UNIVERSITY OF TARTU
Tartu Observatory

The post-outburst evolution of RW Cep

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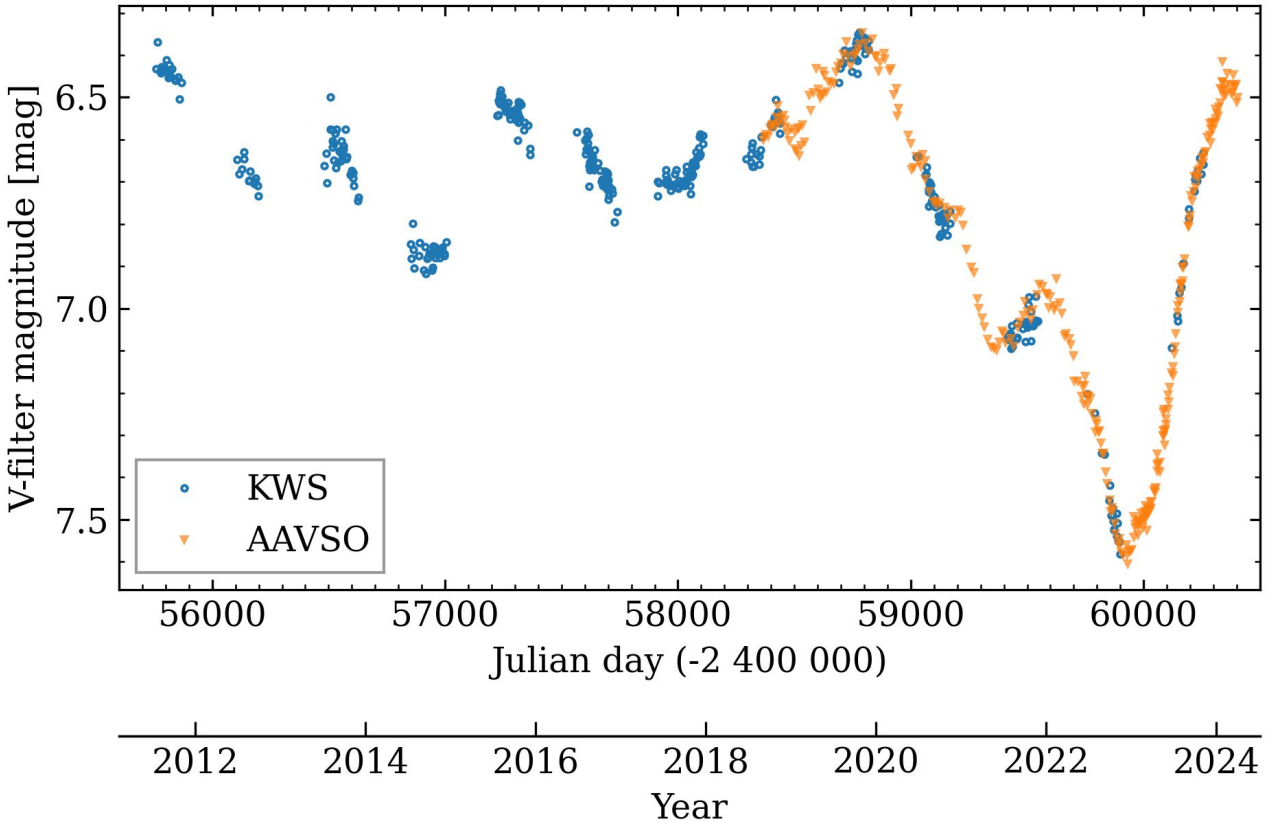
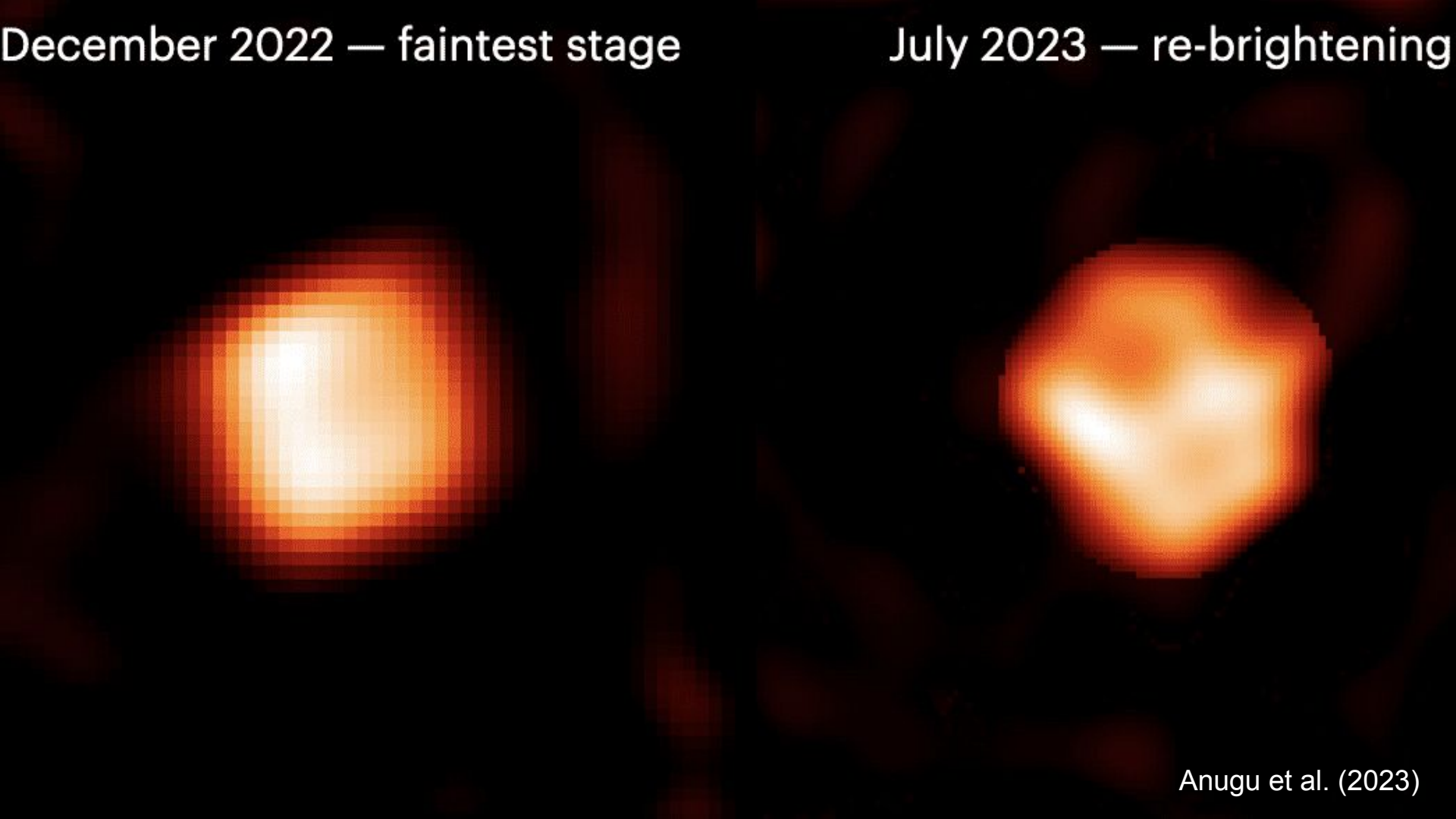
RW Cep - the red(?) hypergiant

