Spectropolarimetric observation of evolved giant stars

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Primordial Chaos, No. 16. Hilma af Klint, 1906-1907
Music suggestion: 65daysofstatic – Massive Star At The End Of Its Burning Cycle

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with **Arturo López Ariste**
Quentin Pilate
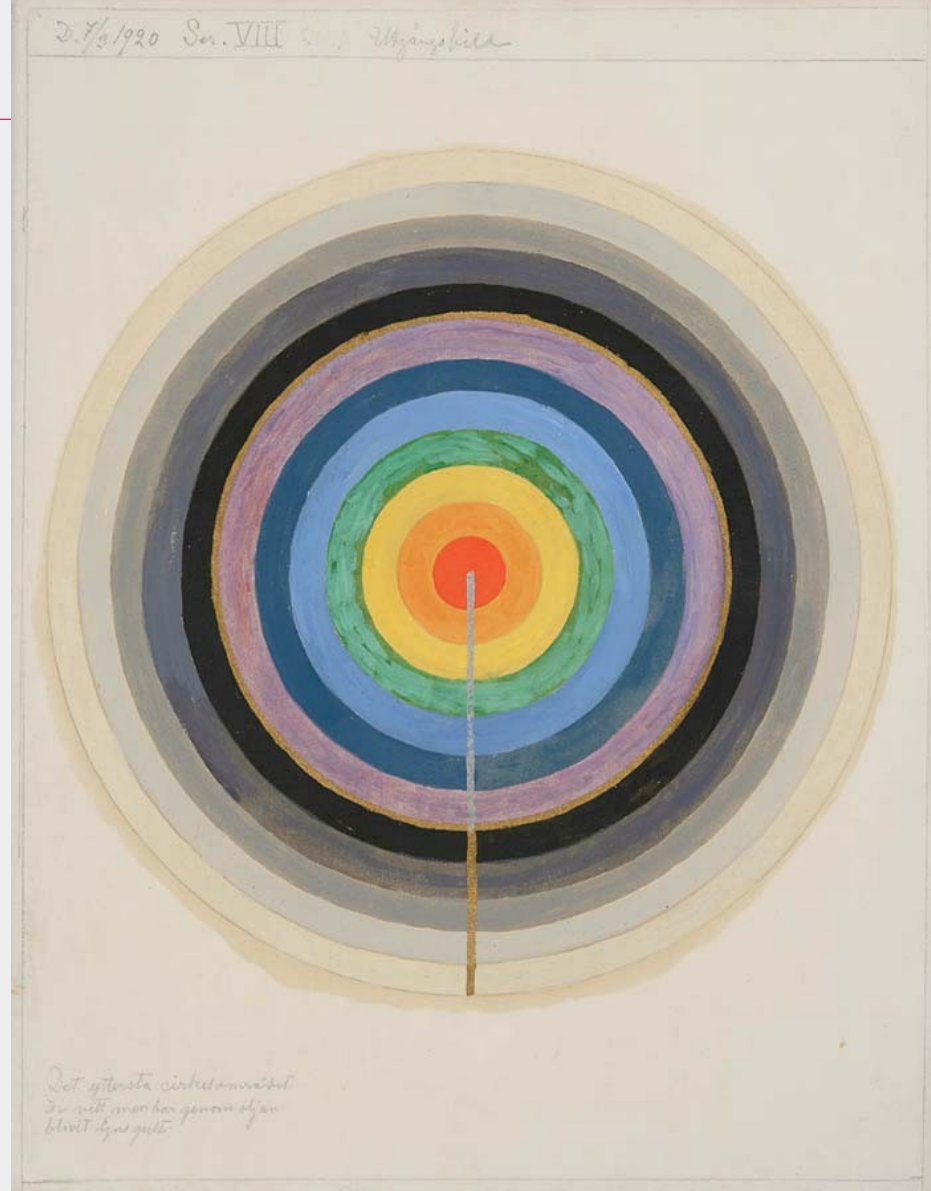**Philippe Mathias**

Primordial Chaos, No. 16. Hilma af Klint, 1906-1907
Music suggestion: 65daysofstatic – Massive Star At The End Of Its Burning Cycle

Takeaway points

1. **Evolved giant stars** are **cosmic engines**, they **enrich** their environment with **chemical elements** which are **the building blocks** of **planets** and **life**.

2. **Spectropolarimetry (spectroscopy** in **polarized light)** observations, which we can get at e.g Télescope Bernard Lyot at **Pic du Midi**, allow us to **map** the **brightness** and **velocities** at the surface of these stars, and better understand the important physics (**convection**, **wind** etc ..)
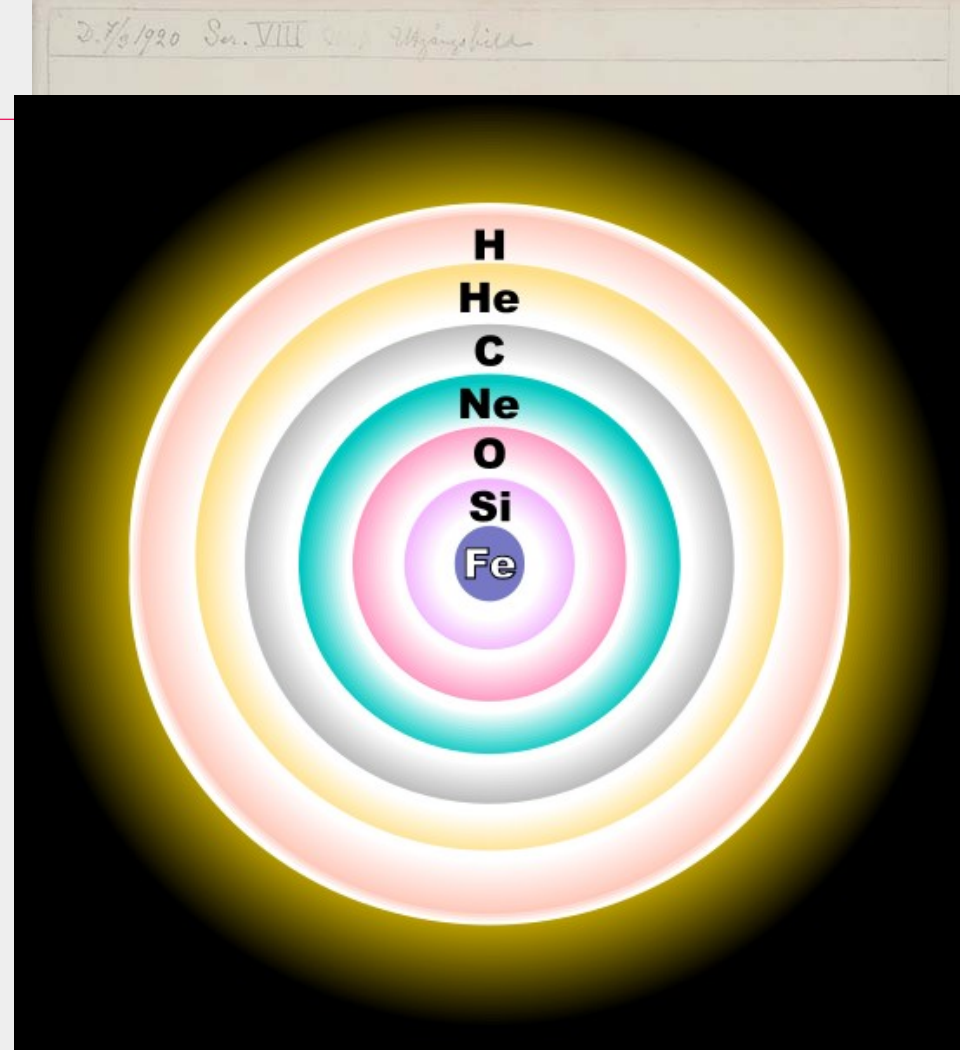
HaK 537, Starting Picture, Series VIII, Hilma af Klint, 1920

