# Surface tomography of the RS Cvn-type double-lined binary V824 Ara (HD 155555)

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# The TempMap Doppler Imaging code

- Fris version is written by John Rice (1989.)
- This code performs single-line inversion by solving the radiative transfer equation and minimizing this expression:

$$E = \sum_{\varphi}\sum_{\lambda} [R_{\text{calc}}(\lambda,\varphi) - R_{\text{obs}}(\lambda,\varphi)]^2 + f(M)$$

- The initial image is calculated by integrating over the surface
- With iterating, the above expression is minimized → this will produce the result image
- Regularization is necessary!

- **Double-lined** → extremely difficult target for Doppler Imaging due to line blending
  - Simultaneous inversion for the two profiles → two many free parameters (double as usual + vr-shift)

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- New iterative approach:

  1. Average-profile extraction
  2. Applying Doppler Imaging on the disentangled spectra
  3. Using the map as a template to calculate disturbed profile for the component
  4. Extract the calculated profile from the original spectra
  5. Apply DI on the remaining (the other) component
  6. Repeating

**V824 Ara** (HD 155555): double-lined RS CVn type binary system with two (G5 IV and K0 IV-V) active components

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Orbital parameters (Strassmeier et al 2000)

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|---|---|
| Epoch | 2446998.4102 |
| Orbital Period | 1.681646d |
| Inclination | 52 deg |
| Eccentricity | 0 |

# **V824 Ara** (HD 155555): double-lined RS CVn type binary system with two active components

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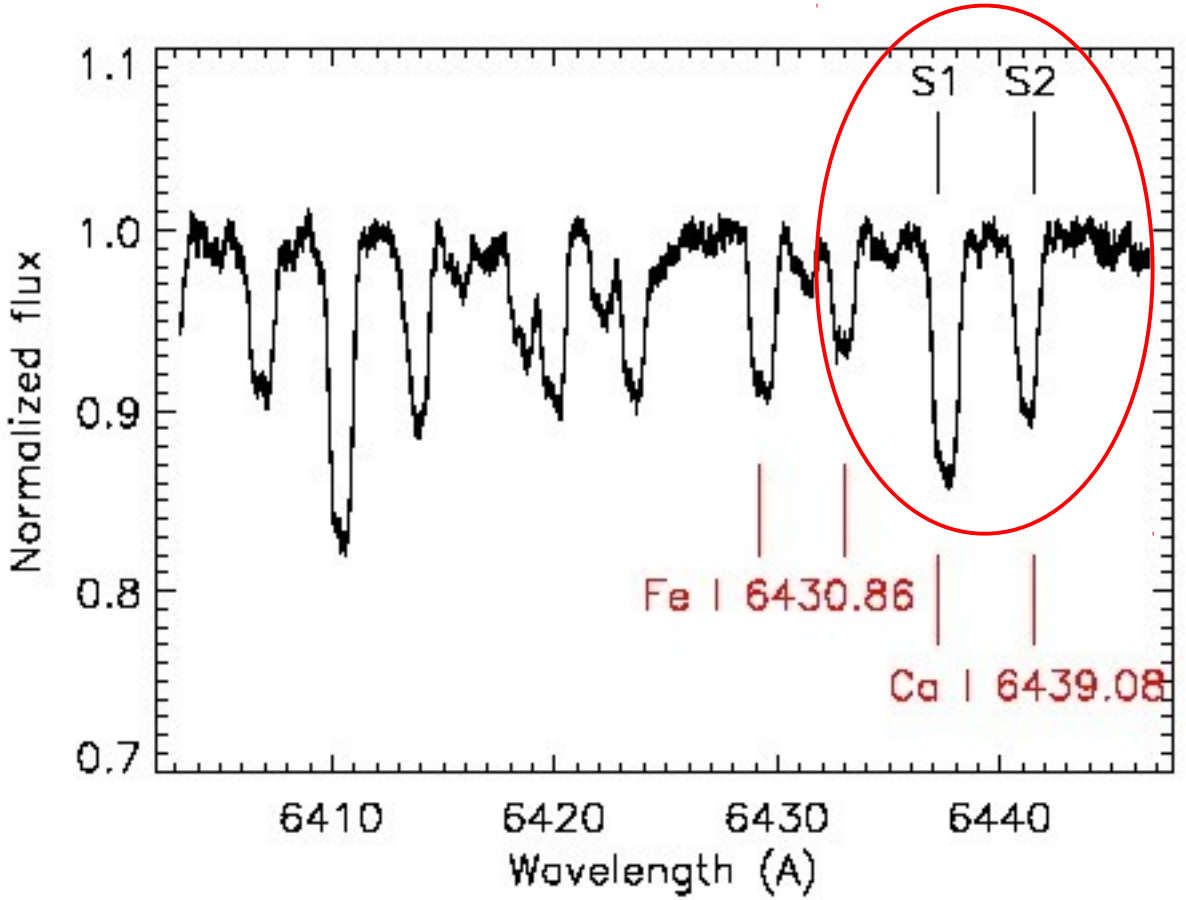
## Astrophysical parameters (Strassmeier et al 2000)

| | Primary | Secondary |
|---|---|---|
| Teff | 5400±100 K | 5050±100 K |
| logg | 4.0±0.5 | 4.5±0.5 |
| vsini | 36.8±1 km/s | 33.7±1.5 km/s |
| m | 1.101±0.013 | 1.001±0.011 |
| Spectral type | G5 IV | K0 IV-V |

Dataset:

- 11 spectra taken between 19. 09. 2002 and 23. 09. 2002 with 3P6-CES (La Silla, Chile) in single order mode covering one orbital period