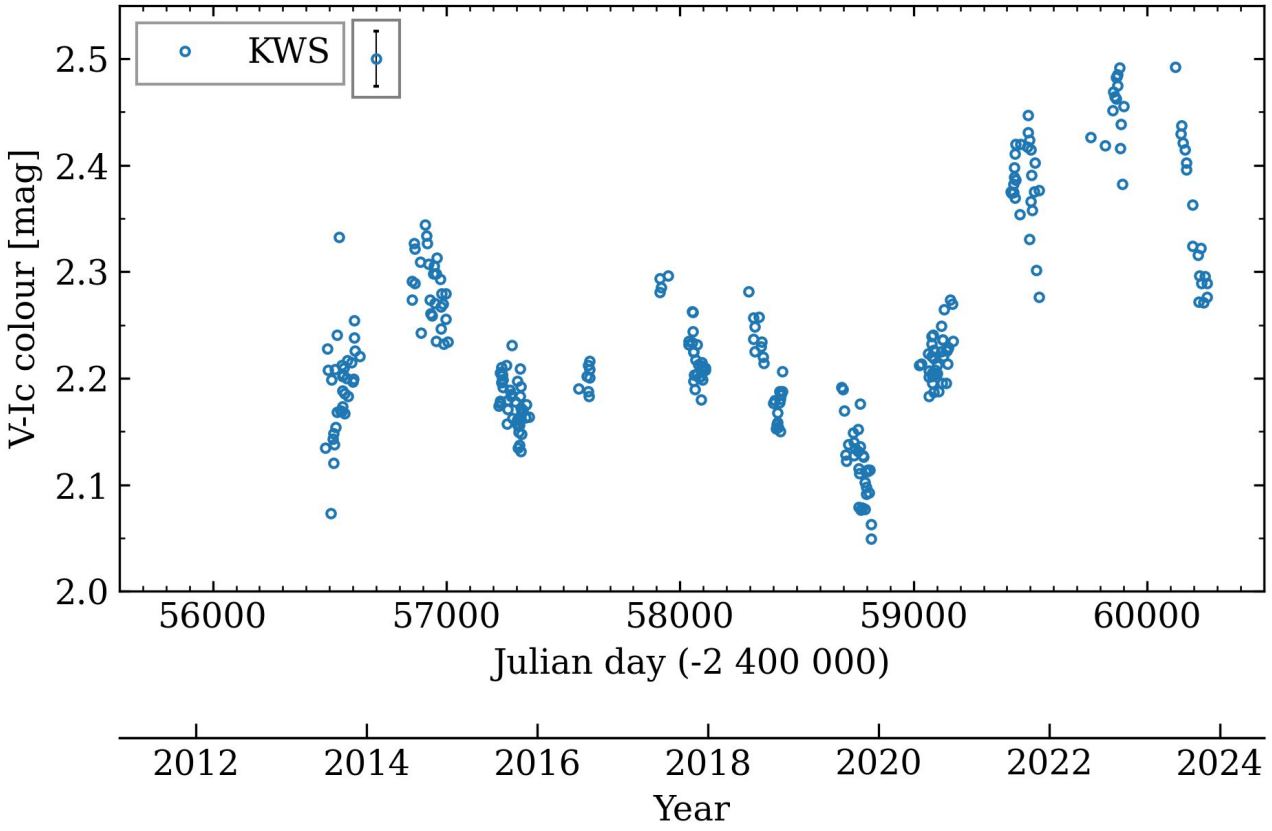
- Spectral class M0-G8
- Irregular variable, V ~ 6.3-6.9 mag
- T_{eff} ~ 3900–4200 K
- R ~ 900–1760 $R_{\odot}$
- Distance ~ 3400 pc, part of Cep OB1 association
- Mass-loss rate ~ 7×10^{-6} $M_{\odot}$ yr^{-1}

