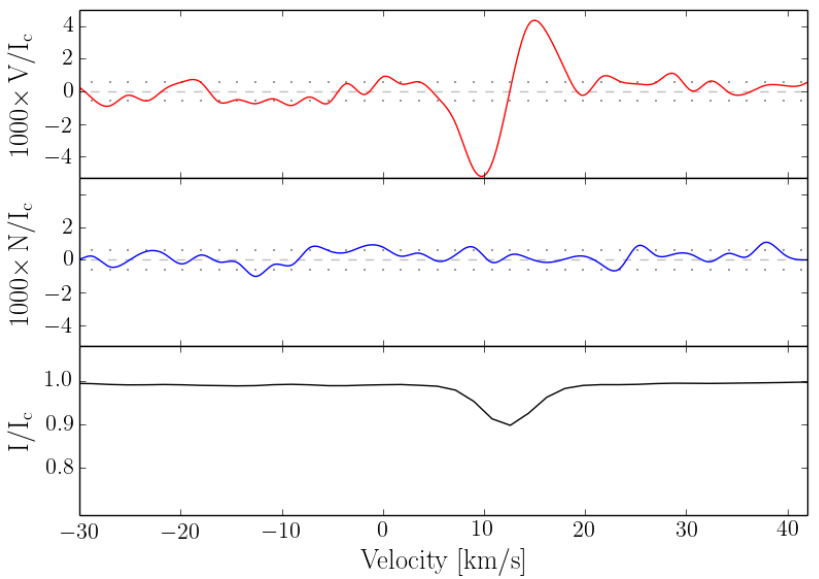


Landé factors Reiners et al. (2013)

Spectral line lists (2/2)

- Aims for WP5.2
  - model atmospheres for M dwarfs
    - Montpellier VALD mirror
    - Tests on MARCS models
    - PHOENIX for reference line lists
  - Molecular lines
    - Compile existing data
    - LSD tests
    - ➥ TiO, FeH
    - Additional data
    - ➥ exp: P. Crozet et al.
    - ➥ FeH, NiH, CrH
    - ➥ high-J extrapolation
    - Identify best nIR molec/bands
    - Extend methodology





AD Leo: TiO *B. Tessore & Th. Masseron*

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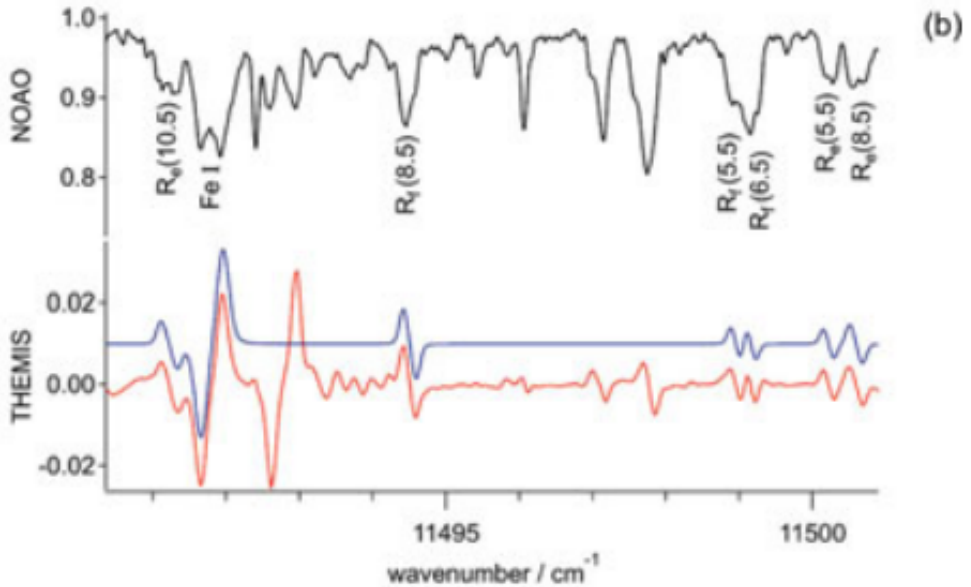
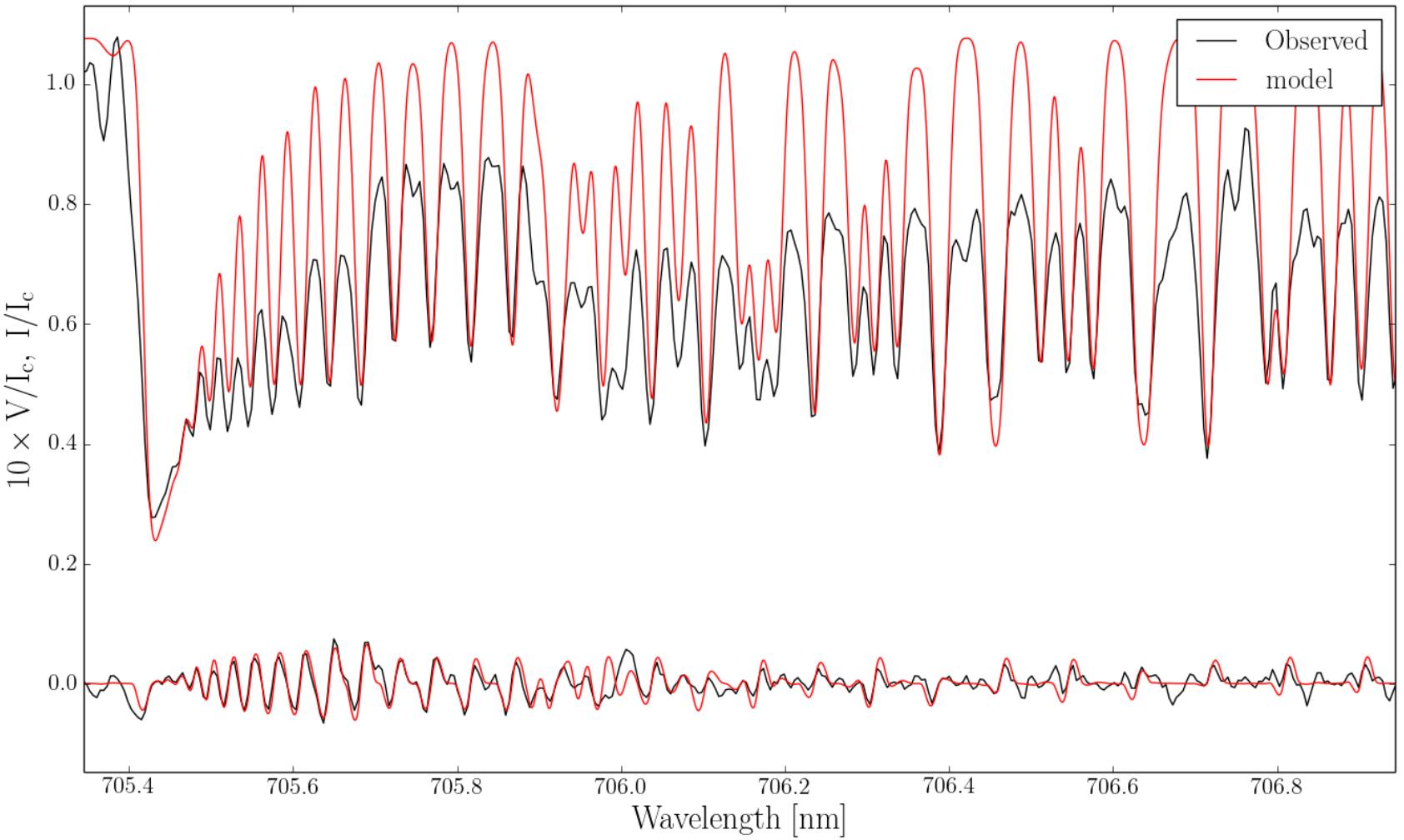


