Magnetic fields in Intermediate Mass T-Tauri Stars

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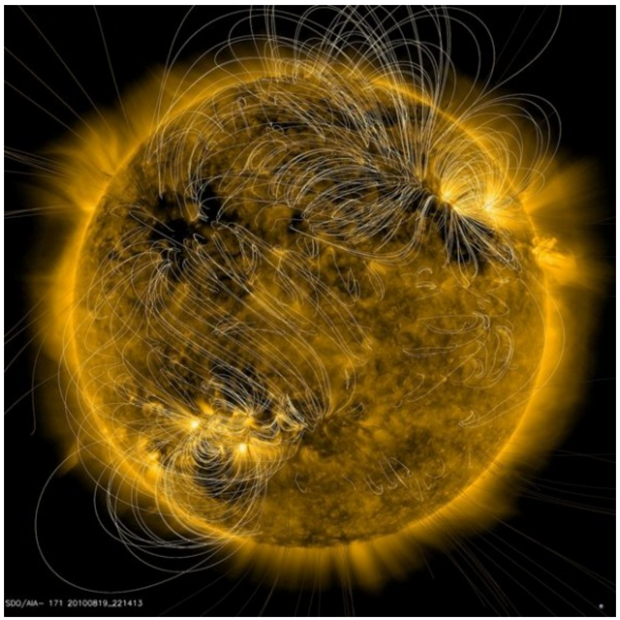
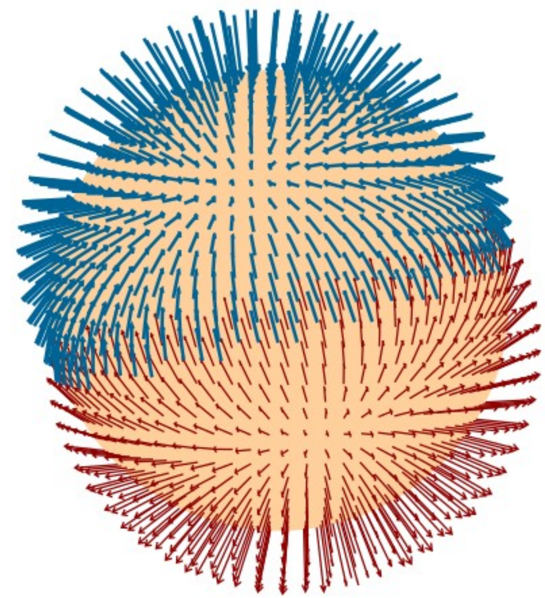
→ Stellar magnetic fields

cool stars against hot stars



For cool stars such as the Sun, the magnetic field is:

> rapidly evolving
> complex
> weak

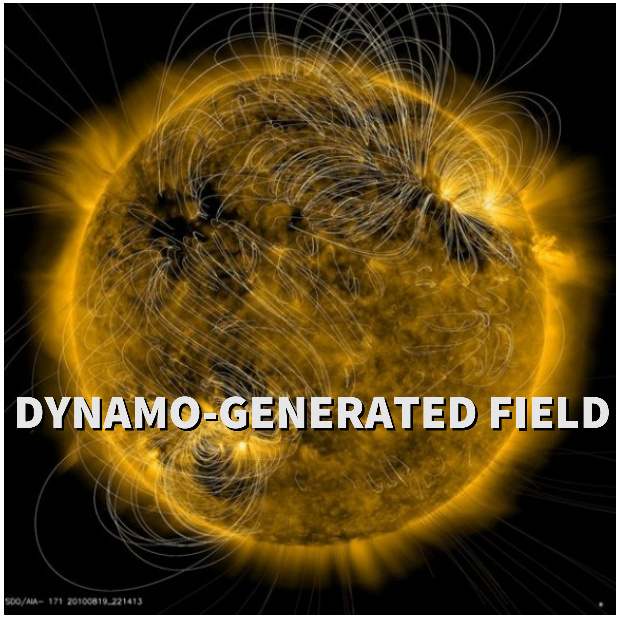


Hot stars tend to present magnetic fields which are:

> very strong
> organized
> roughly dipolar

➔ Stellar magnetic fields

cool stars against hot stars



For cool stars such as the Sun, the magnetic field is:

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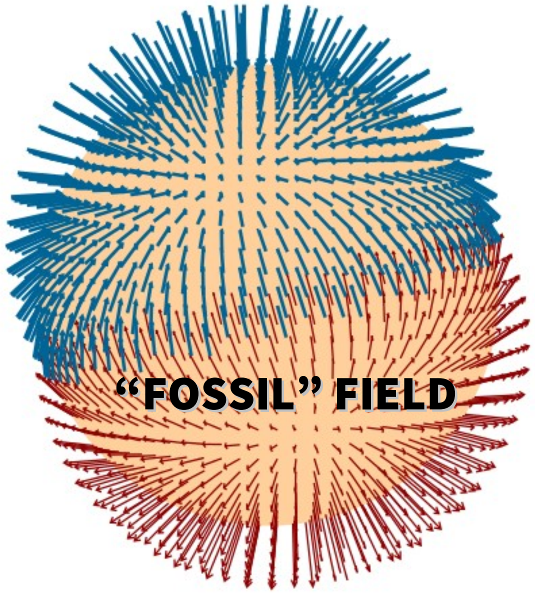

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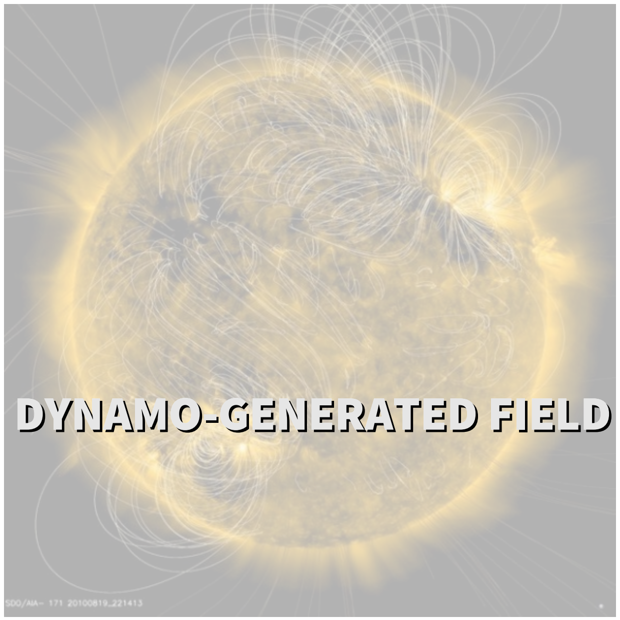
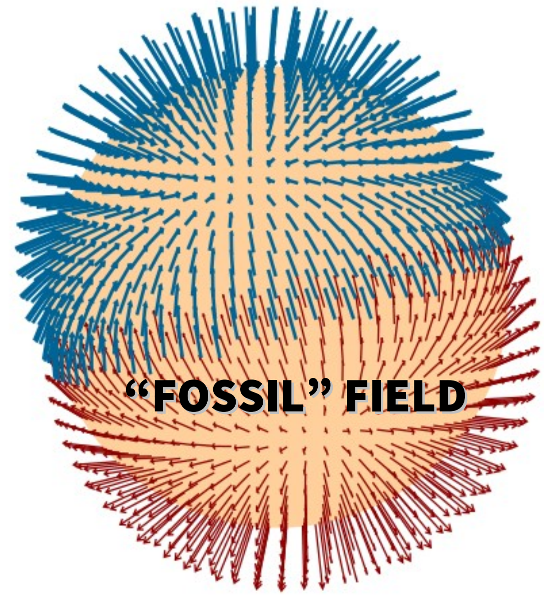
→ Stellar magnetic fields

dynamo against fossil fields



?