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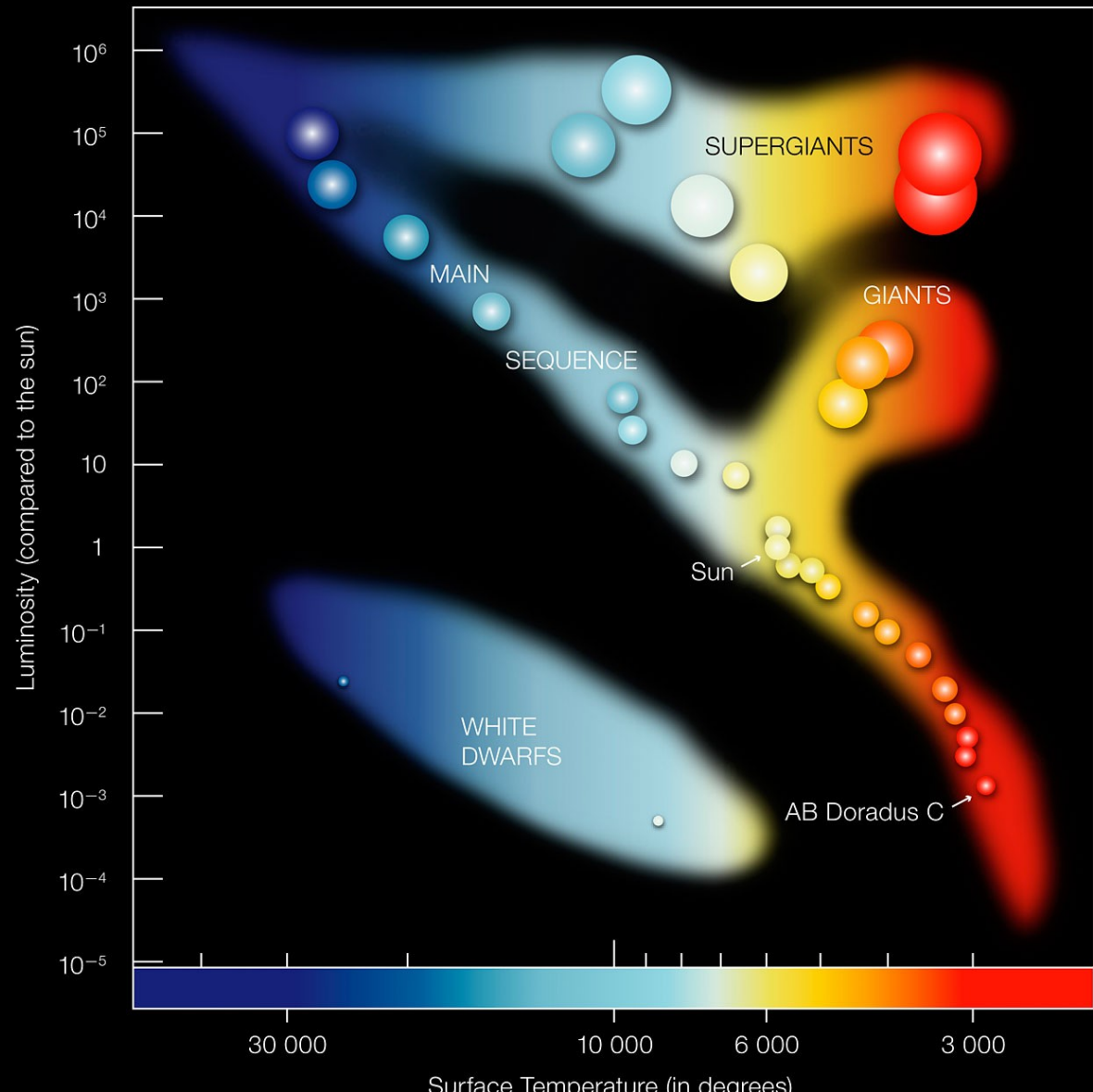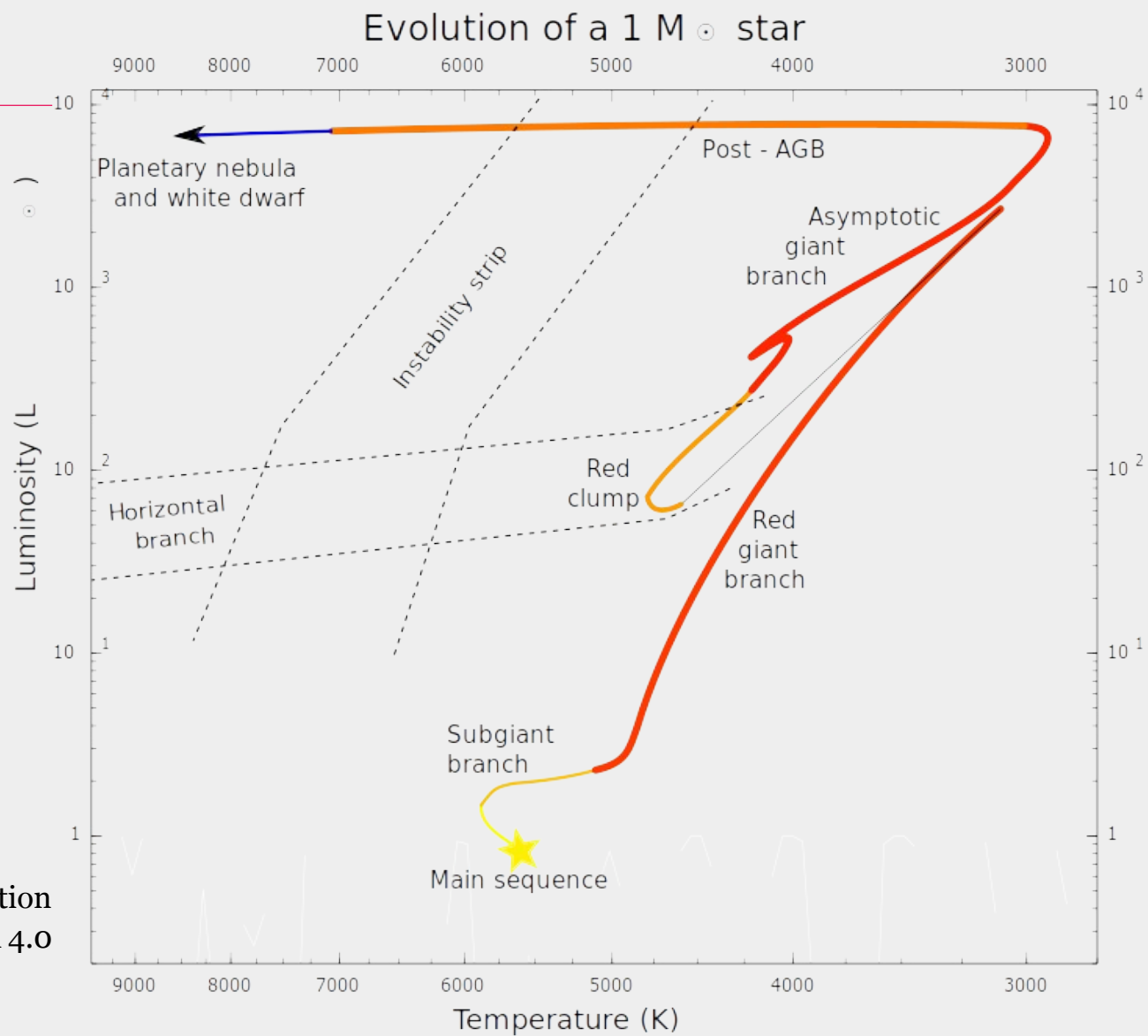
HaK 537, Starting Picture, Series VIII, Hilma af Klint, 1920