CES single-order spectrum from 2002



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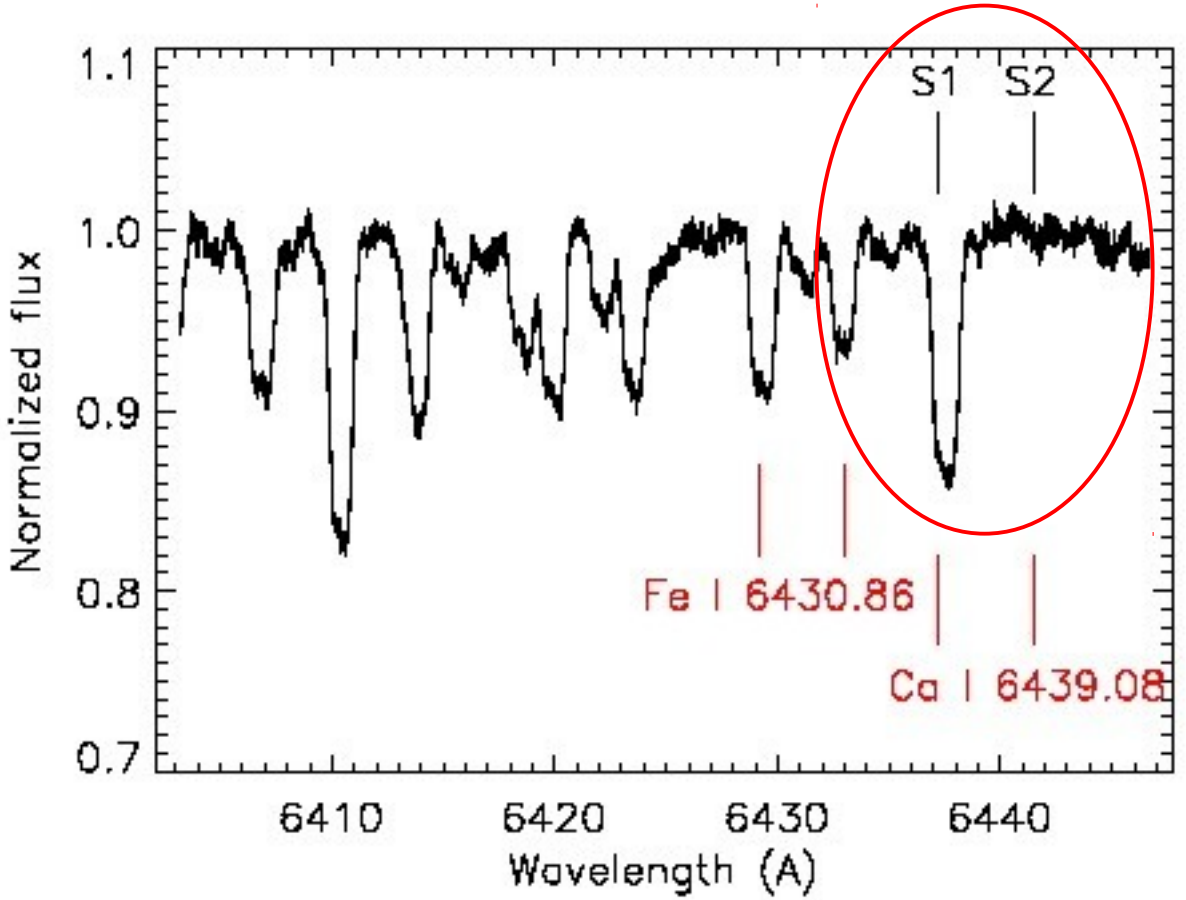
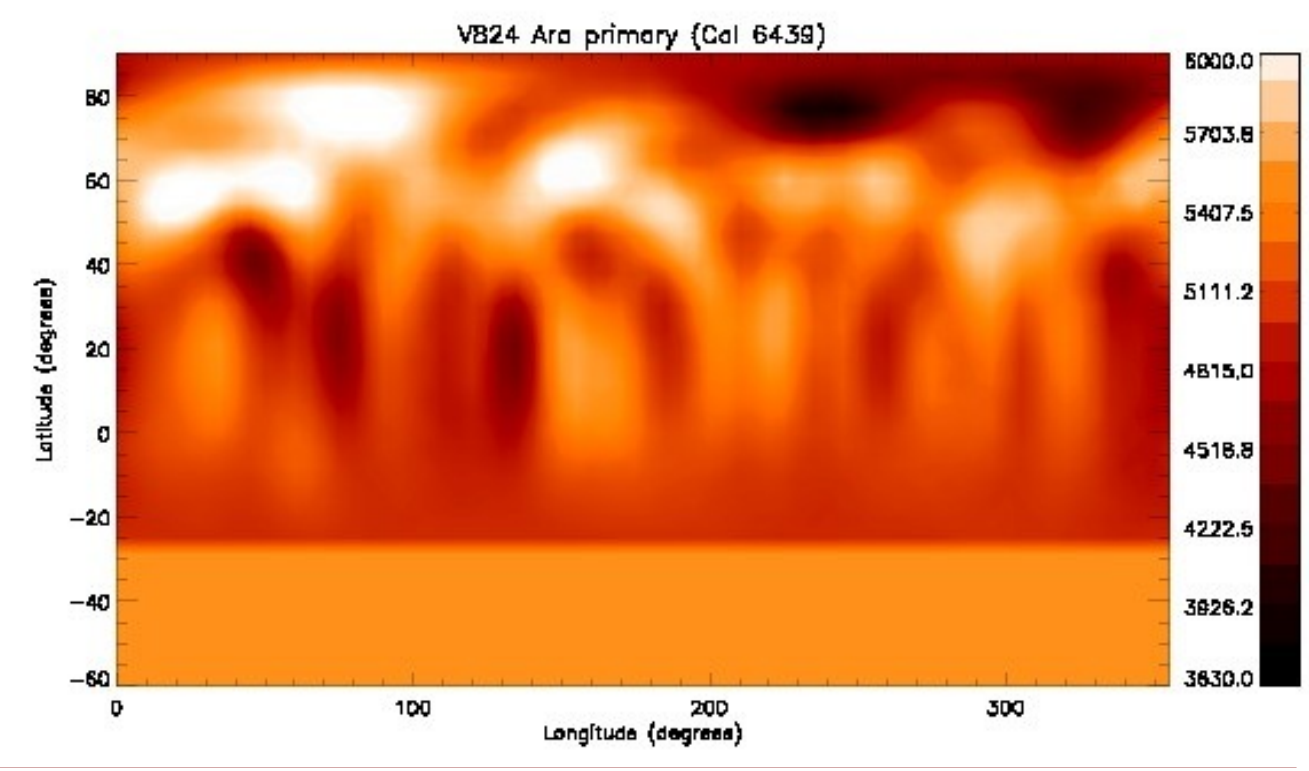
Example of an

extracted spectrum



## Ca I 6439

- The most obvious choice for DI since there are only a few blends in the vicinity of the line