Uncertain origin of fossil field ..

> galactic magnetic field captured by the star ?

> leftovers from dynamo processes ?

➔ Intermediate Mass T-Tauri stars (IMTTS)

in stellar evolution context

***T-Tauri stars*:**

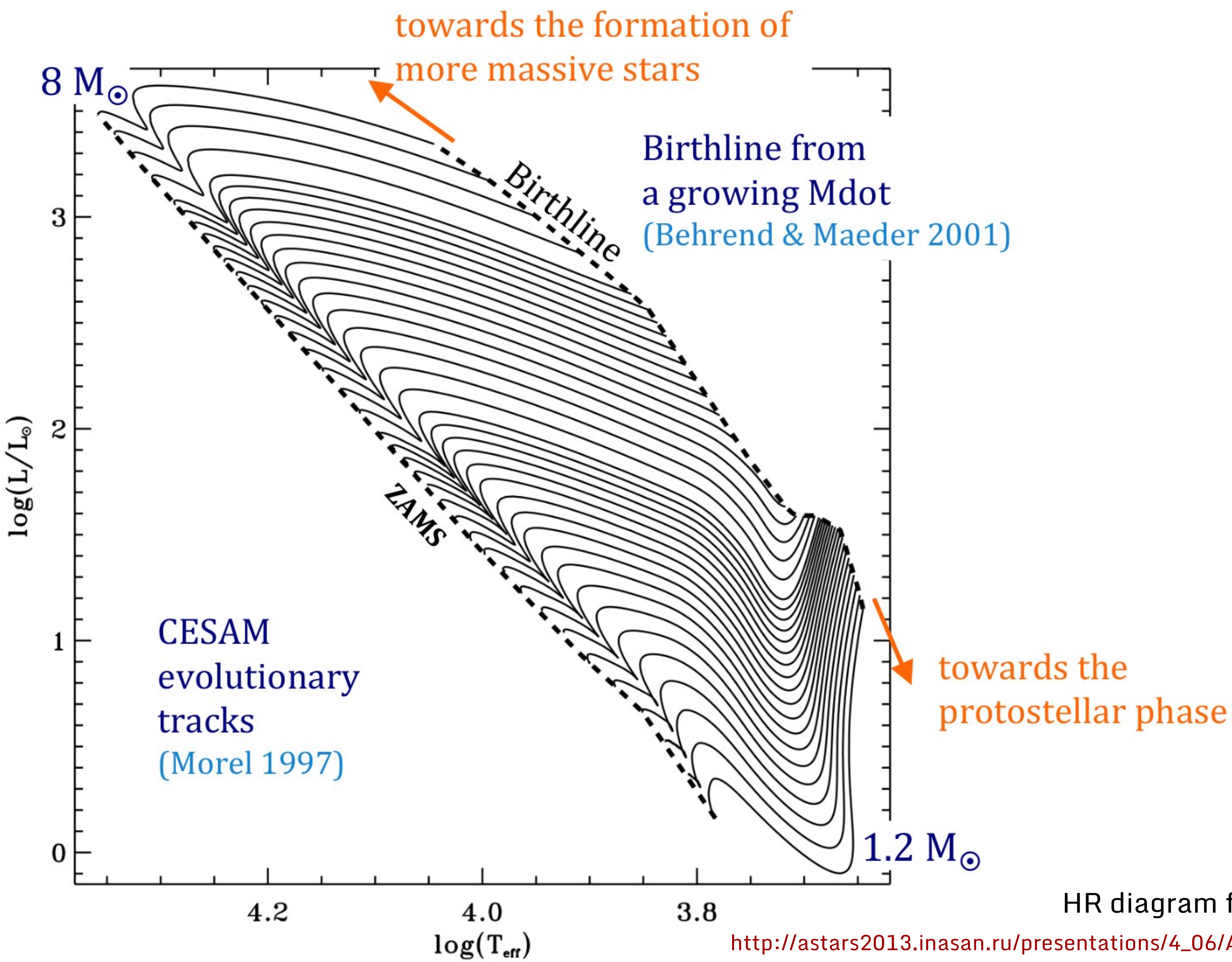
> roughly between 0.5 and 3.5 solar masses
> accreting material from surrounding protoplanetary disc
> fueled by gravitational energy from star's contraction

***Intermediate Mass T-Tauri Stars*:**

> around 2 solar masses
> progenitors of Herbig Ae/Be stars and ultimately A/B type stars

→ Intermediate Mass T-Tauri stars (IMTTS)

in stellar evolution context



HR diagram from **Evelyne Alecian**

http://astars2013.inasan.ru/presentations/4_06/Alecian/Alecian_Moscou.pdf

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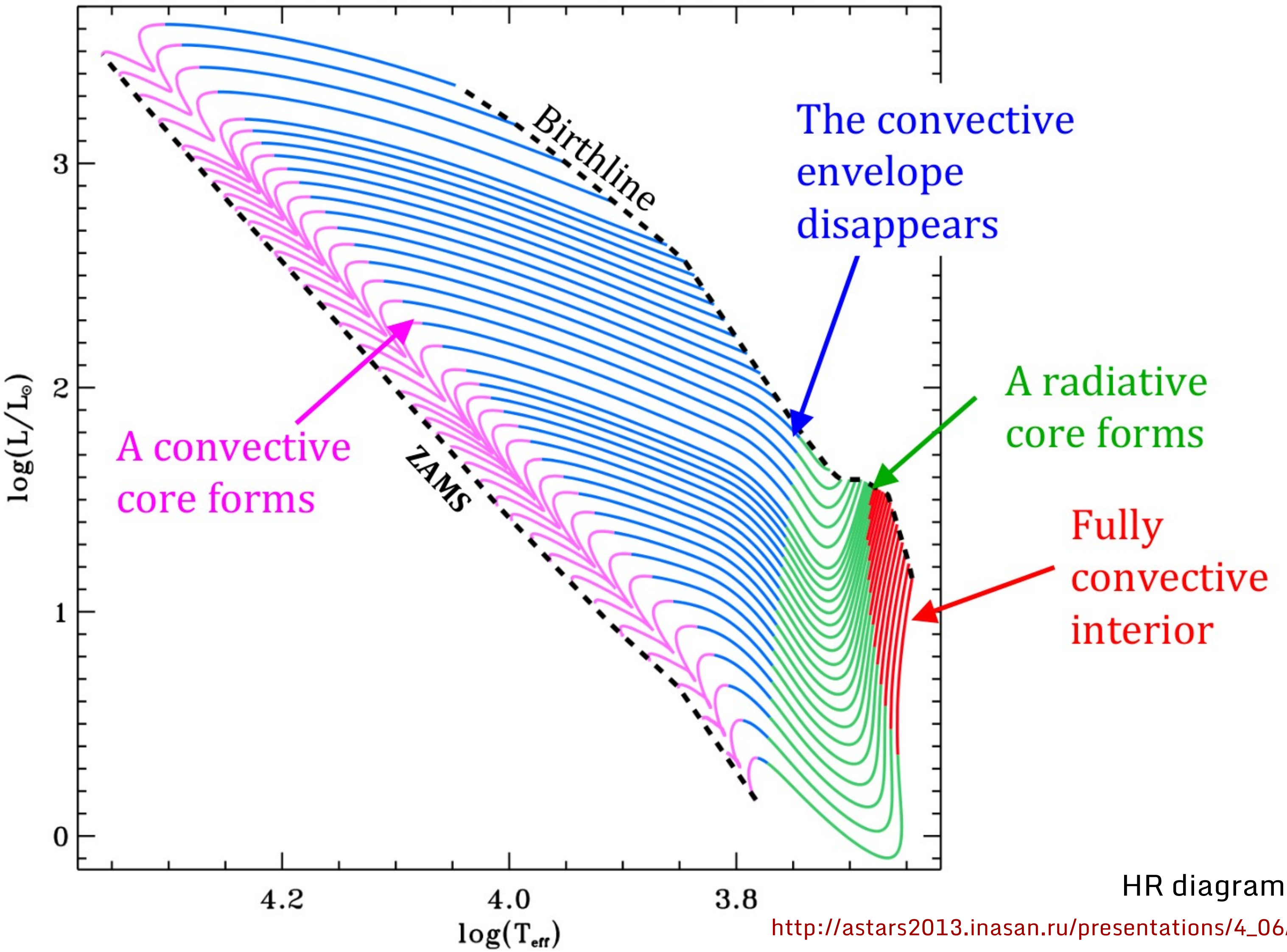