A star's life

Hertzsprung-Russell Diagram
Credits : ESO

A star's life

Evolution of a 1 M☉ star

Planetary nebula and white dwarf

Instability strip

Post - AGB

Asymptotic giant branch

Red clump

Red giant branch

Horizontal branch

Subgiant branch

Main sequence

Luminosity (L☉)

Temperature (K)

Models of red supergiants

Computer simulation of a red supergiant star like Betelgeuse. *Credits : Bernd Freytag*
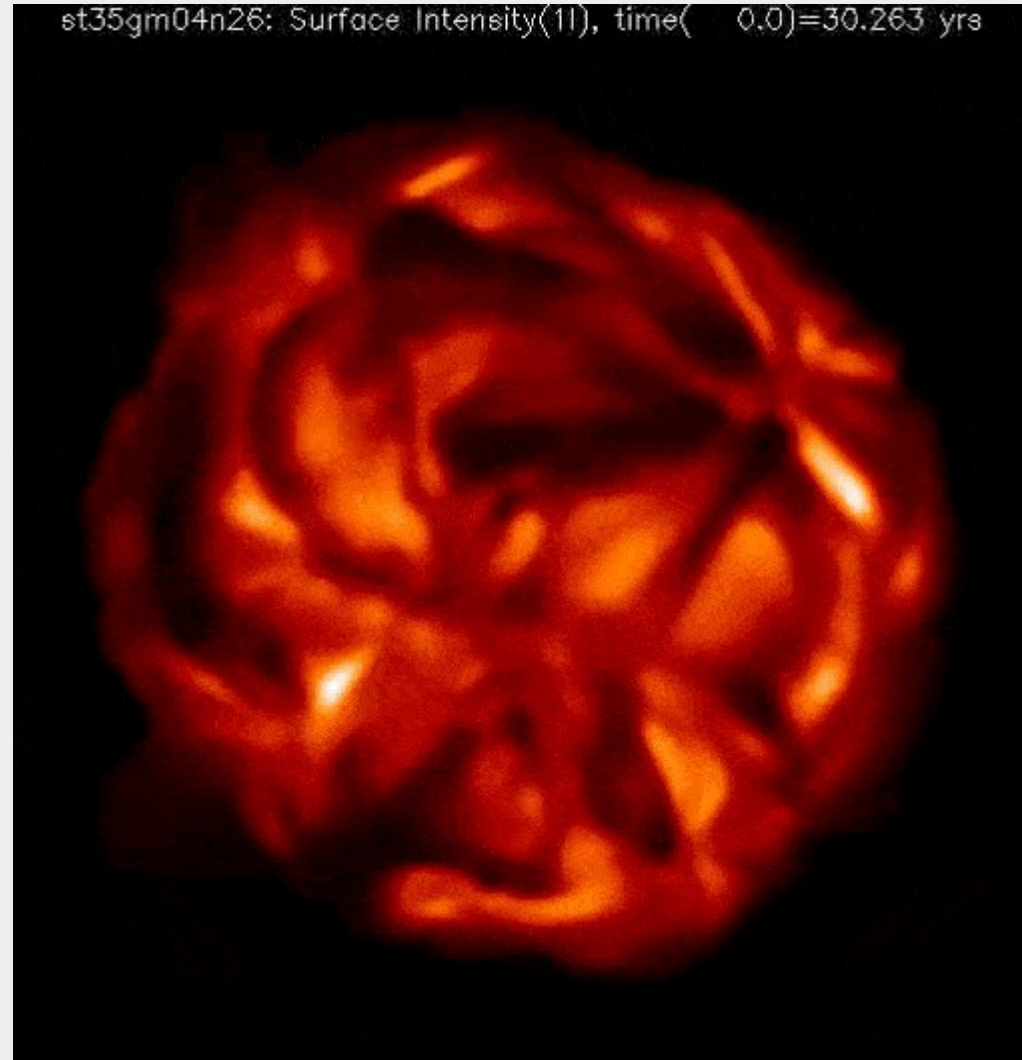
If we take the **largest** telescopes

The ESO Very Large Telescope (VLT) during observations, the four 8.2-metre Unit Telescopes (UTs) are visible. Credits: ESO/S. Brunier

Betelgeuse observations using the SPHERE instrument at the ø 8-metre Very Large Telescope *Credits: ESO/M. Montargès et al.*
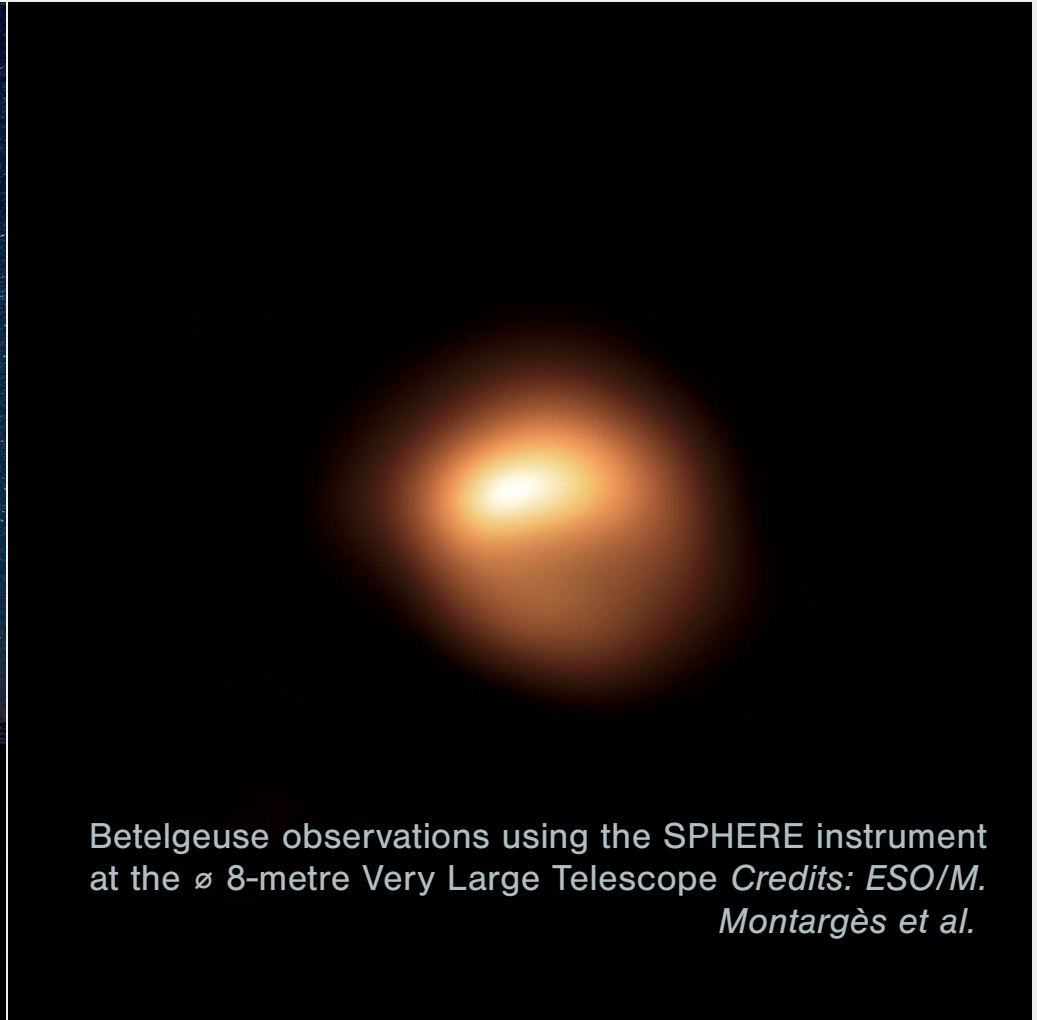
Spectropolarimetric observing programme