V824 Ara primary (Cal 6439)
Latitude (degrees)
Longitude (degrees)
80
60
40
20
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−20
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−60
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100
200
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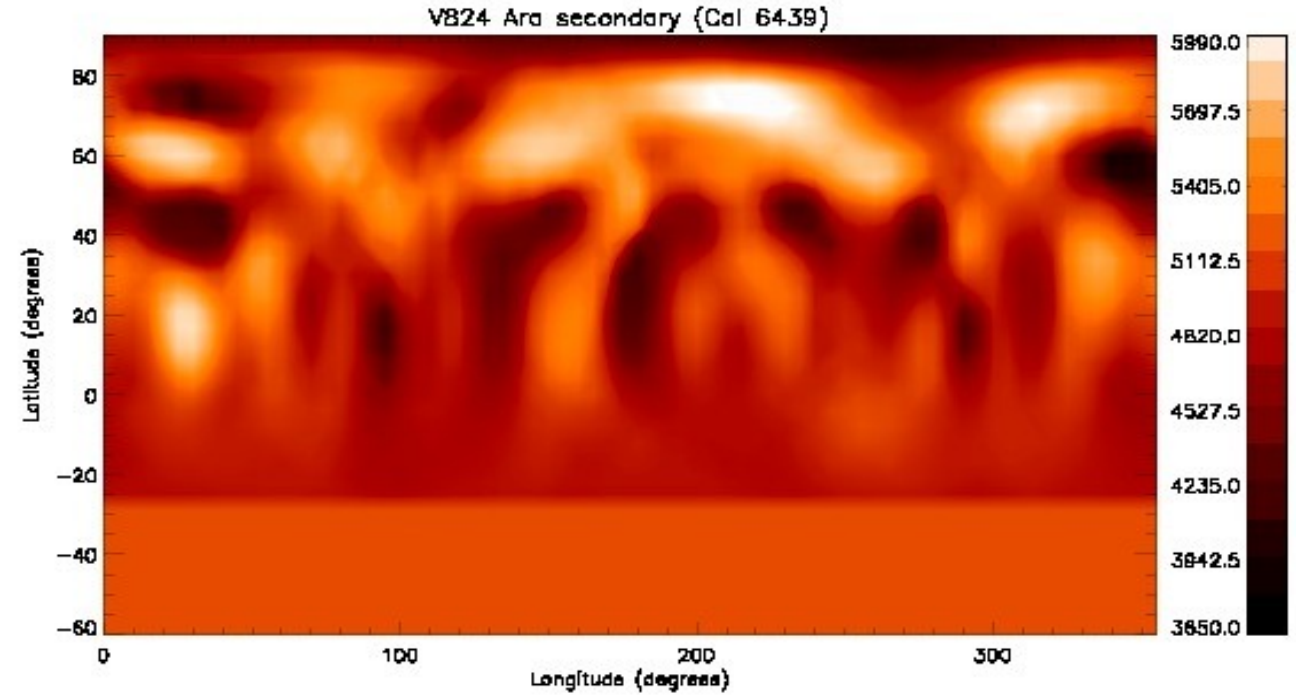
6000.0
5703.8
5407.5
5111.2
4815.0
4518.8
4222.5
3926.2
3630.0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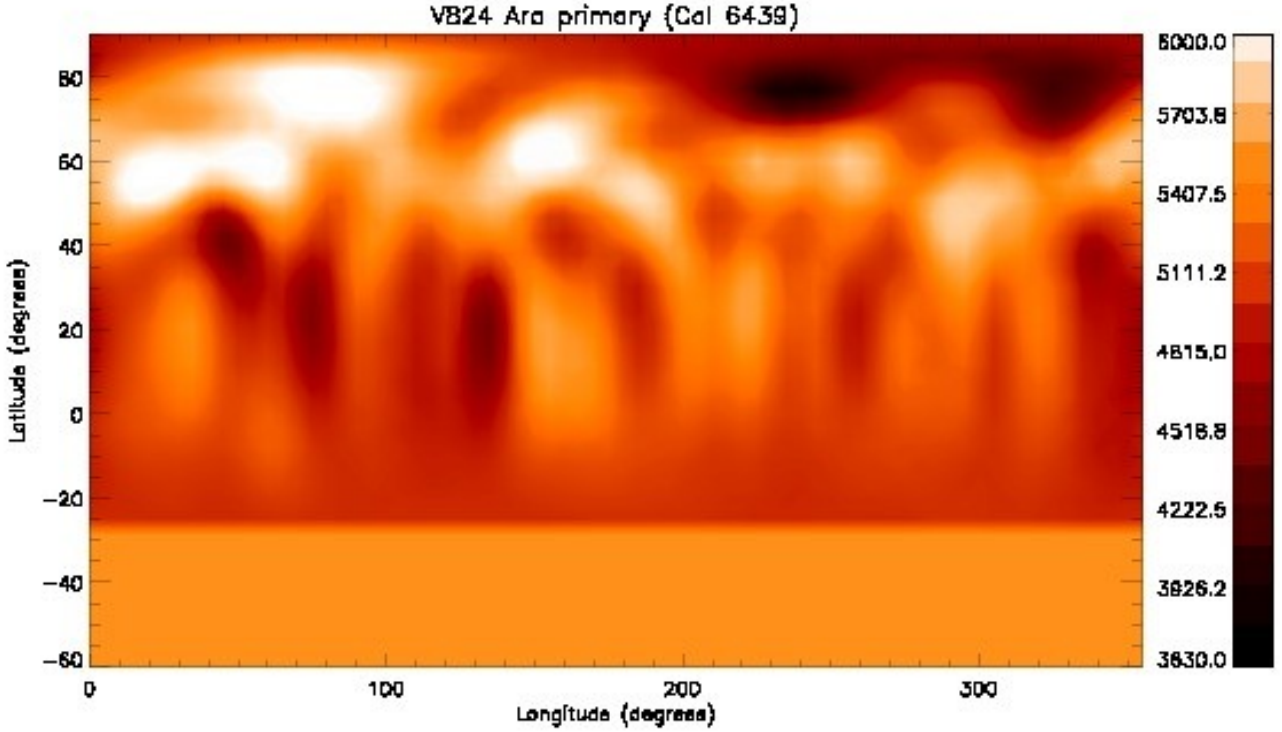
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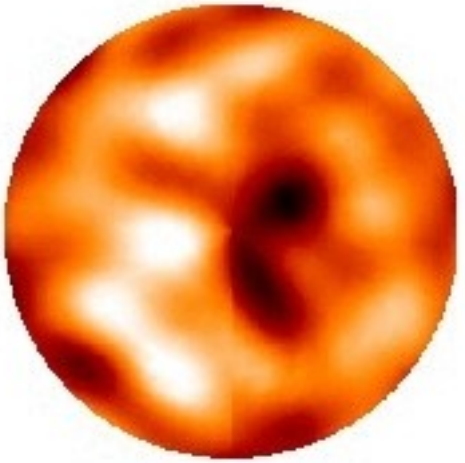

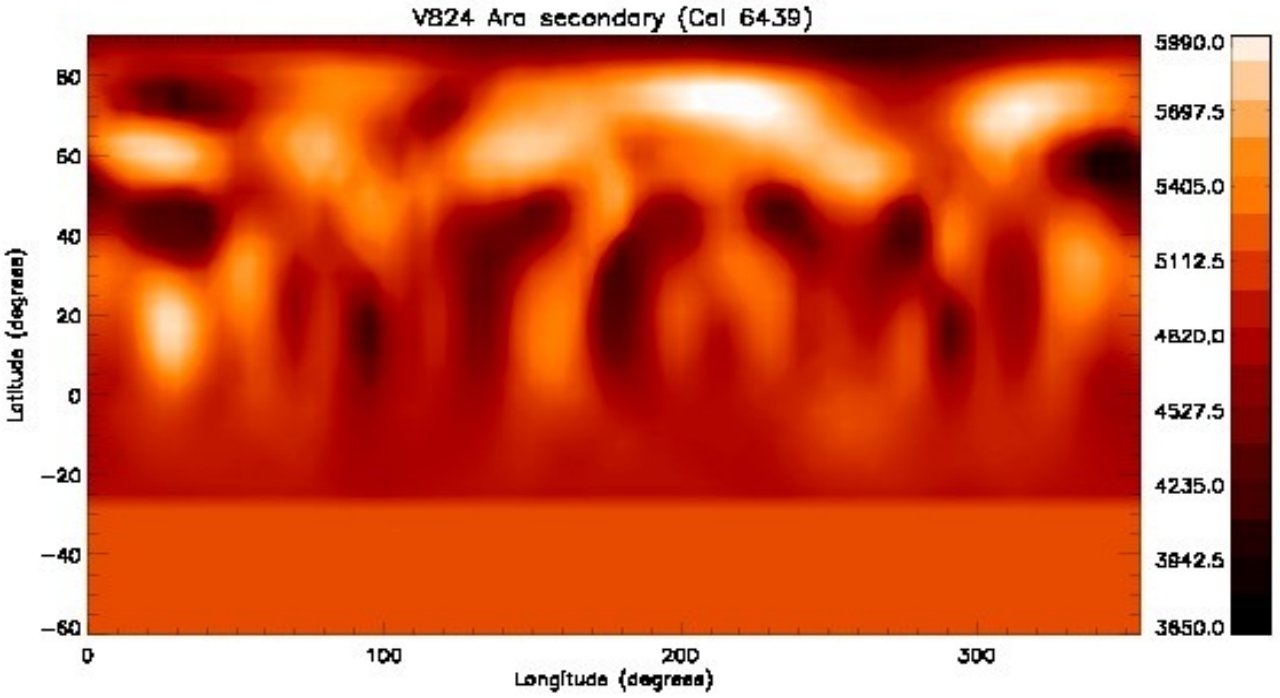
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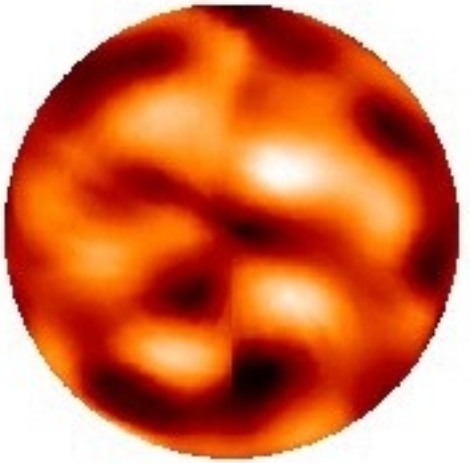