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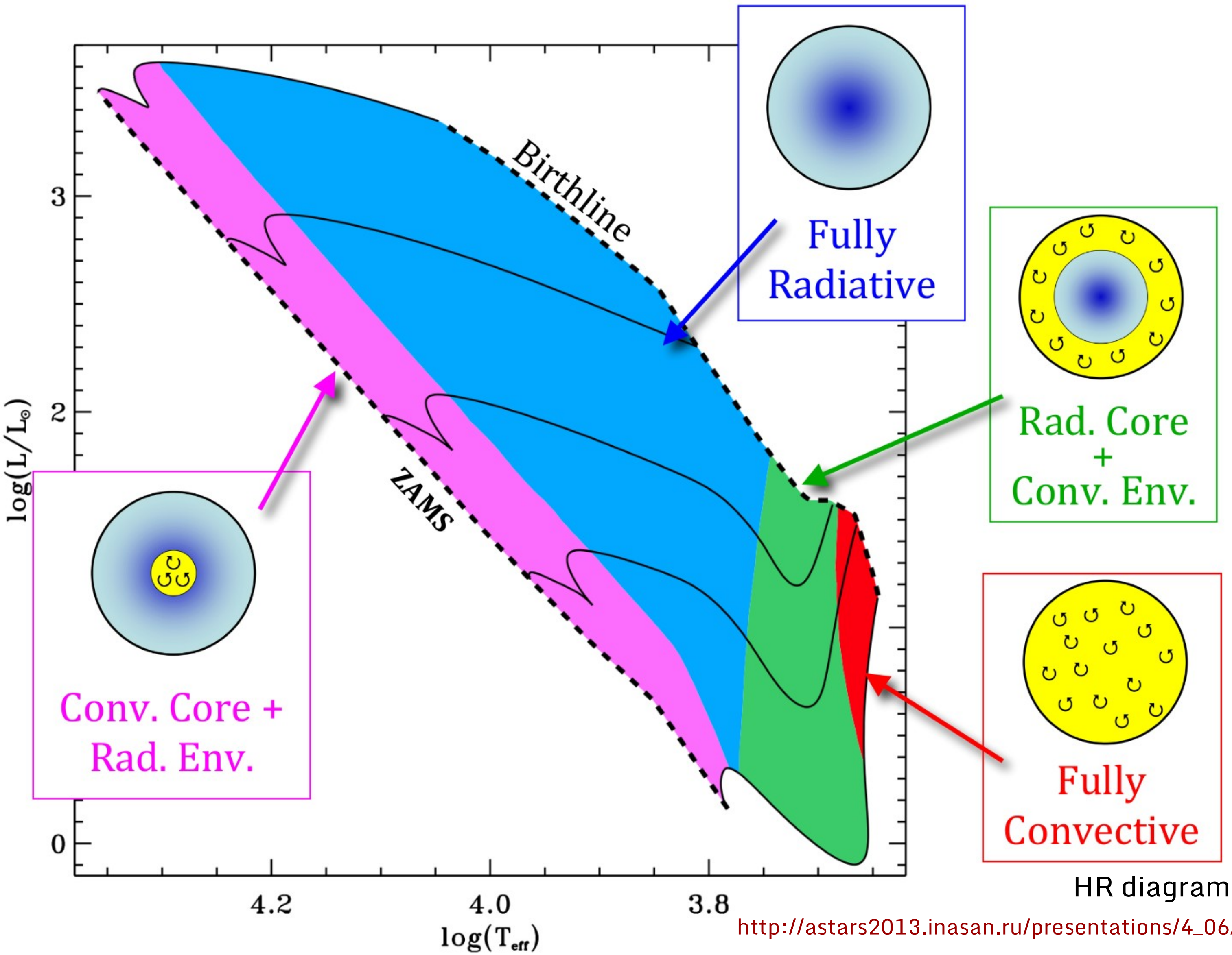

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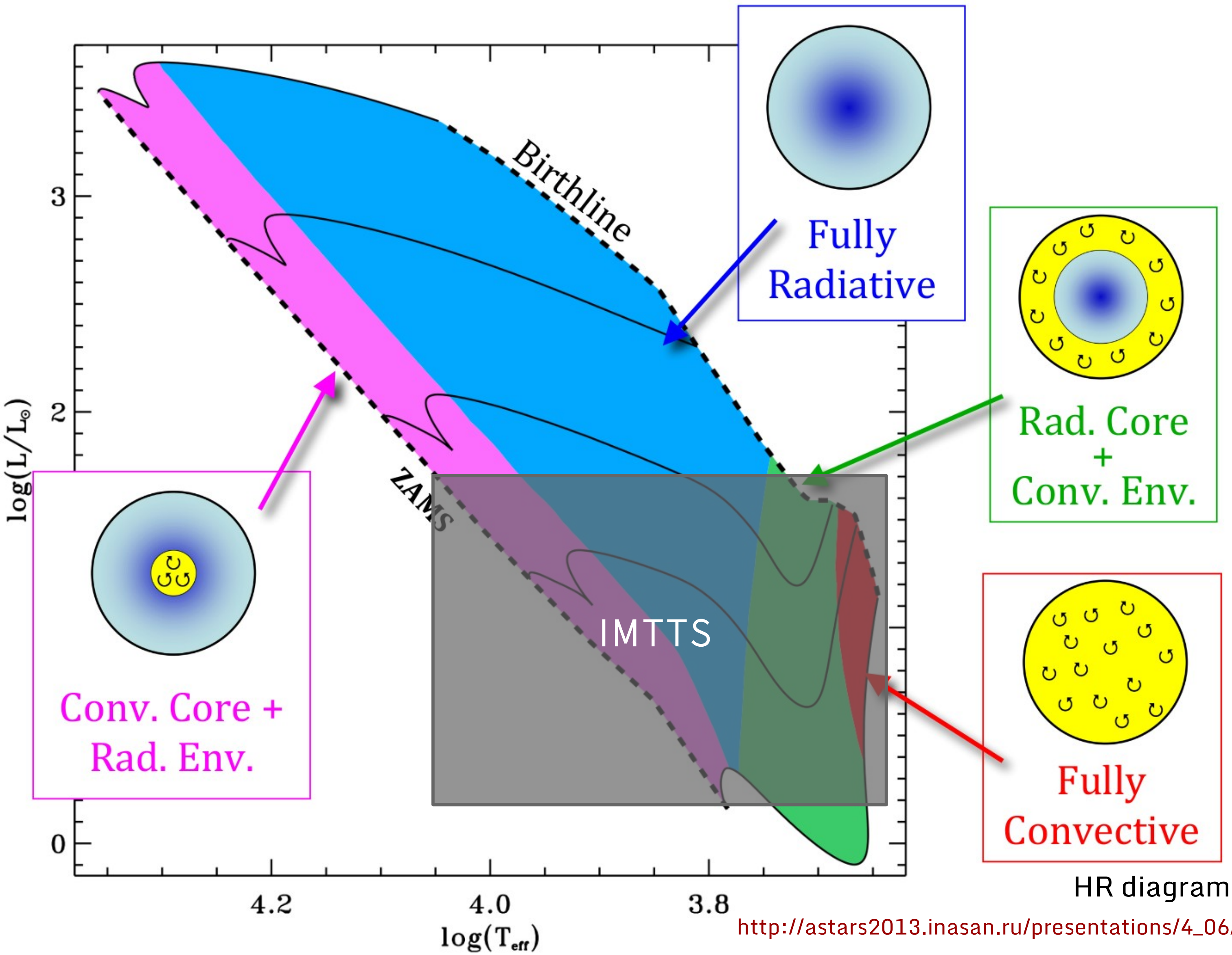