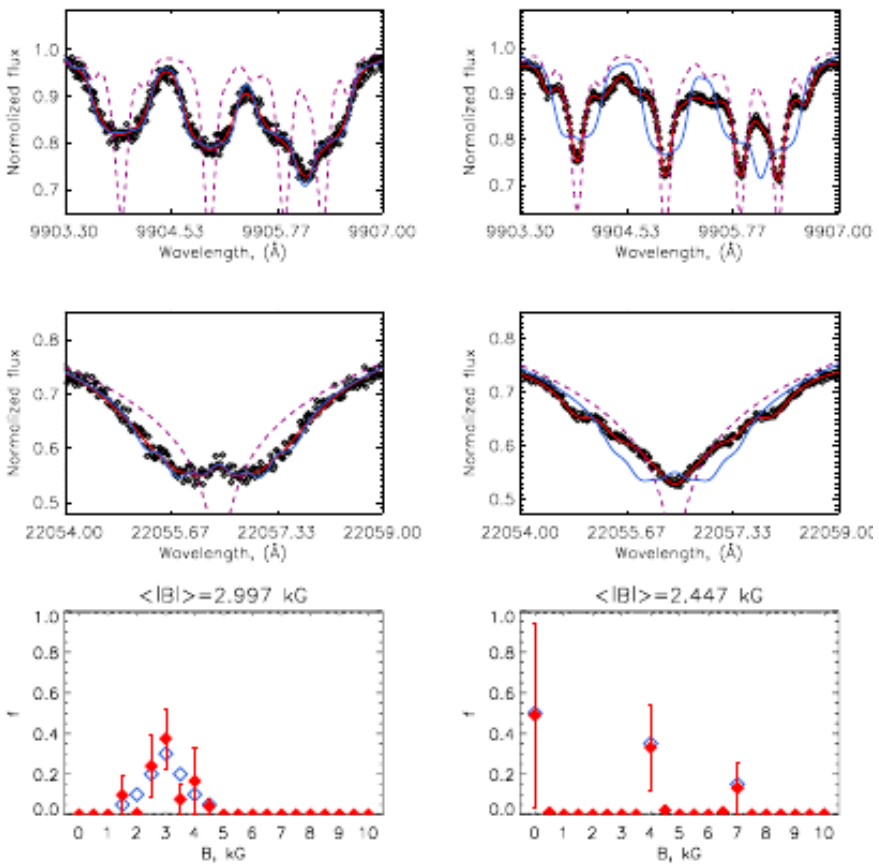
Sunspot: FeH Crozet et al. (2014)

Spectral line lists (2/2)



SW/Tools for magnetic measurements

- Standard versions
- Pipeline mode
  - LSD, B_ℓ
  - *Bf* (Zeeman Broadening)
    - atomic + molecular
  - ZDI
  - Simple field charact.
    - low $v \sin i$



Bf *Shulyak et al. (2014)*

Outline

Summary

- $B_\star$ charact is key to WP1,2,3
  - Planet detection
  - Planet environment charact.
  - TTS $B_\star$
- $B_\star$ is a by-product of M dwarf survey (WP1,2)
- Tools to refine
  - Line lists
    - model atmospheres
    - molecular lines
  - ➥ link WP3.3
  - SW tools
- What else?