2-metre Télescope Bernard Lyot at Pic du Midi de Bigorre (2877m) **dedicated to spectropolarimetry**

Equipped with a recently upgraded high-resolution **optical** spectropolarimeter: **Neo-Narval**

Soon will host a near-infrared **sister** instrument **SPIP**

Both with be able to work at the same time

Photo: Pascal Petit

Spectropolarimetric observing programme

> Large observing programme run every semester

> ~ 20 nights / semester

> Targeting 15-20 stars

> Time-series covering years (sometimes decades)
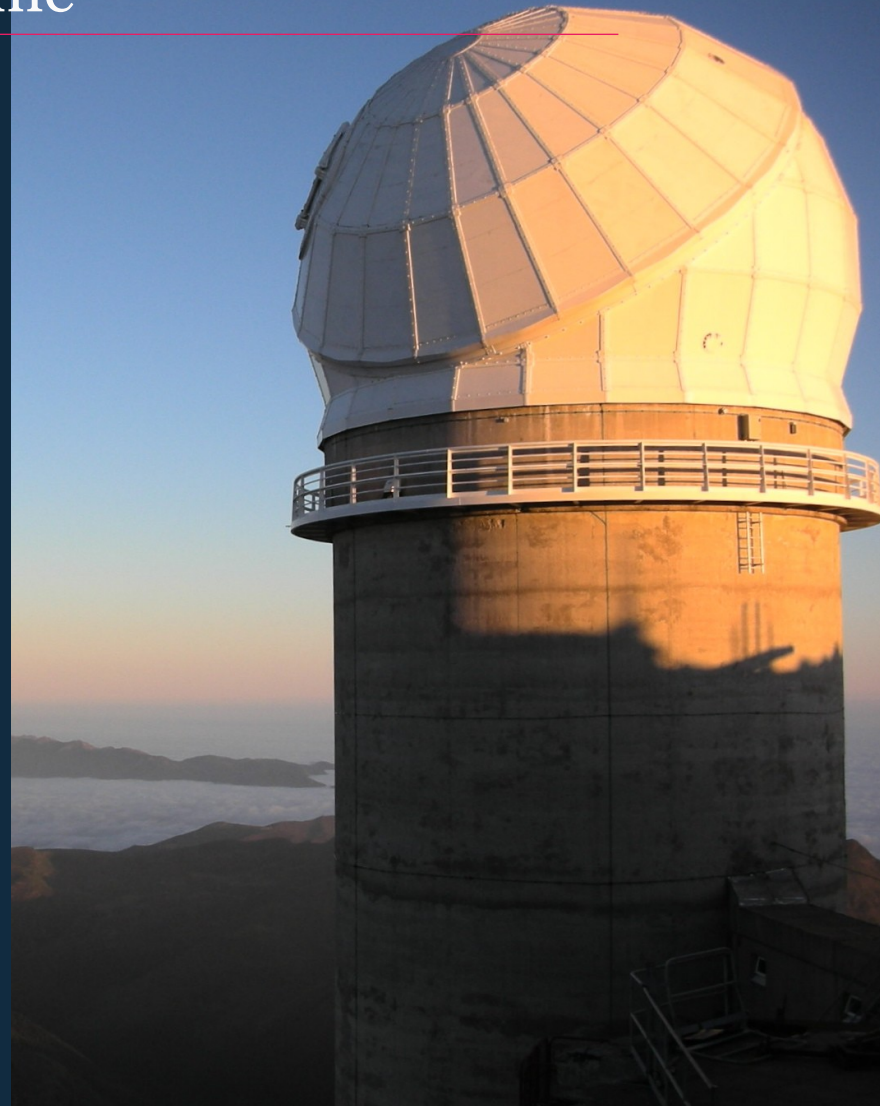
Photo: Pascal Petit