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→ Intermediate Mass T-Tauri stars (IMTTS)

and their magnetic field

IMTTS → **Herbig Ae/Be** → **Ap/Bp star**

IMTTS	Herbig Ae/Be	Ap/Bp star
both large scale and complex magnetic fields	~10 % host strong large-scale magnetic fields	5-10 % host strong large-scale magnetic fields

Low-Mass T-Tauri Stars

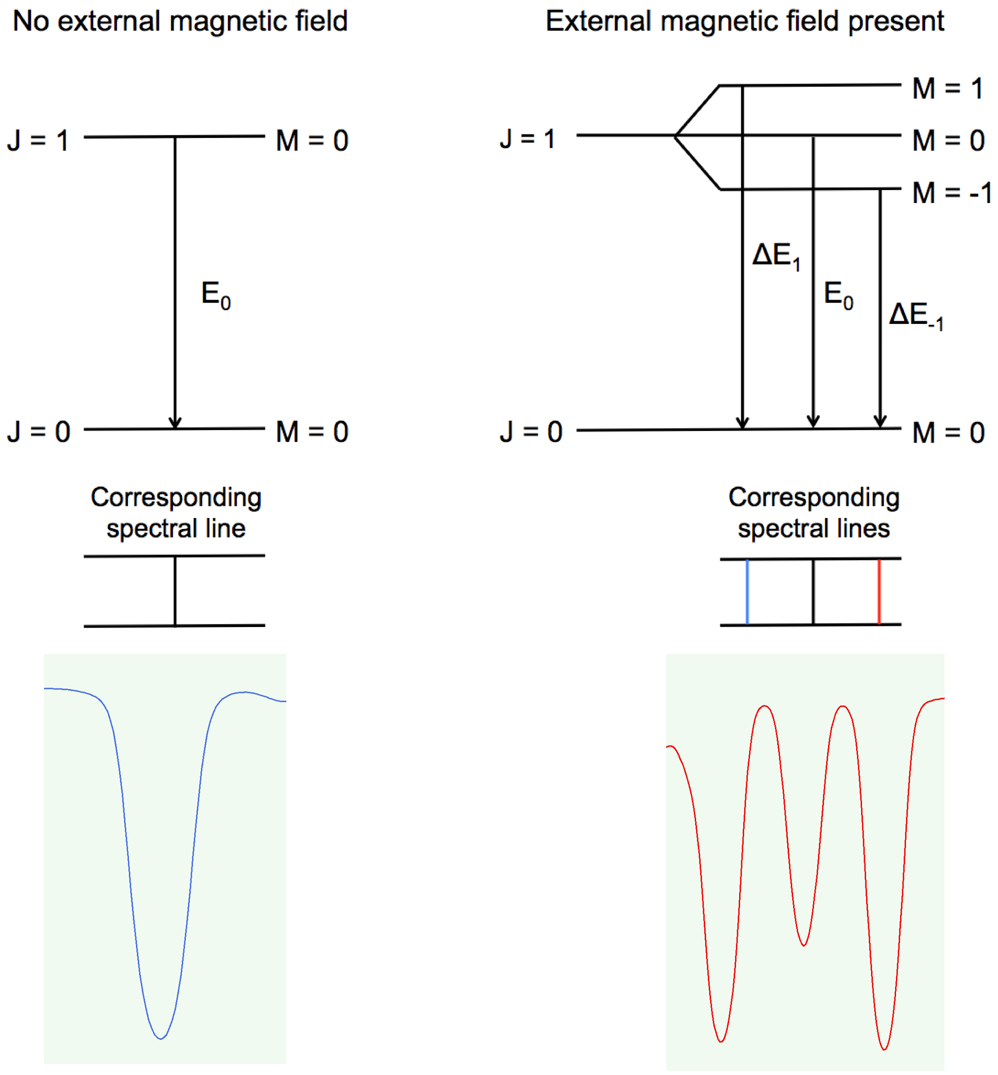
complex magnetic fields generated by dynamo processes

Science case:
Studying evolution of magnetic field with the age of IMTTS to see if:

- fields goes from "dynamo" to "fossil"
- dynamo fields gradually disappear while fossil fields stay in constant proportion

Observing stellar magnetic field

Zeeman effect in stellar spectra



Zeeman effect

First observed by Zeeman in 1896

First observable

> Spectral lines split into several components when a magnetic field is present

$$\Delta\lambda = 0.00467\, g\, \lambda^2\, |B|$$

$\Delta\lambda$ is the component shift in nm

λ is the wavelength in μm

g is the Landé factor of the component

B is the m.f. strength in kG

>> the component shift is proportional to the **magnetic field strength**, **wavelength**, and **Landé factor**

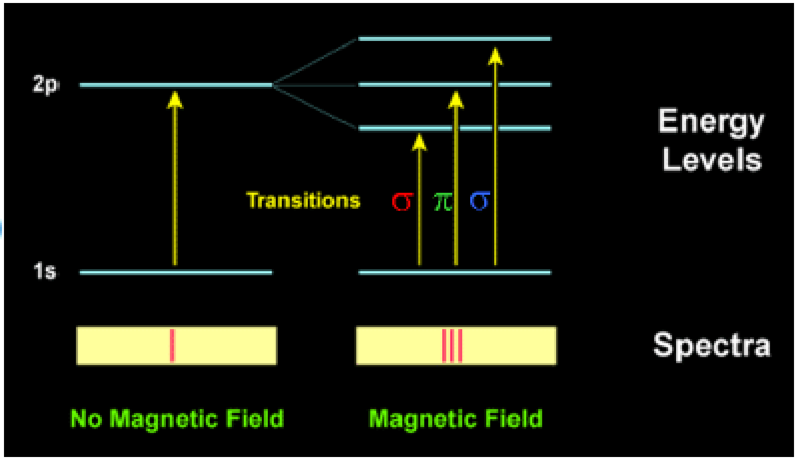
Observing stellar magnetic field

Zeeman effect in stellar spectra

Second observable

> The **π** and **σ** components exhibit **linear** or/and **circular polarization** according to the magnetic field orientation w.r.t. the line of sight.