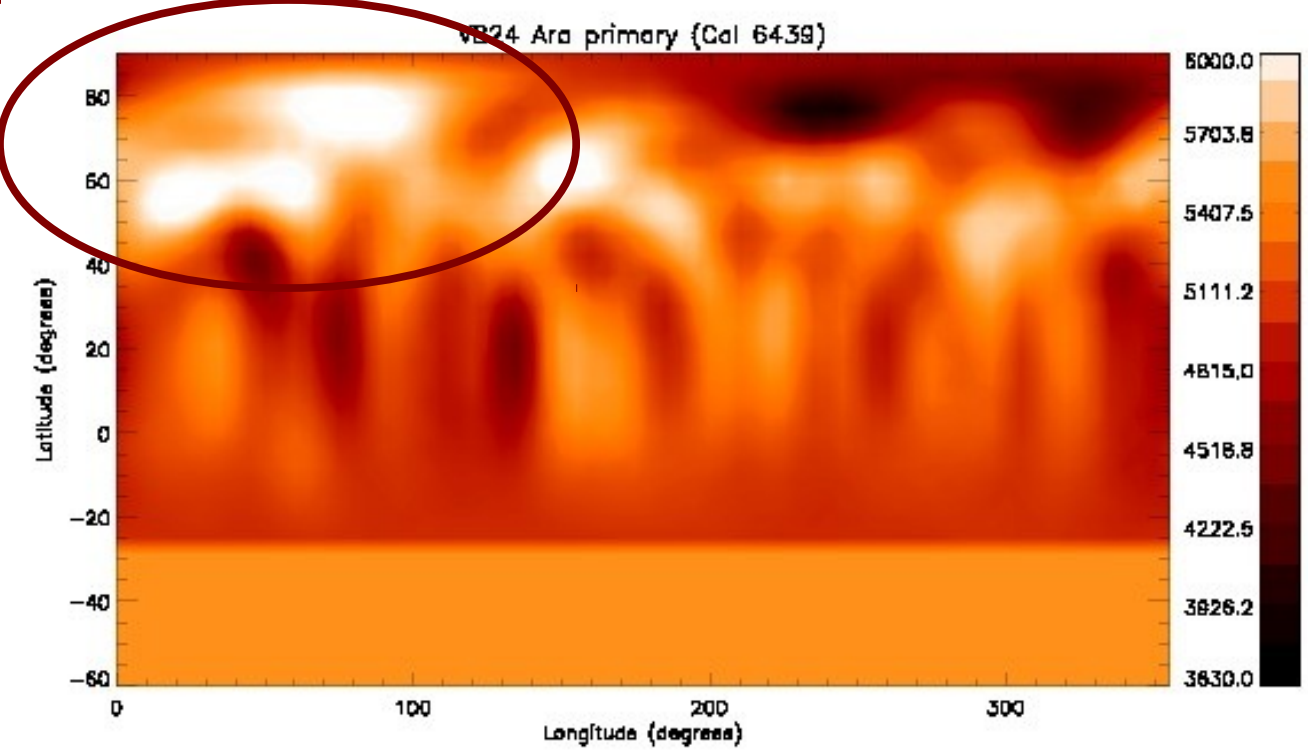
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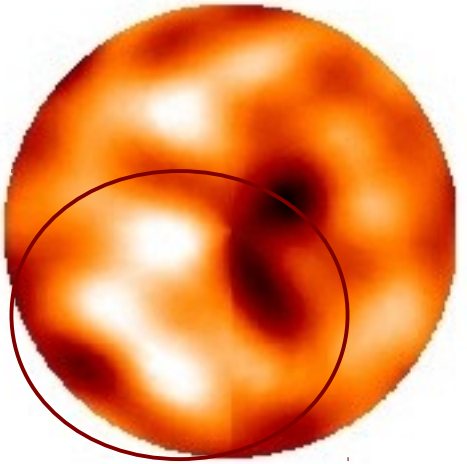