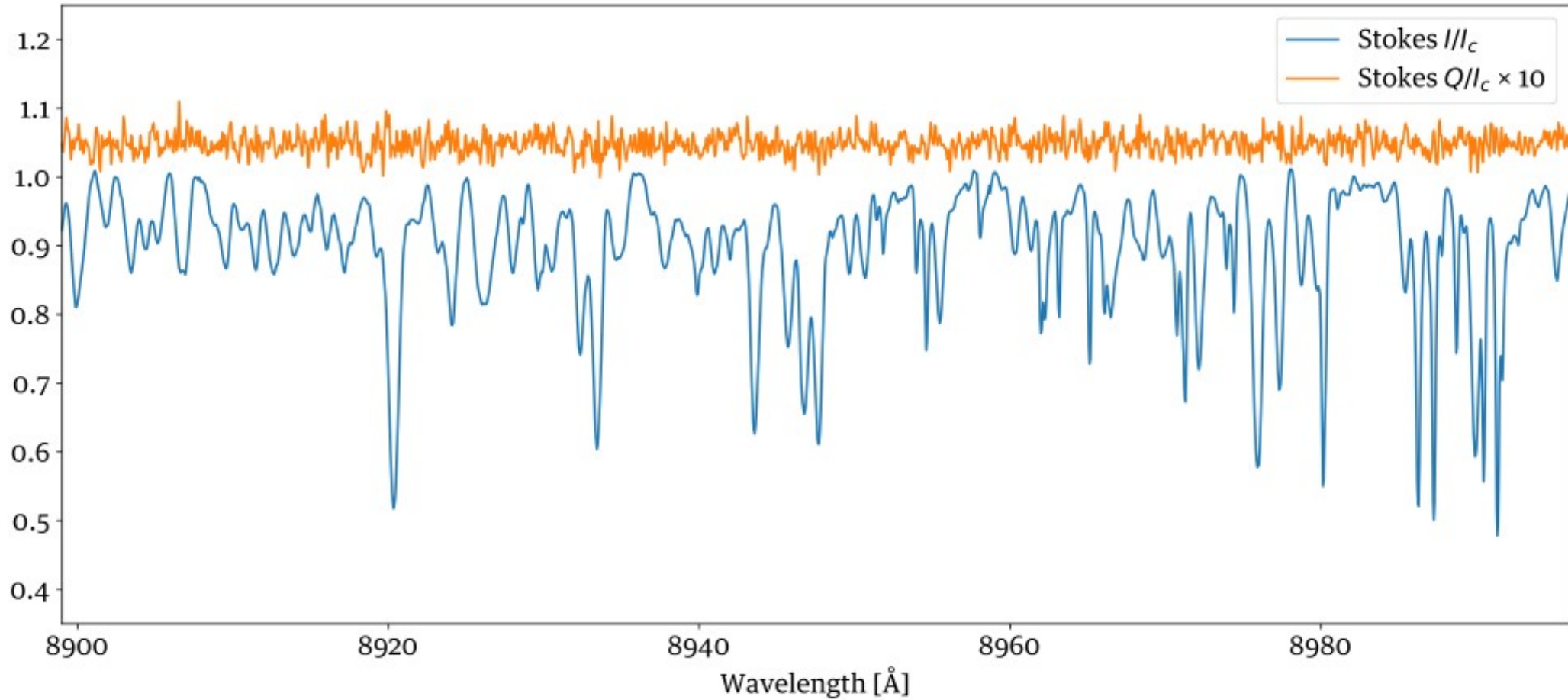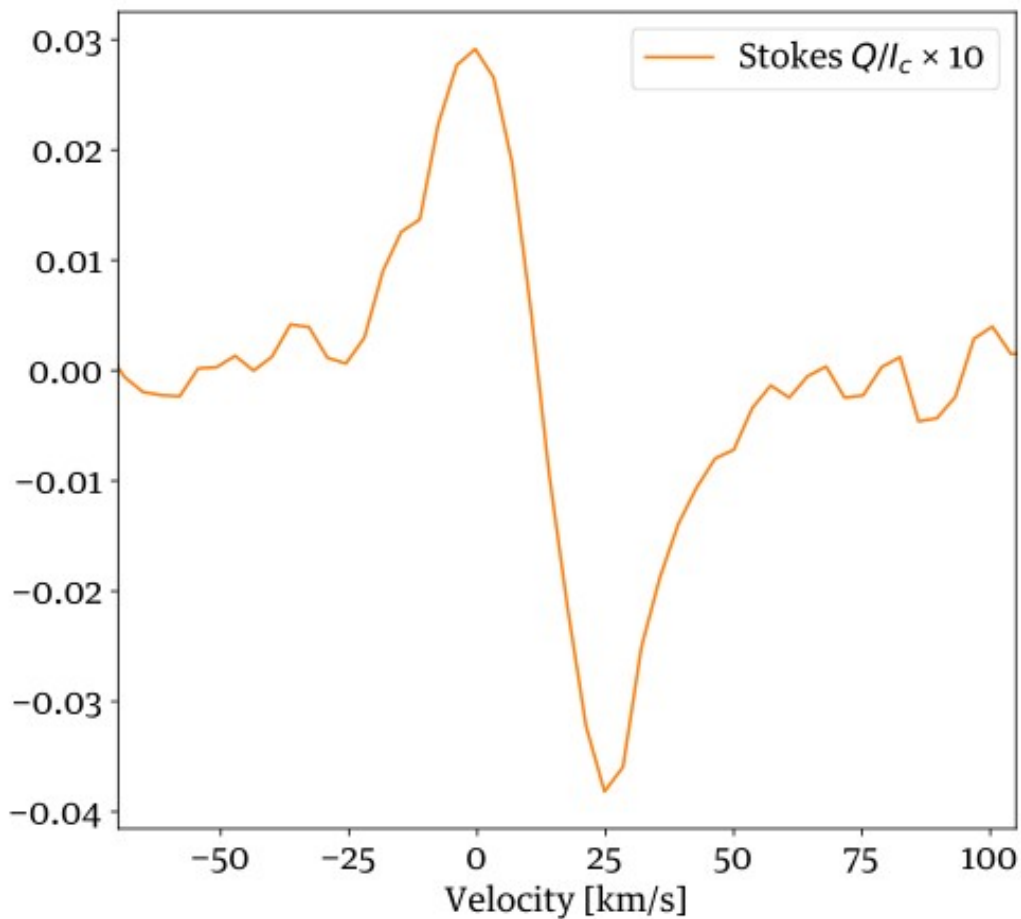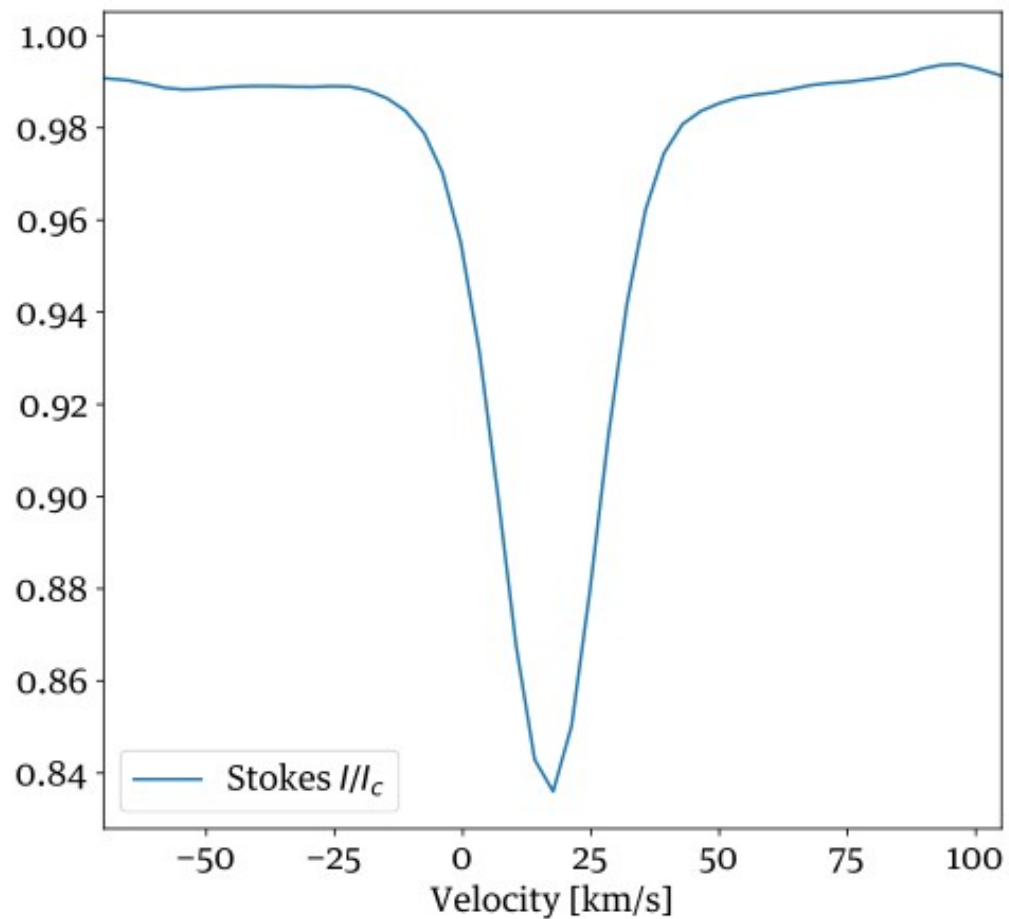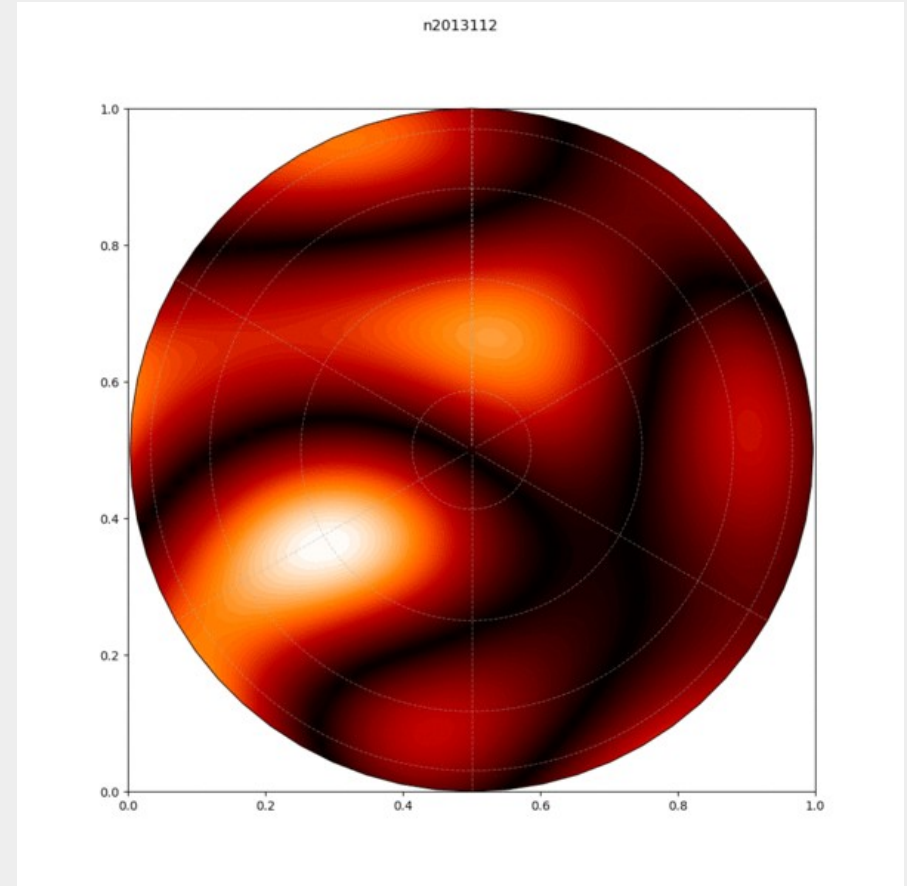# Spectropolarimetry 