(a)



(b)

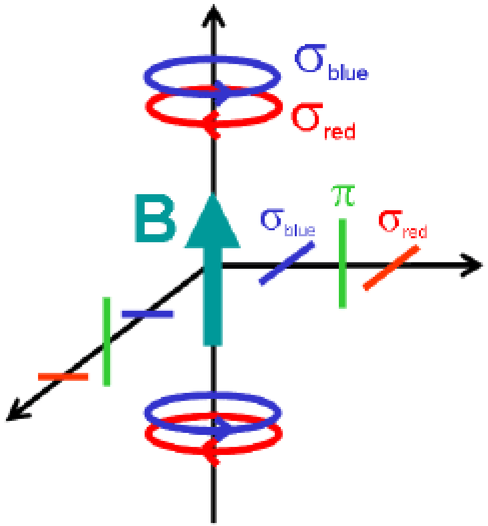
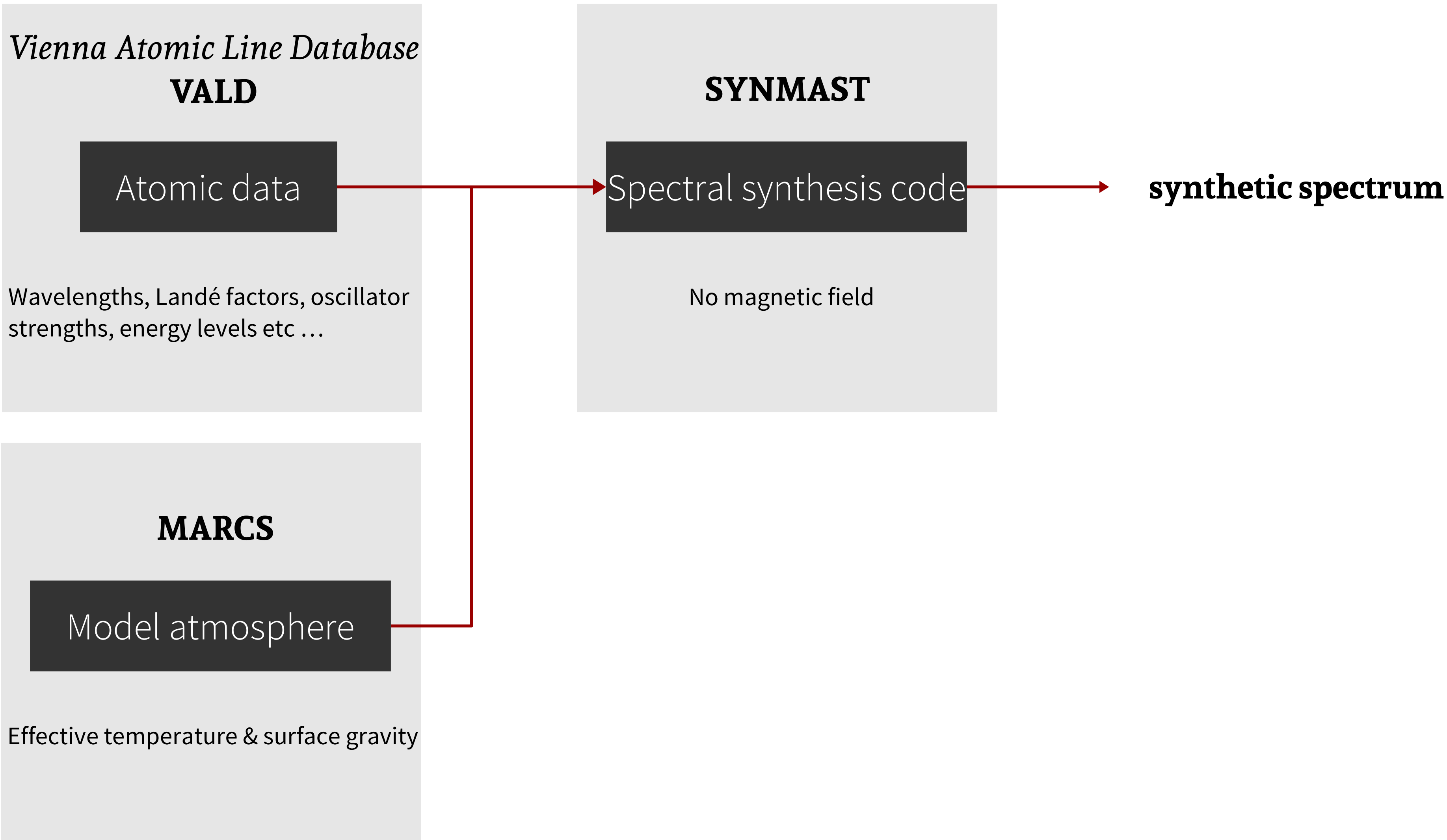