Light curve and the Great Dimming




December 2022 — faintest stage
July 2023 — re-brightening
Anugu et al. (2023)

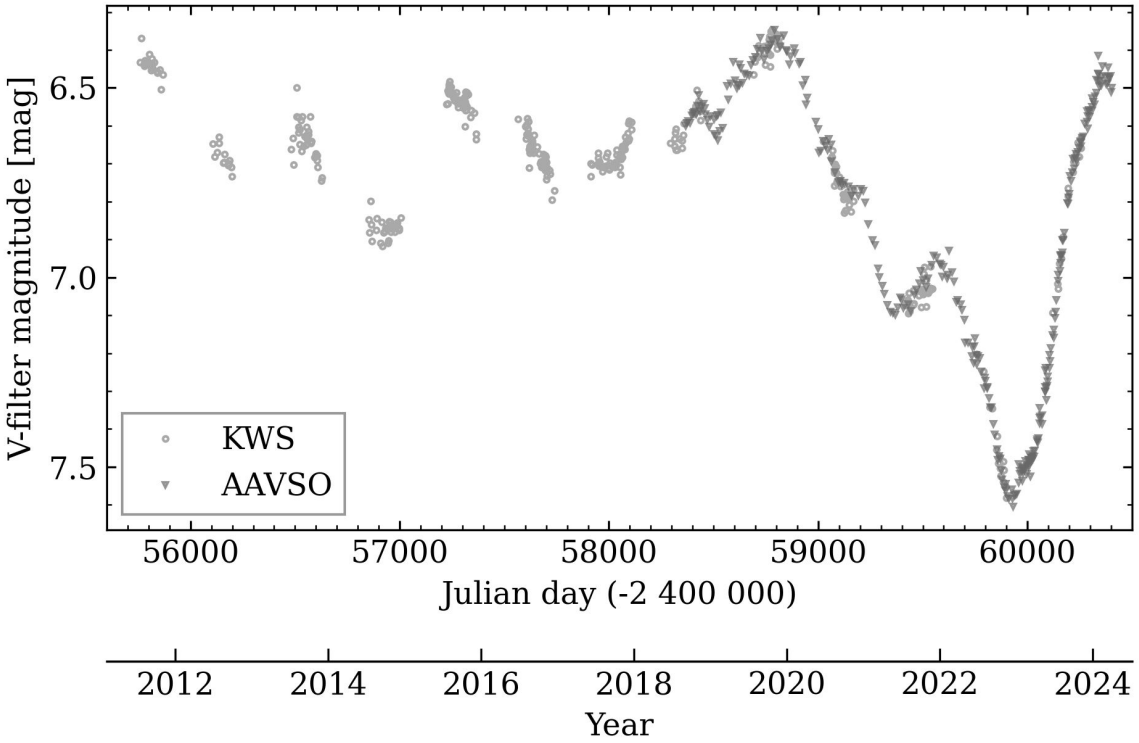
V-Ic colour

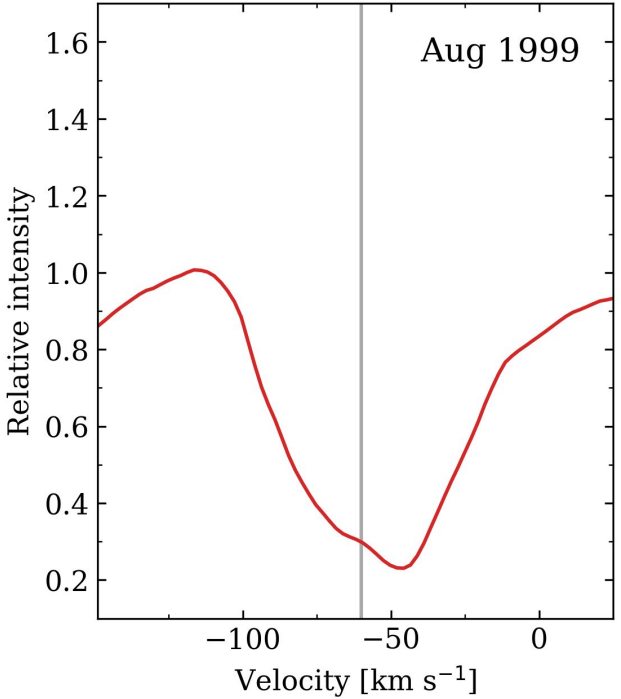

KWS
V-Ic colour [mag]
2.0
2.1
2.2
2.3
2.4
2.5
56000
57000
58000
59000
60000
Julian day (-2 400 000)
2012
2014
2016
2018
2020
2022
2024
Year