101
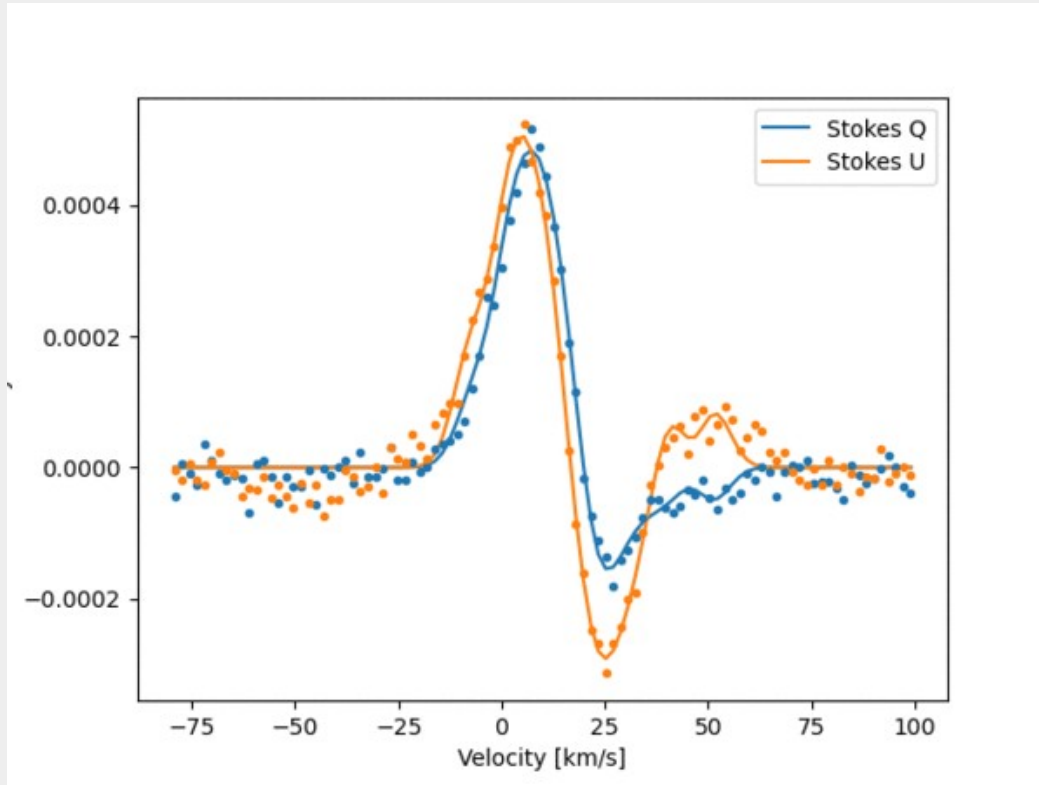
Neo-Narval observation of Betelgeuse | 2024-01-12
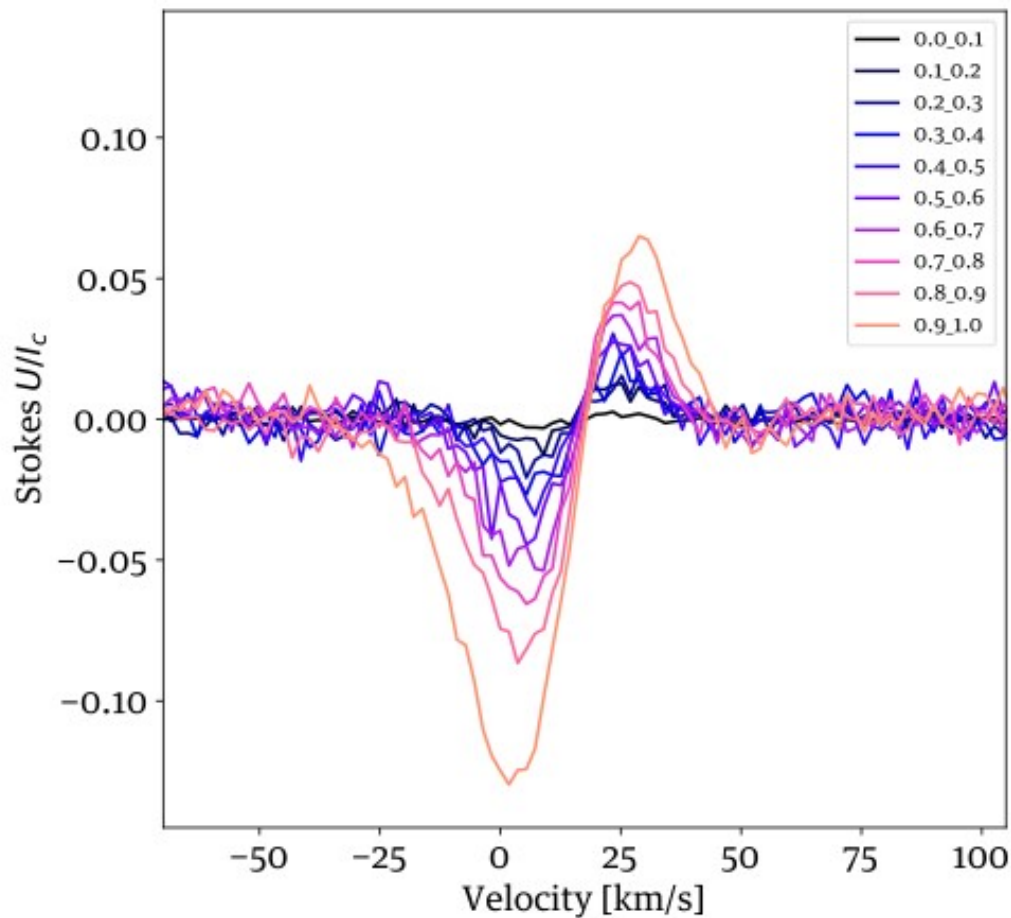