Image from "Observations of Cool-Star Magnetic Fields" by **Ansgar Reiners**

http://solarphysics.livingreviews.org/Articles/lrsp-2012-1/

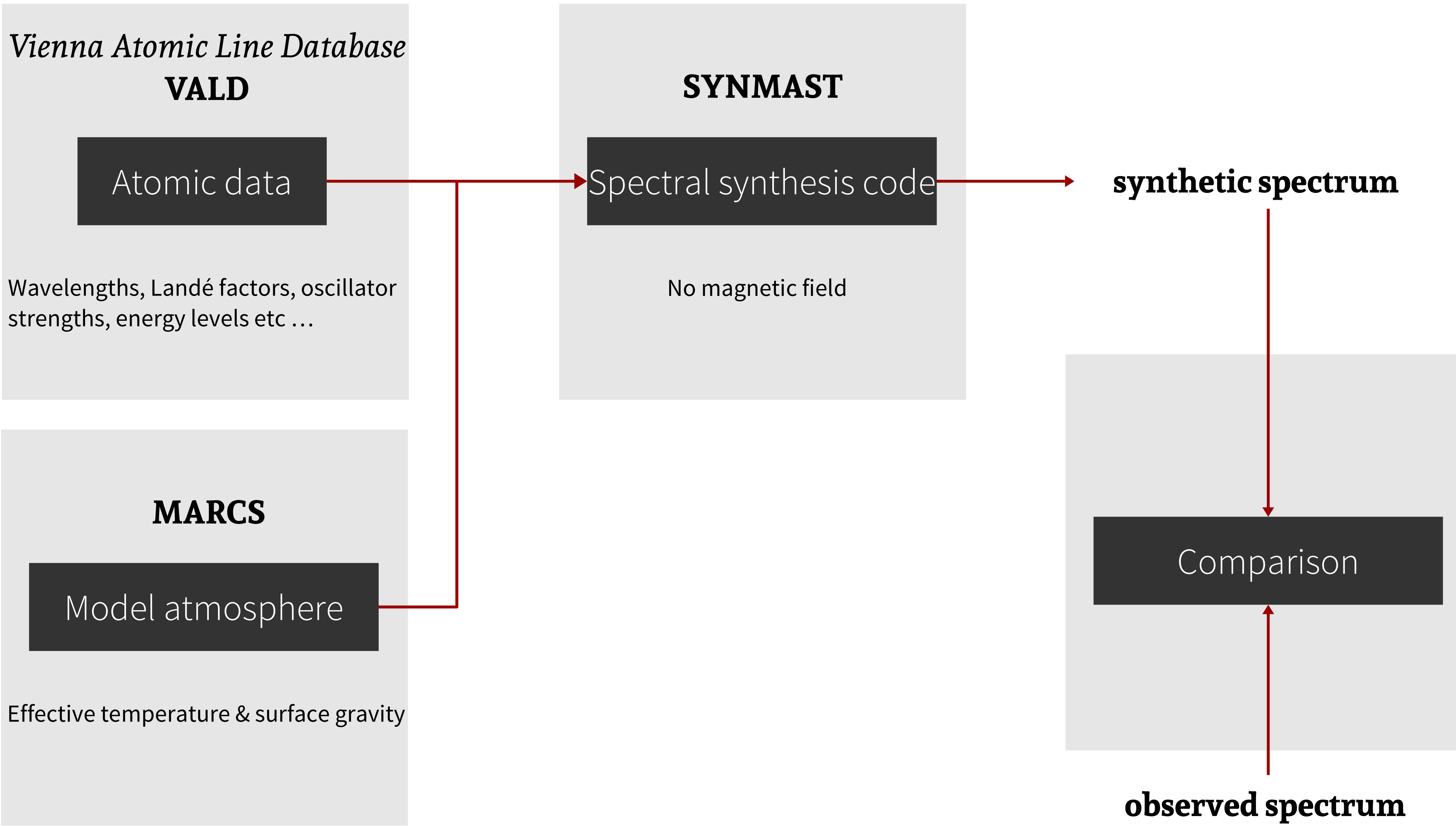
Detection method

spectral synthesis with no magnetic field



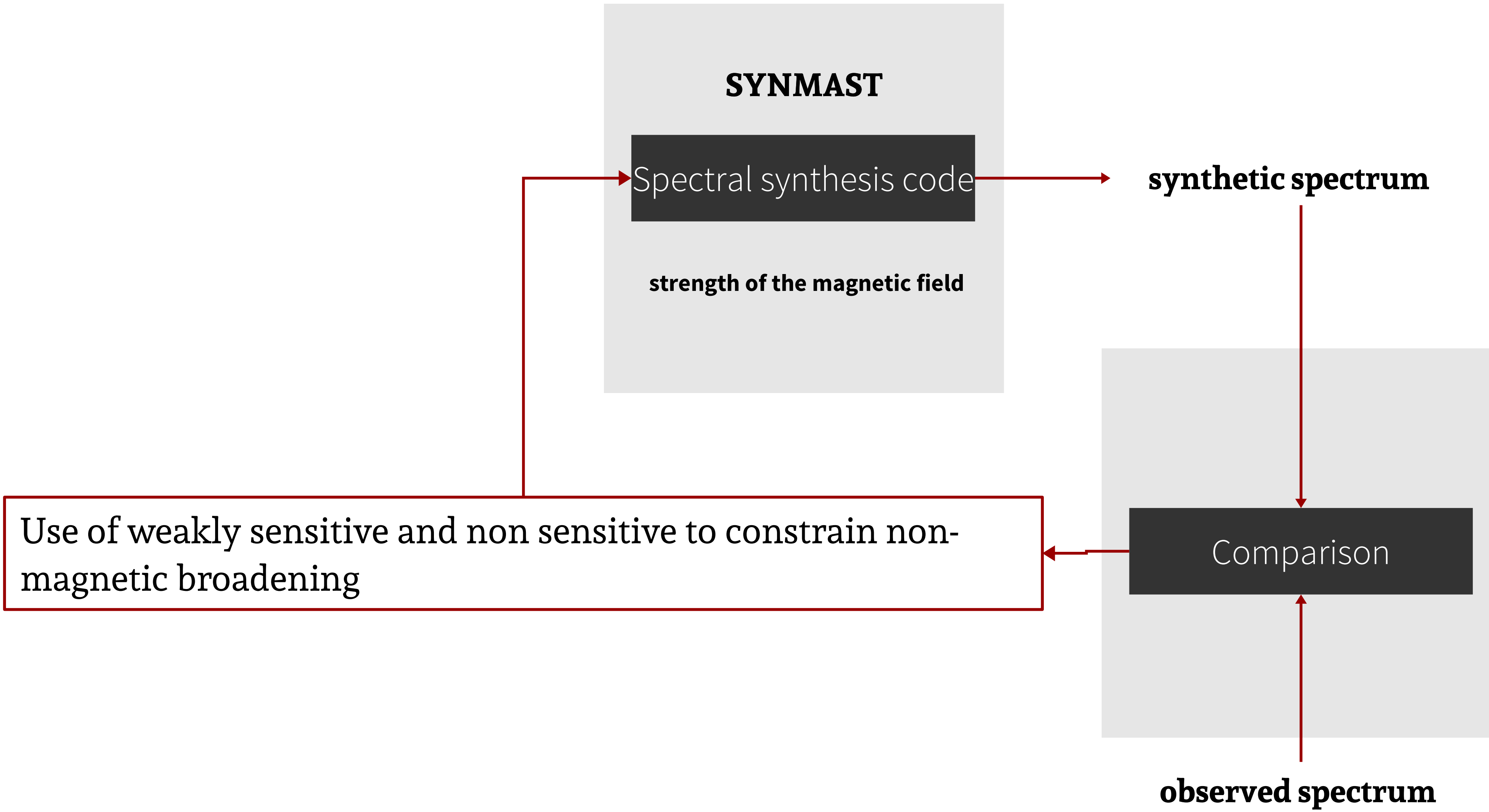
Detection method