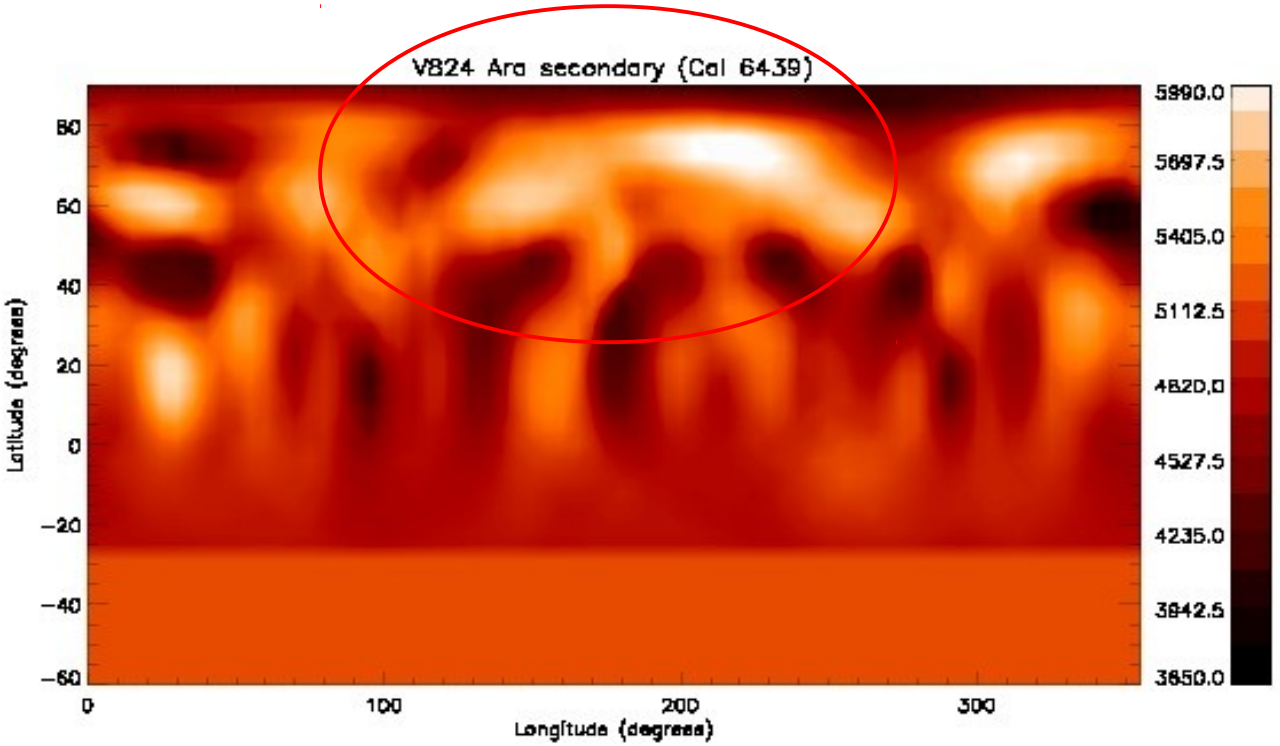
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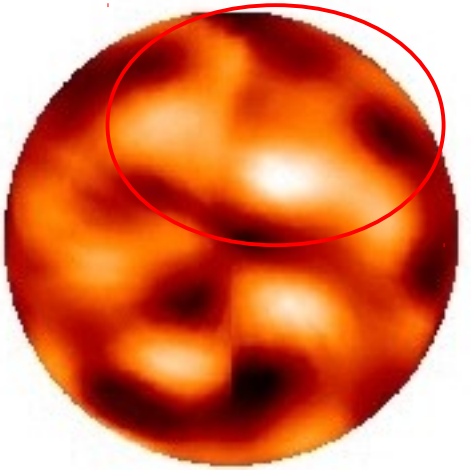
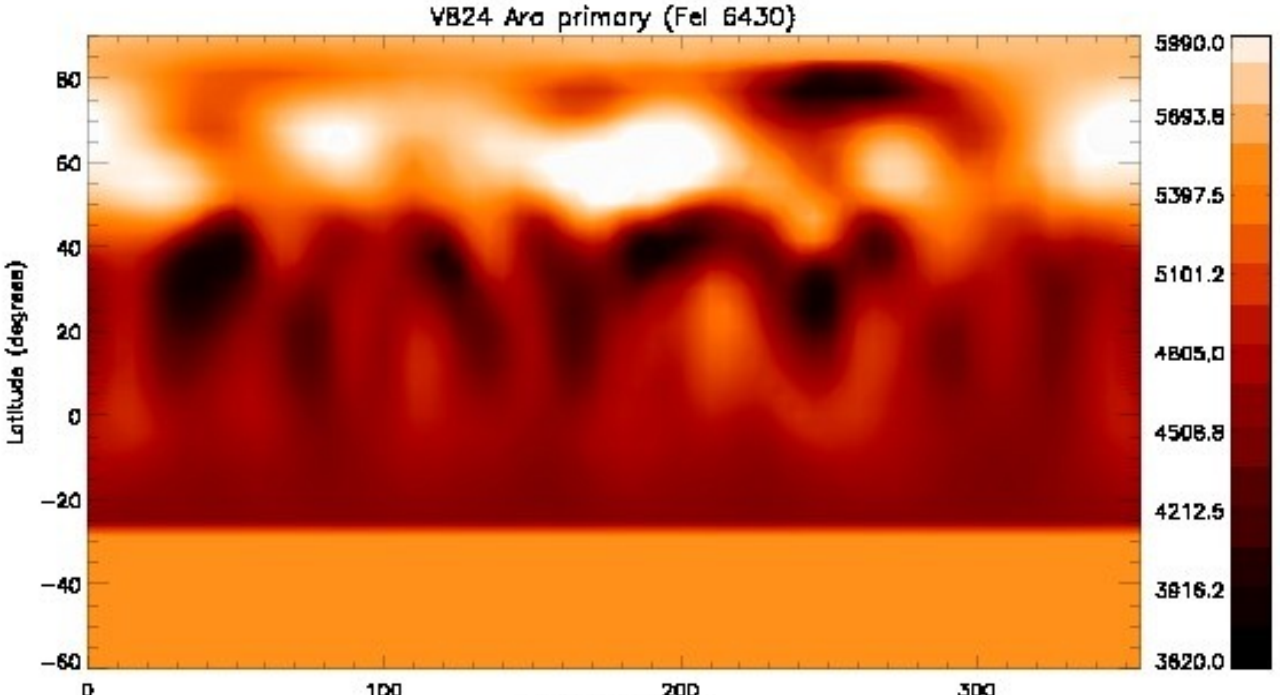


# Ca I 6439

## Fe I 6430

- The blending problem (the Fe II 6432 of the primary blends with the Fe I 6430 of the secondary) can be handled by calculating and extracting the Fe II 6432 profile as well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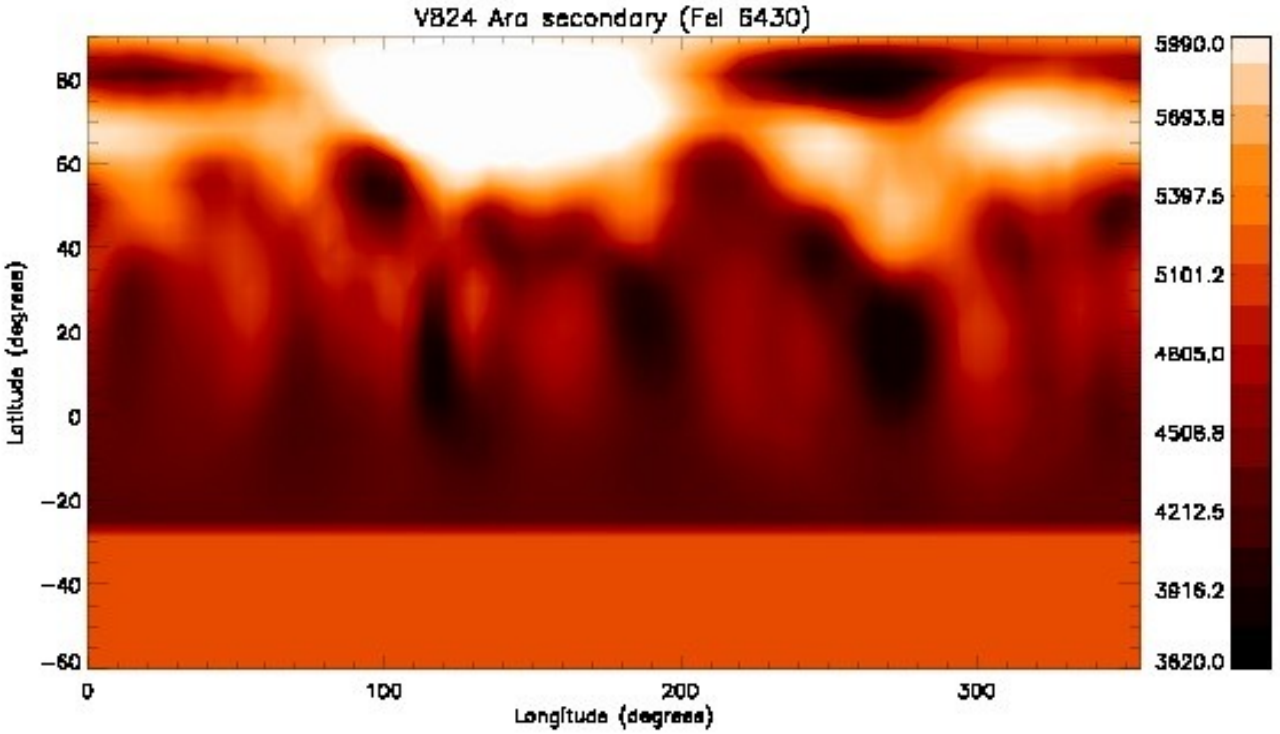
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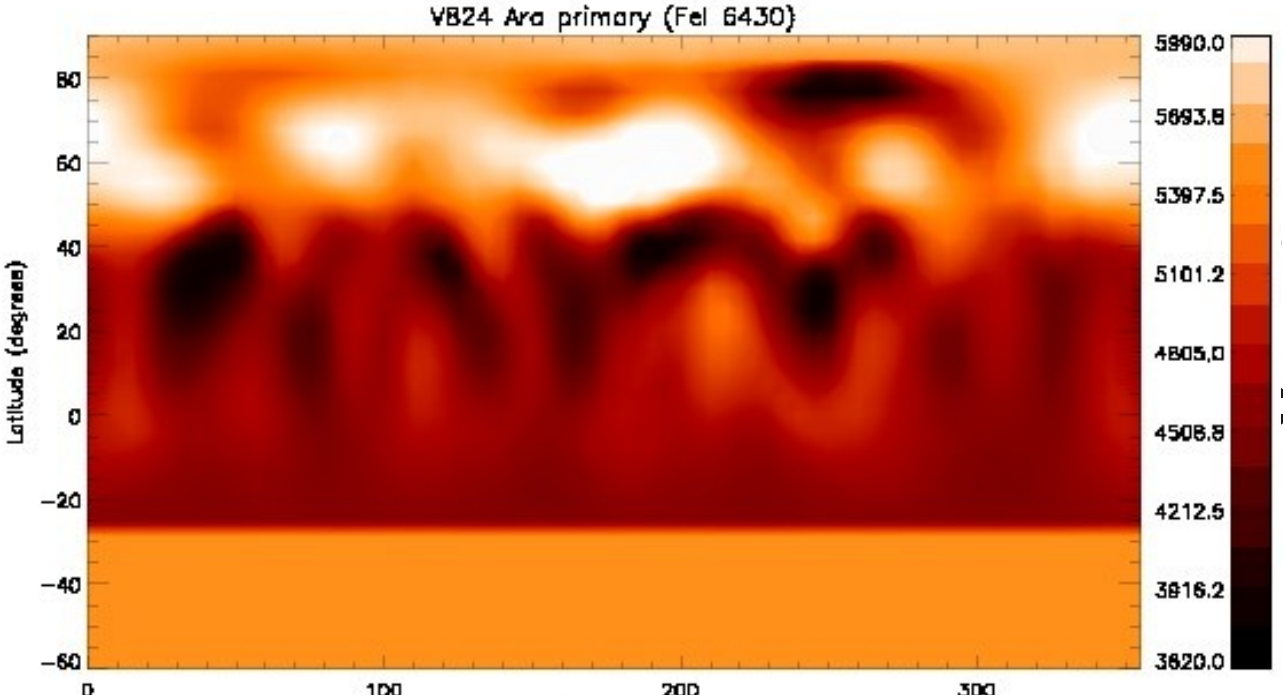
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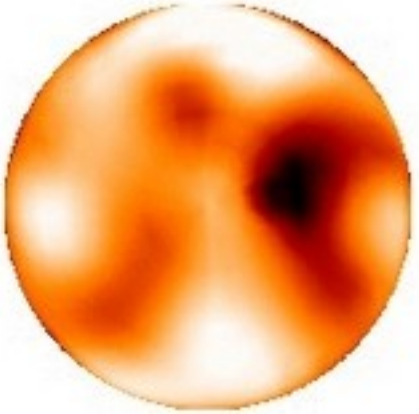