The complex spectrum of RW Cep

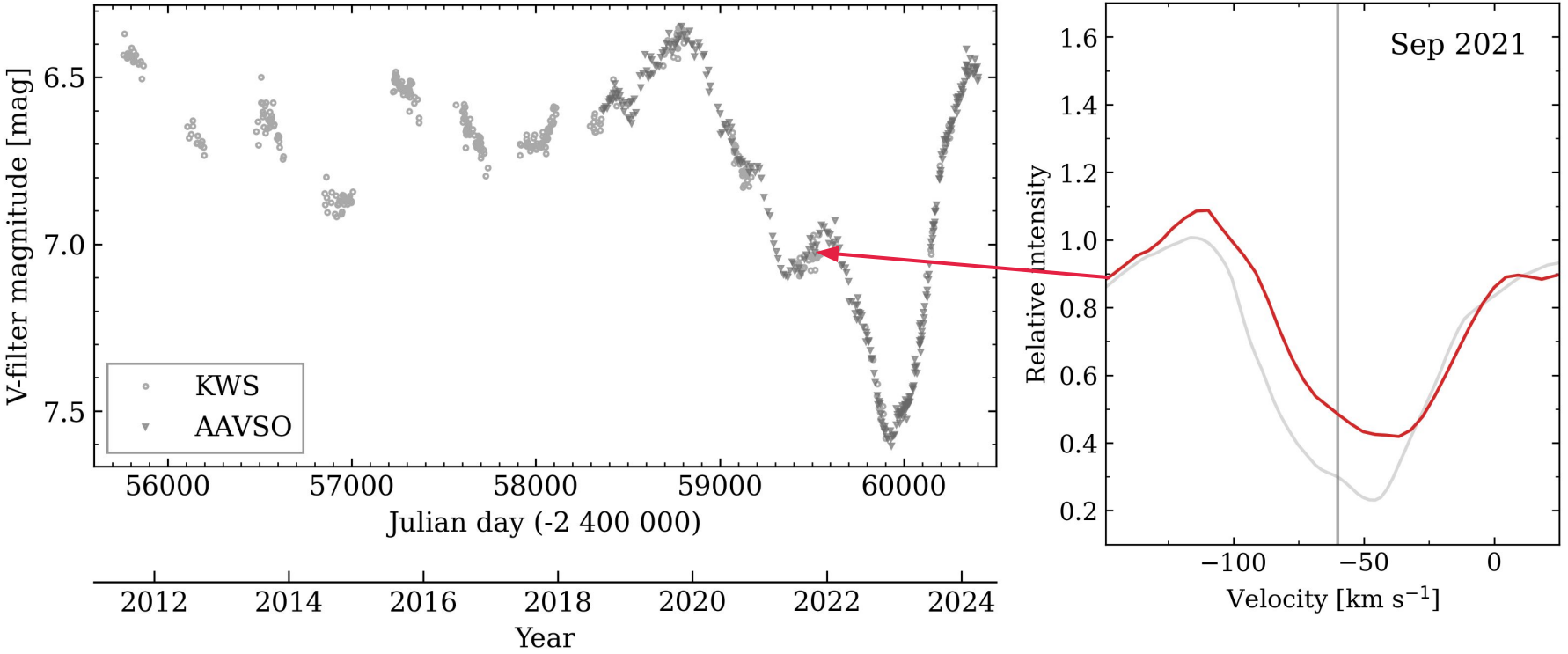
- Peculiar line profiles: wide and shallow or abnormally strong
- Wide two-component absorption lines with a narrow central emission
- Si II lines - usually found in much hotter stars
- The observed profile forms in the extended atmosphere, with contribution from many layers with different physical properties