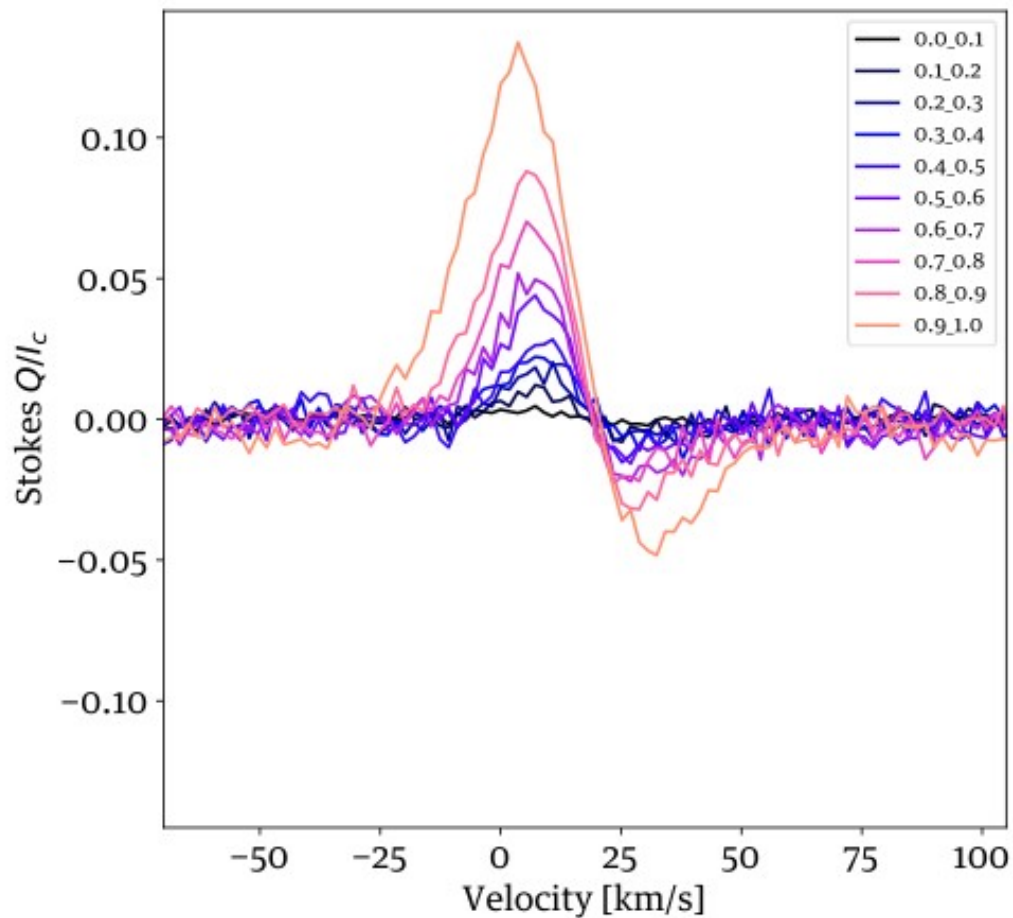
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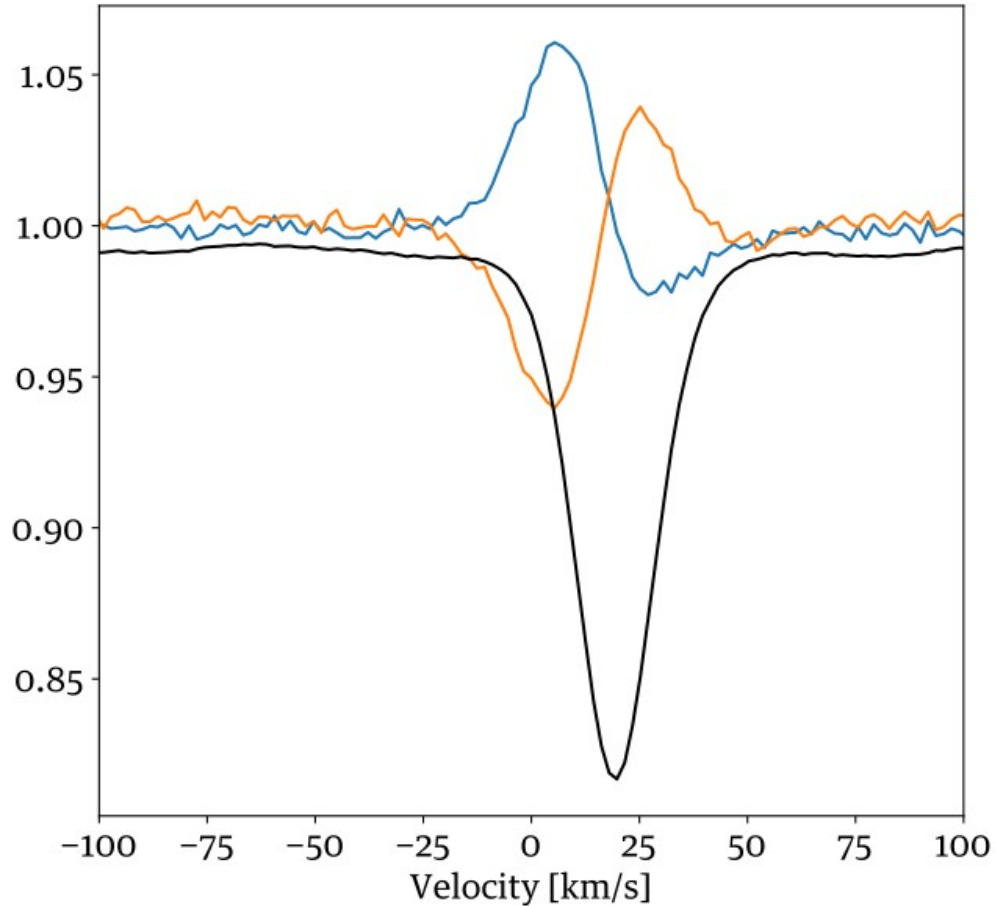
Spectropolarimetric imaging