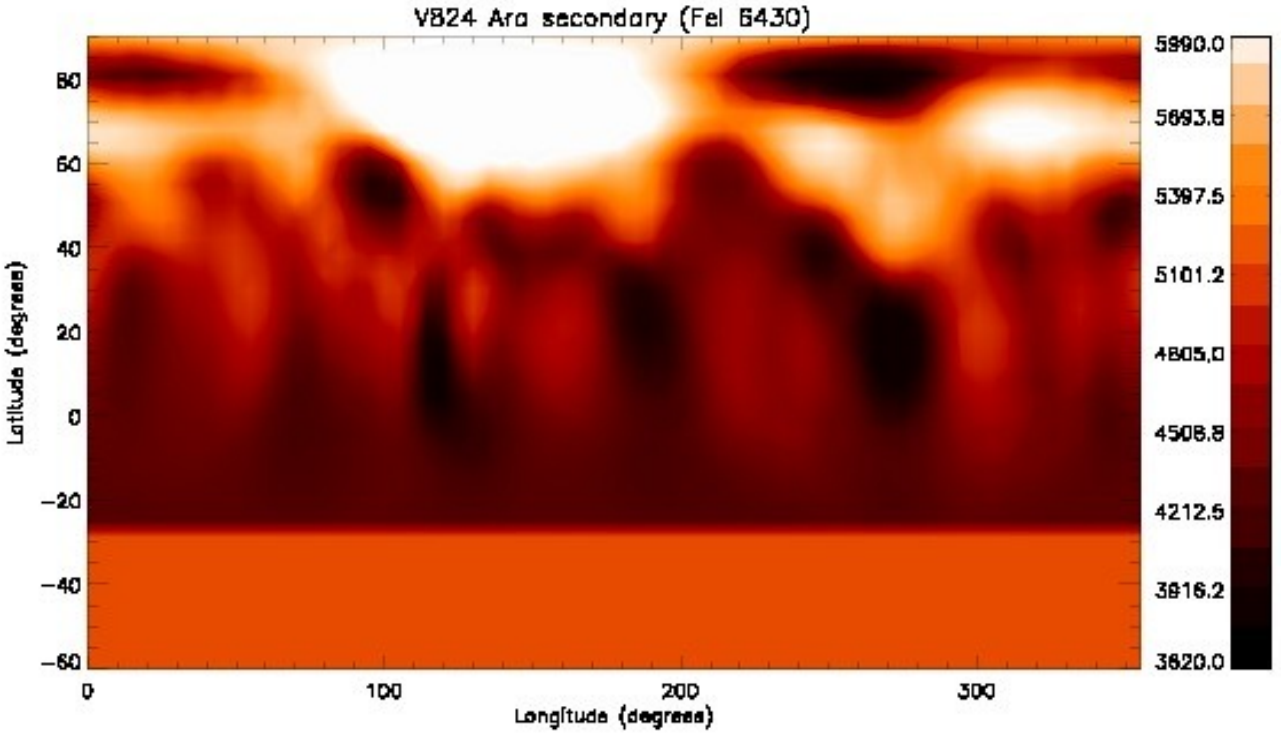
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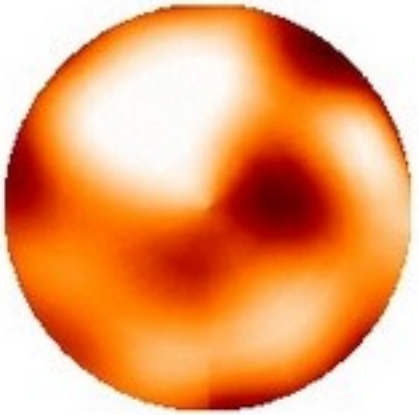