Dimming in the spectrum - Hα





Dimming in the spectrum - Hα



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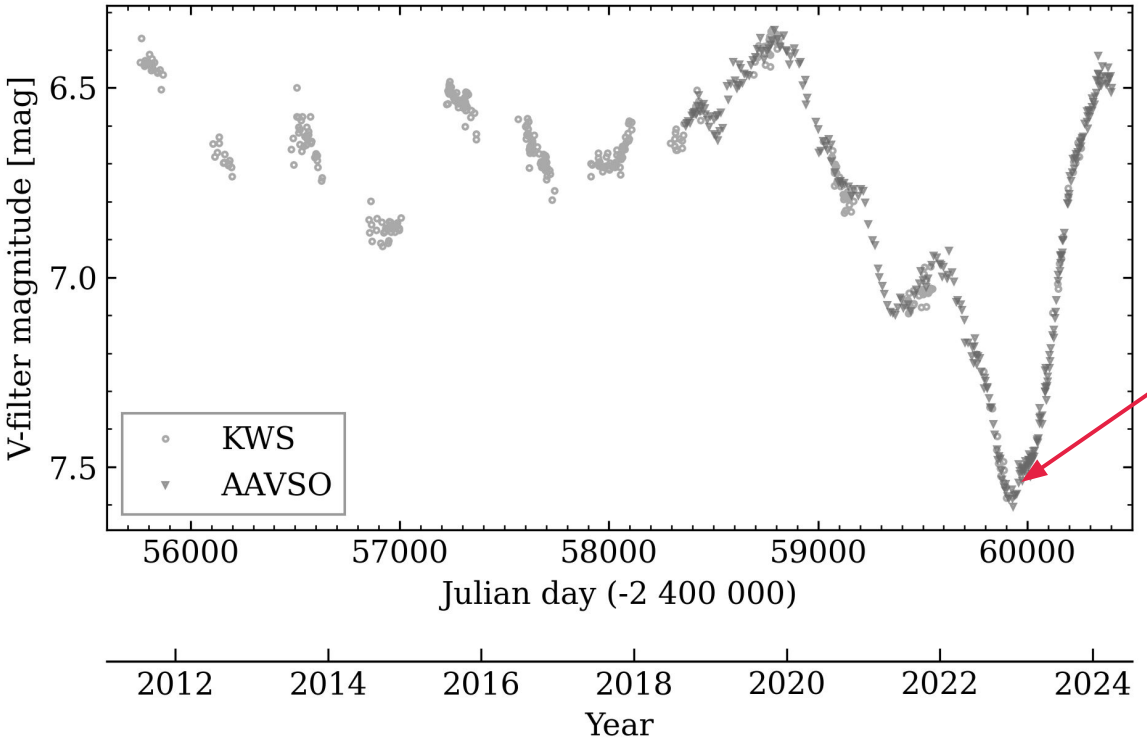