Comparison between synthetic and observed spectra



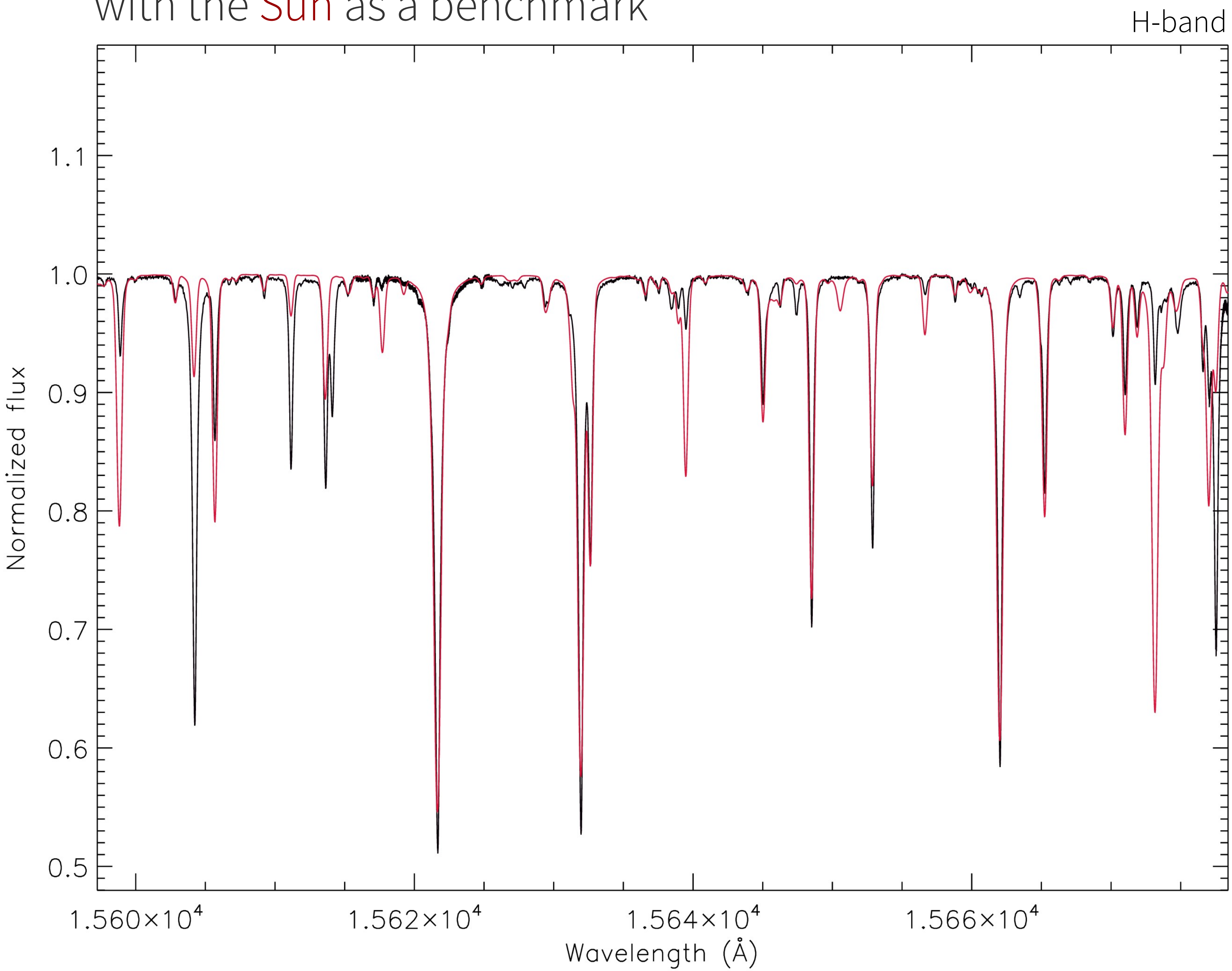
Detection method

spectral synthesis with magnetic field



➔ Improving atomic data

with the Sun as a benchmark



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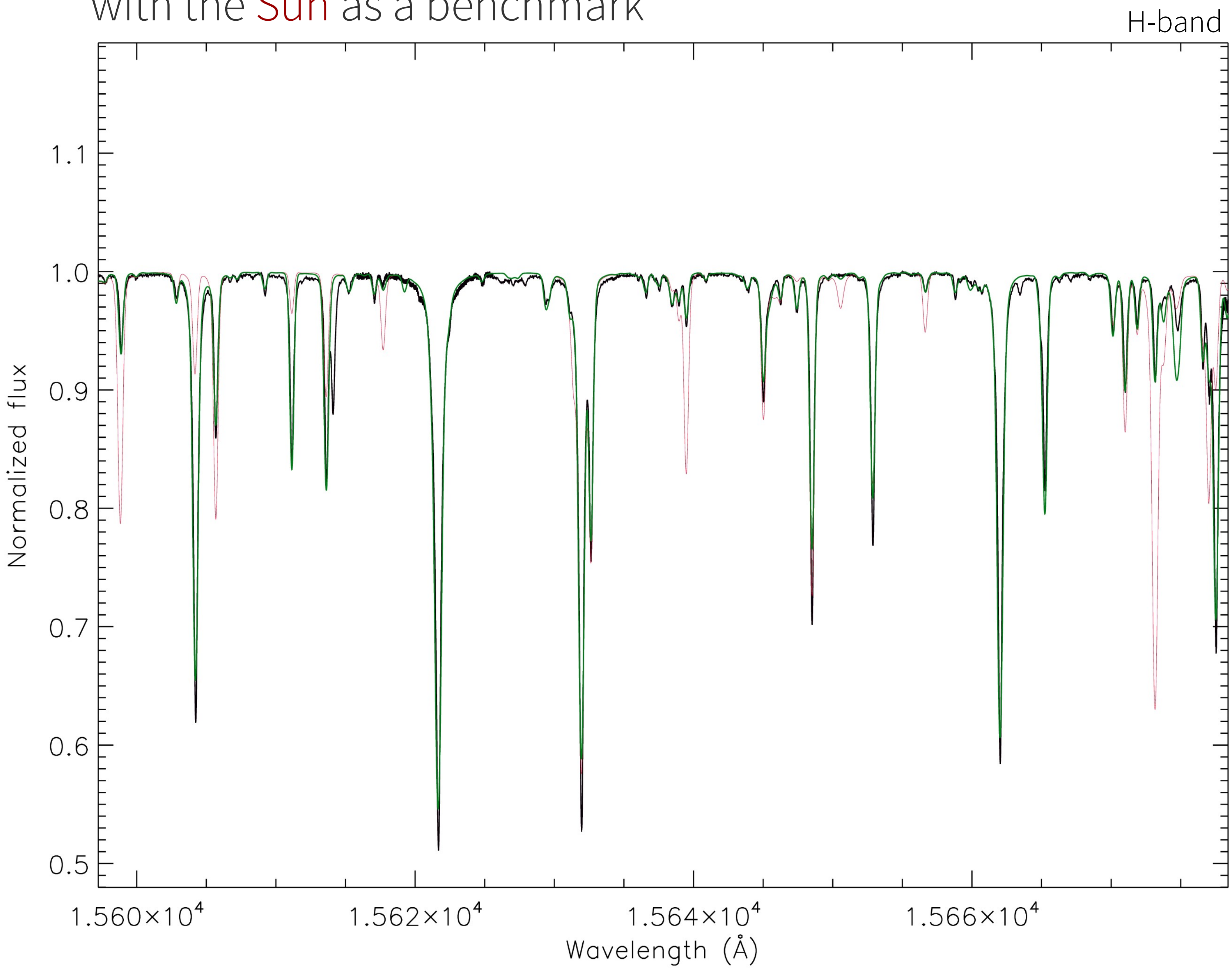
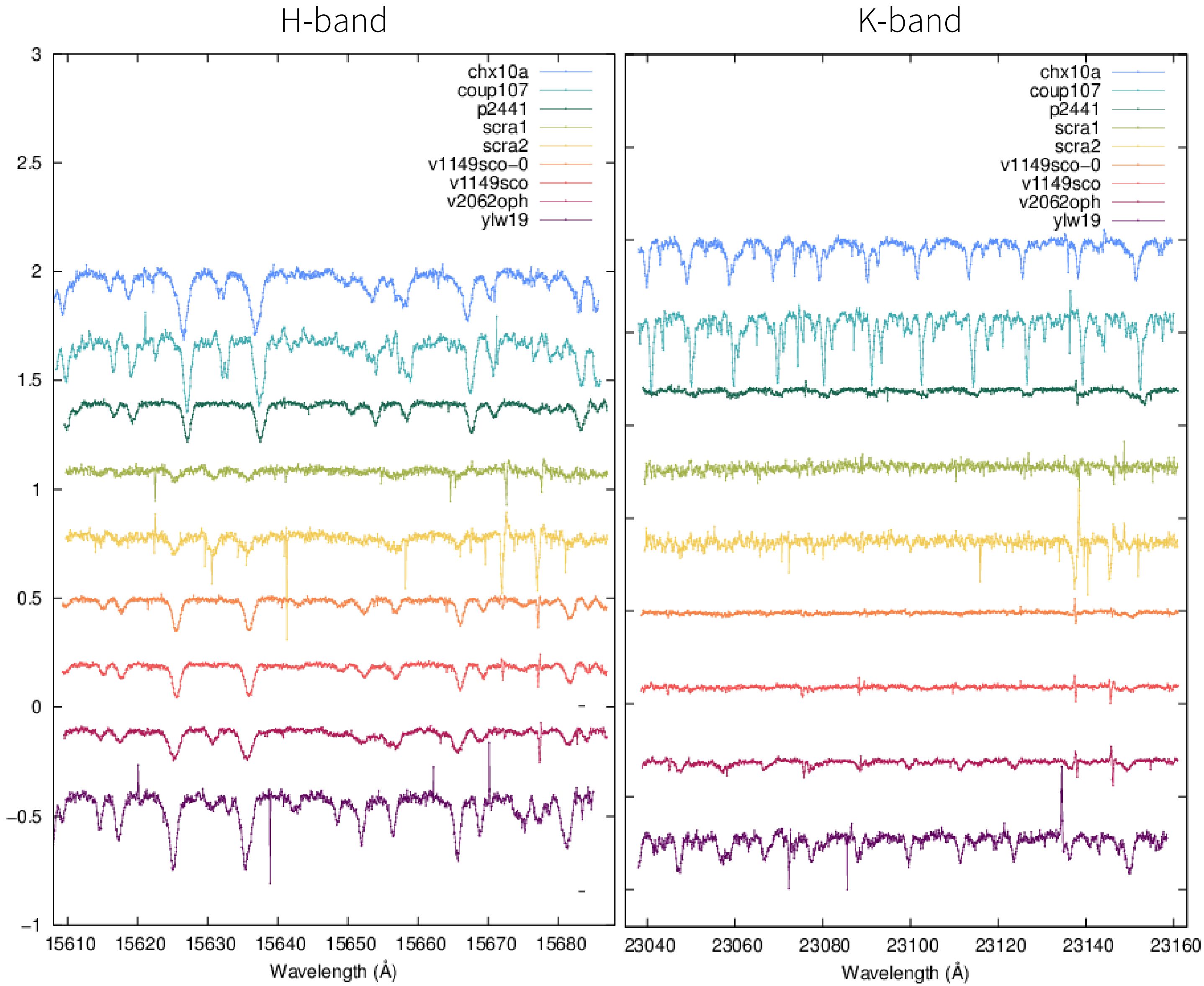