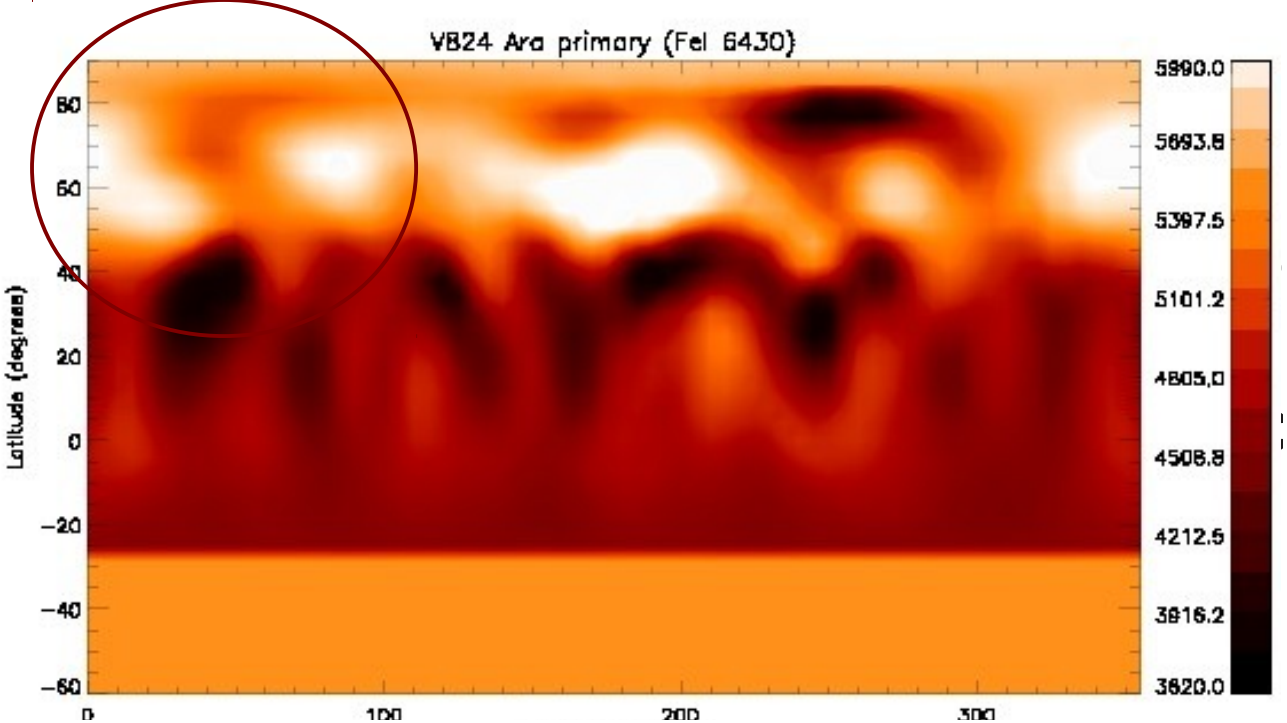
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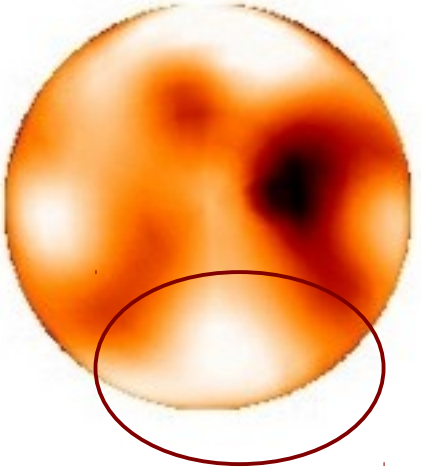

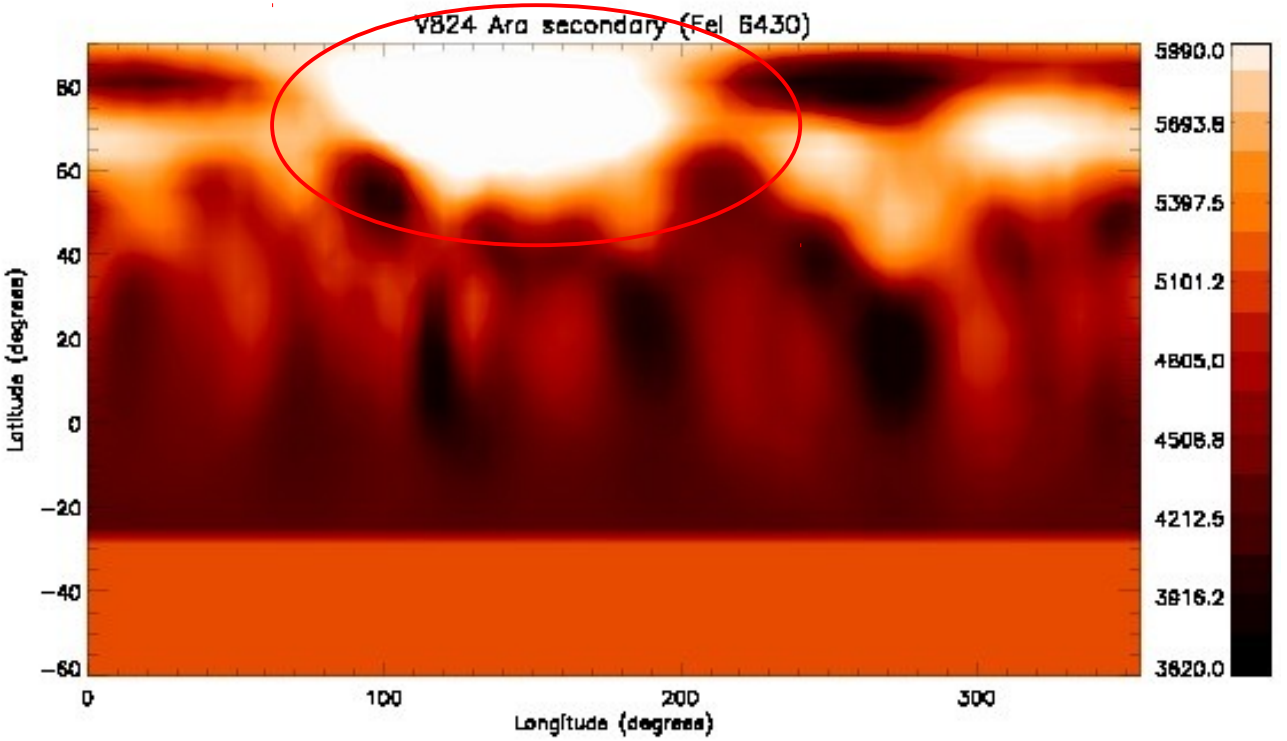
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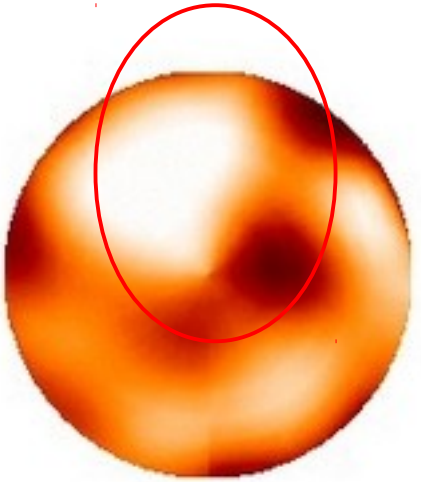
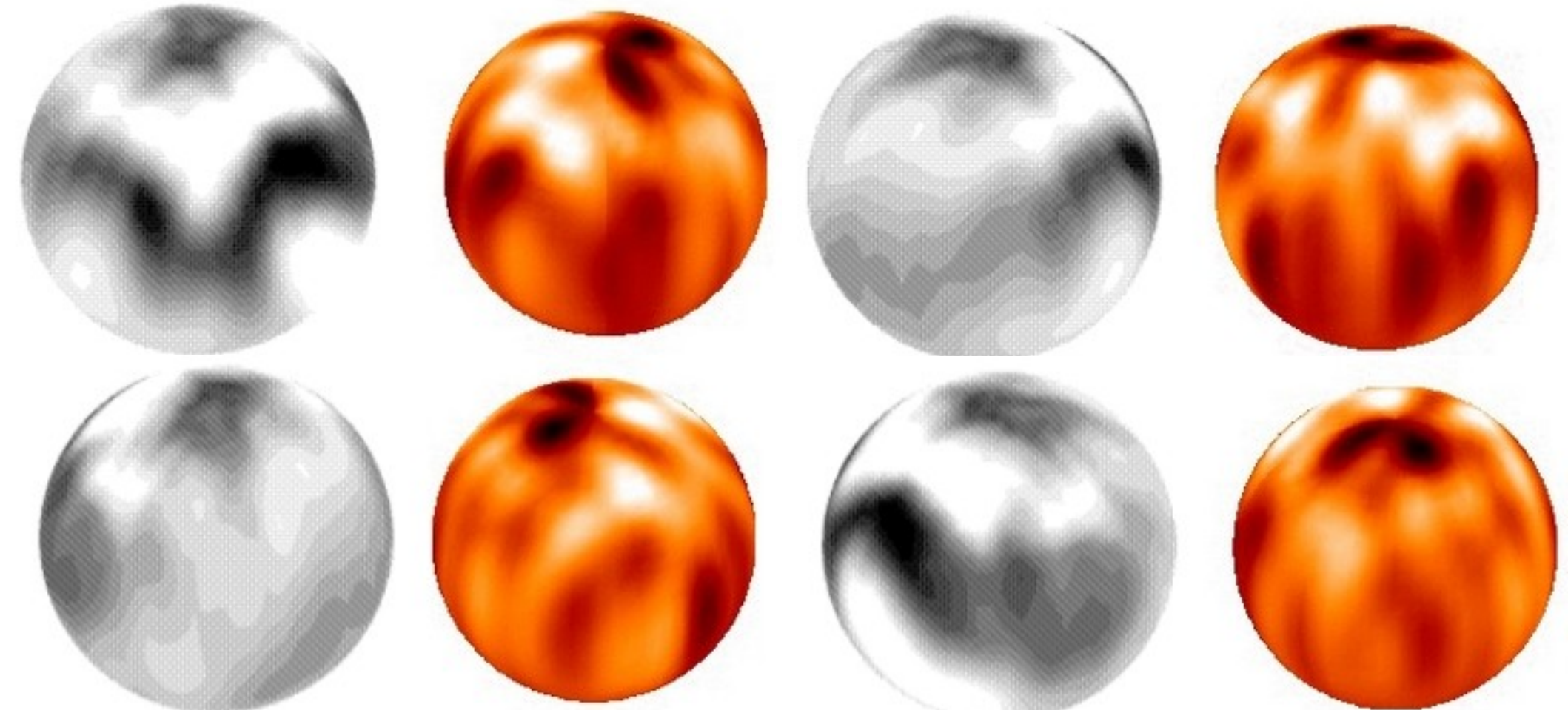