Narval observation of Betelgeuse | 2013-12-11

Spectropolarimetric imaging

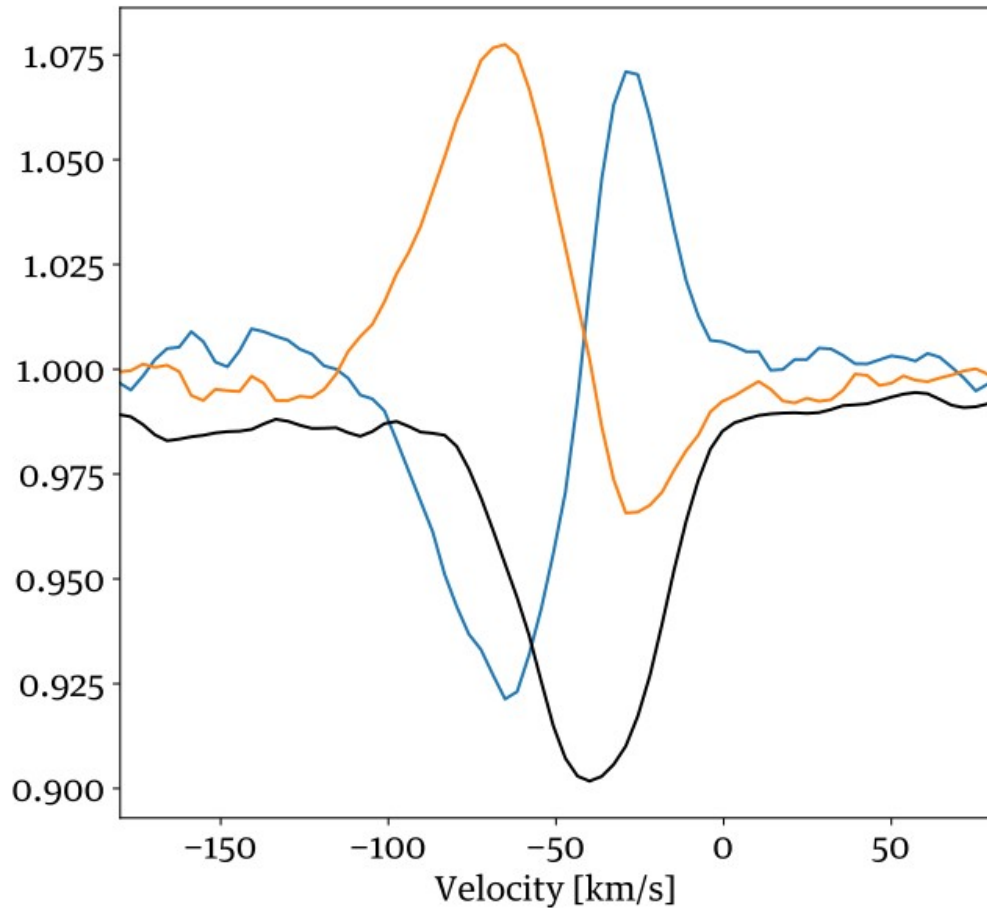Narval observation of Betelgeuse | 2013-12-11

Puzzle:
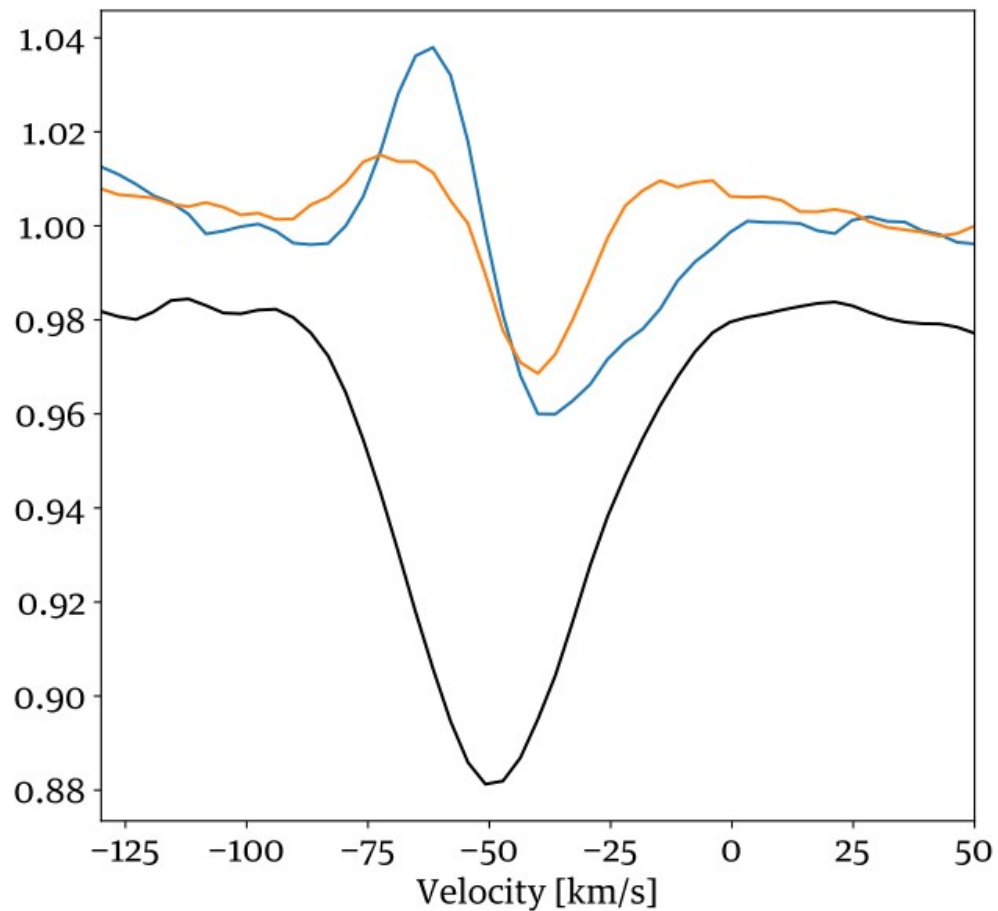We observe a larger velocity span in polarization than in velocity.

Spectropolarimetric imaging

Neo-Narval observation of RW Cep | 2023-09-05

Spectropolarimetric imaging

Neo-Narval observation of PZ Cas | 2023-11-19

Takeaway points

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2. **Spectropolarimetry** allows us to **map** the **brightness** and **velocities** at the surface of these stars, and better understand the important physics (**convection**, **wind** etc ..)

3. We have tons of data, we find interesting puzzles and try to make sense of things !

Acentric, 1924, Wassily Kandinsky