→ Observations

Spectra in H and K band

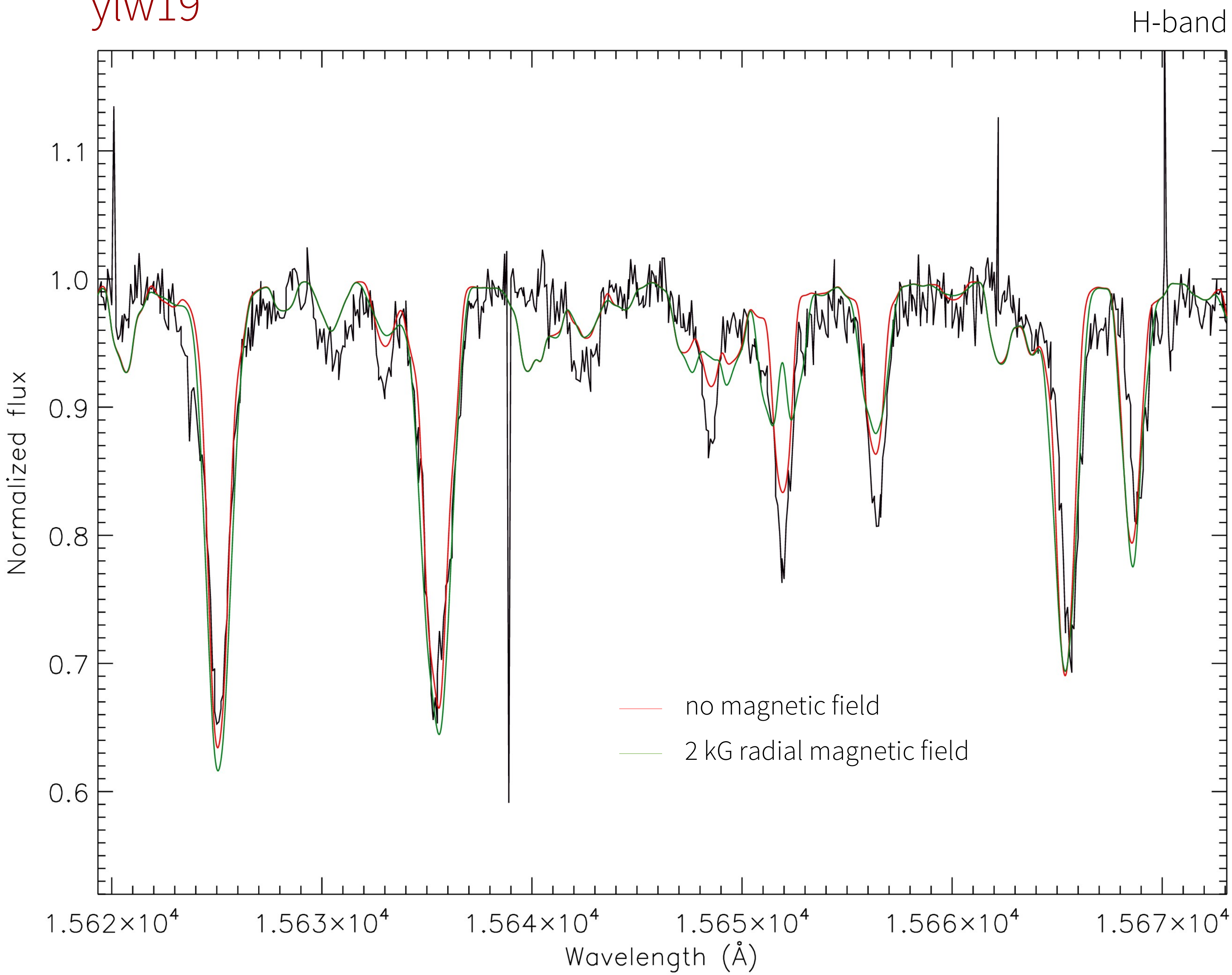


Our spectra are acquired:

- with the CRIRES instrument sitting at the VLT
- for ~10 stars with effective temperature roughly between 4000 K and 6000 K
- in 2 infrared spectral bands: **H-band** (around 1.56 μm) and **K-band** (around 2.31 μm)

➔ Real data

ylw19



Future work

Now what?

- **Work** on all the spectra and try to get upper limit on magnetic field strength
- Involvement in the upgrade of the CRIRES instrument

Thanks for listening