# Fe I 6430

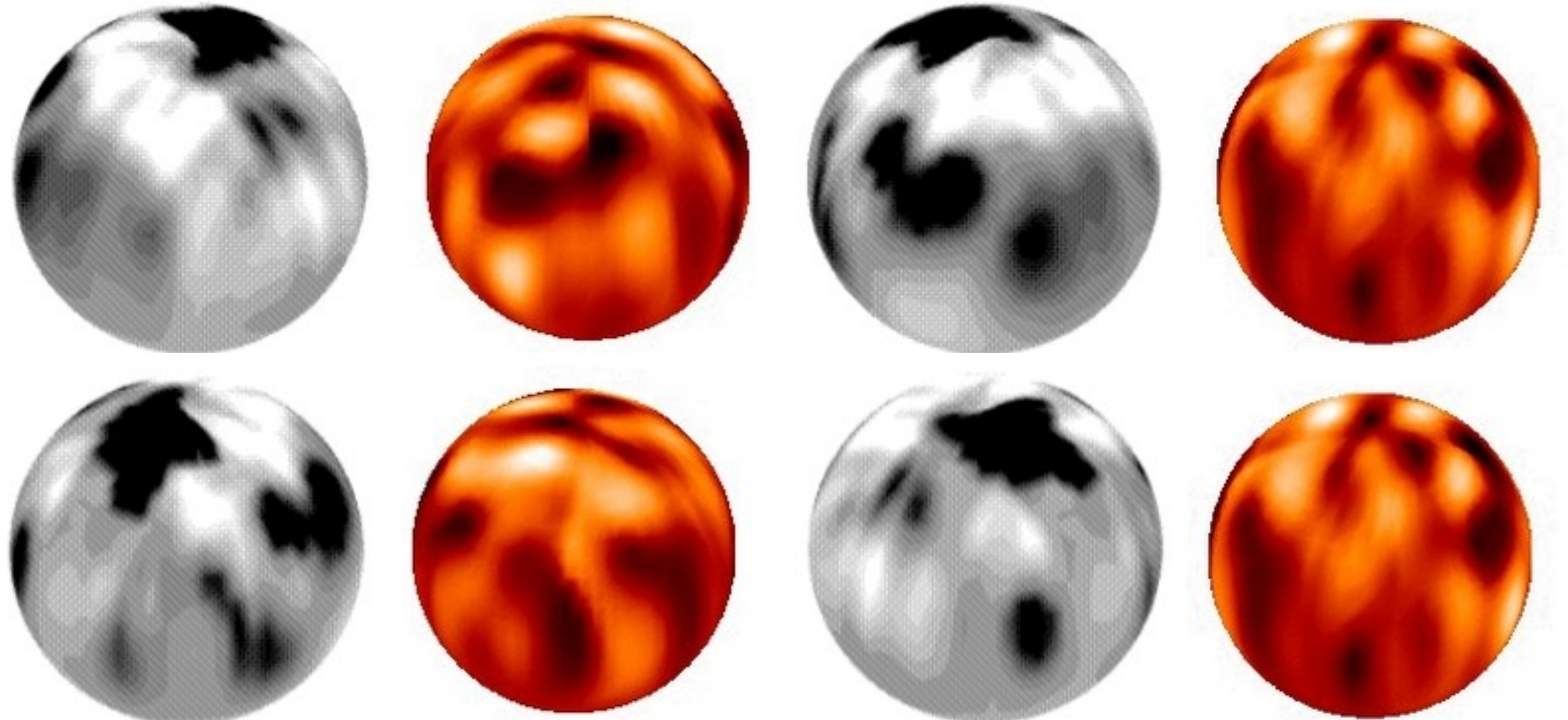
## In comparison with Strassmeier et al 2000...

- Primary component (Ca I 6439):
  - Polar active region seems to be persistent
  - Hot spot around ~0 phase is present on both maps
  - Low latitude features at ~270



## In comparison with Strassmeier et al 2000...

- Secondary component (Ca I 6439):
  - Polar nest is present, but somewhat weaker on the recent map
  - Hot spot at ~0 and 180, but weaker as well



## Conclusions

- The magnetic configuration is not completely unchanged, but there are persistent nests on both components (in comparison with Strassmeier et al 2000, A&A 360, 1019)
  - Primary component:  lower latitude active regions at ~45 and ~300 degs phase, polar features
  - Secondary: weaker polar spot, low latitude active region at ~130 degs
- The hotter spots on the opposing hemispheres require further investigation

# Thank you for your attention!

In collaboration with:

Zsolt Kővári
Katalin Oláh
Krisztián Vida
David Garcia