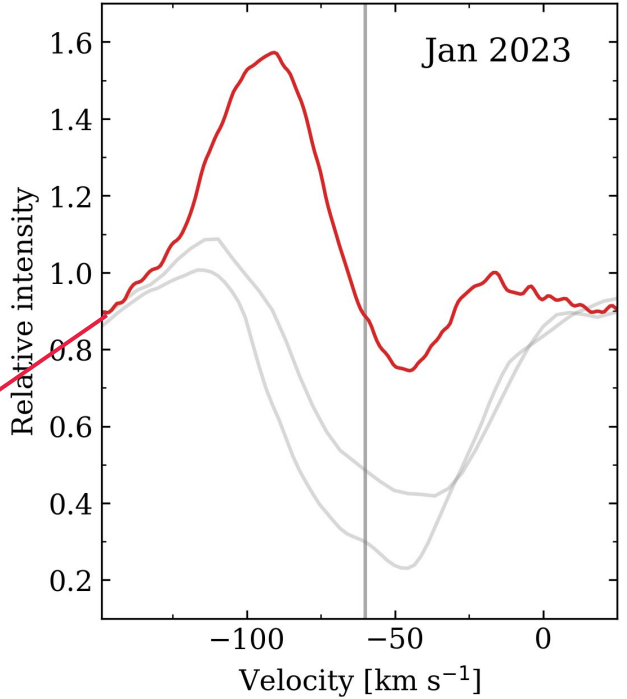

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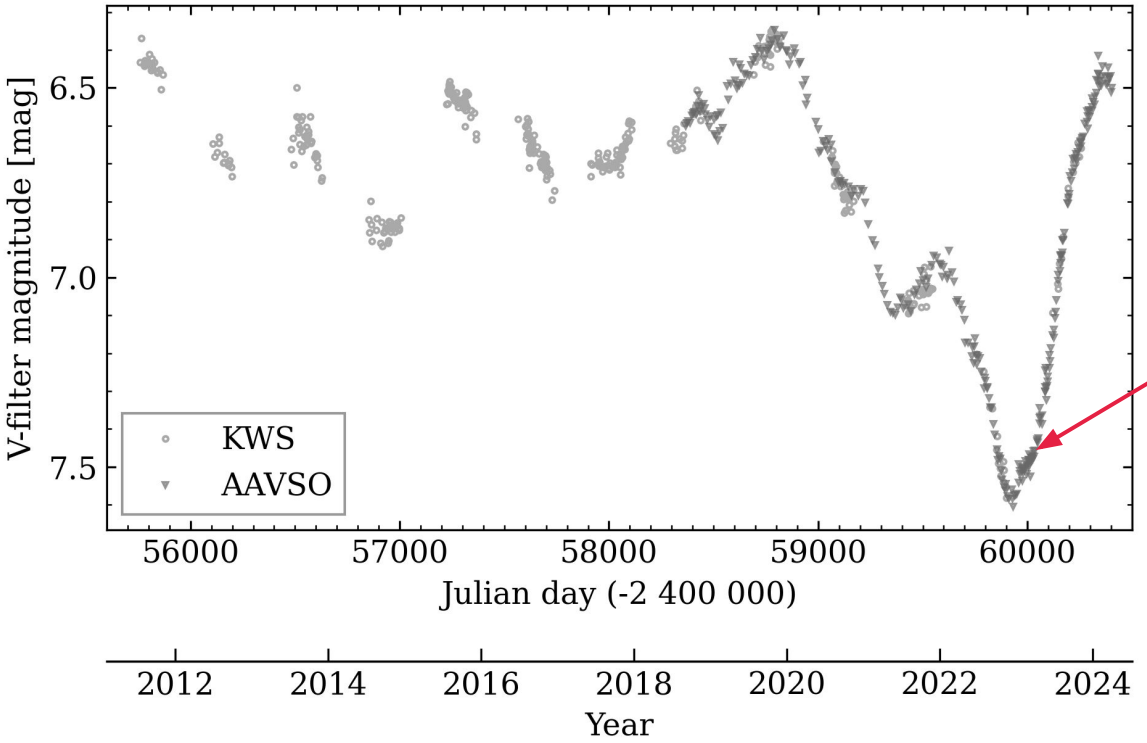

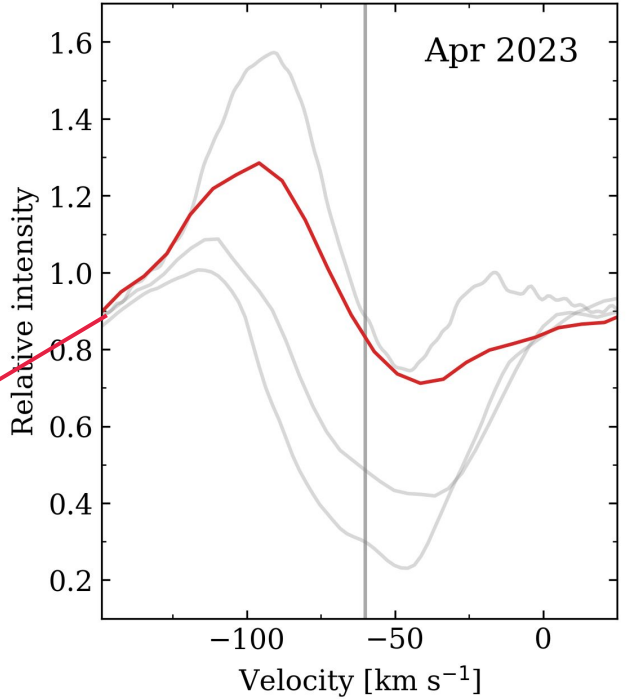

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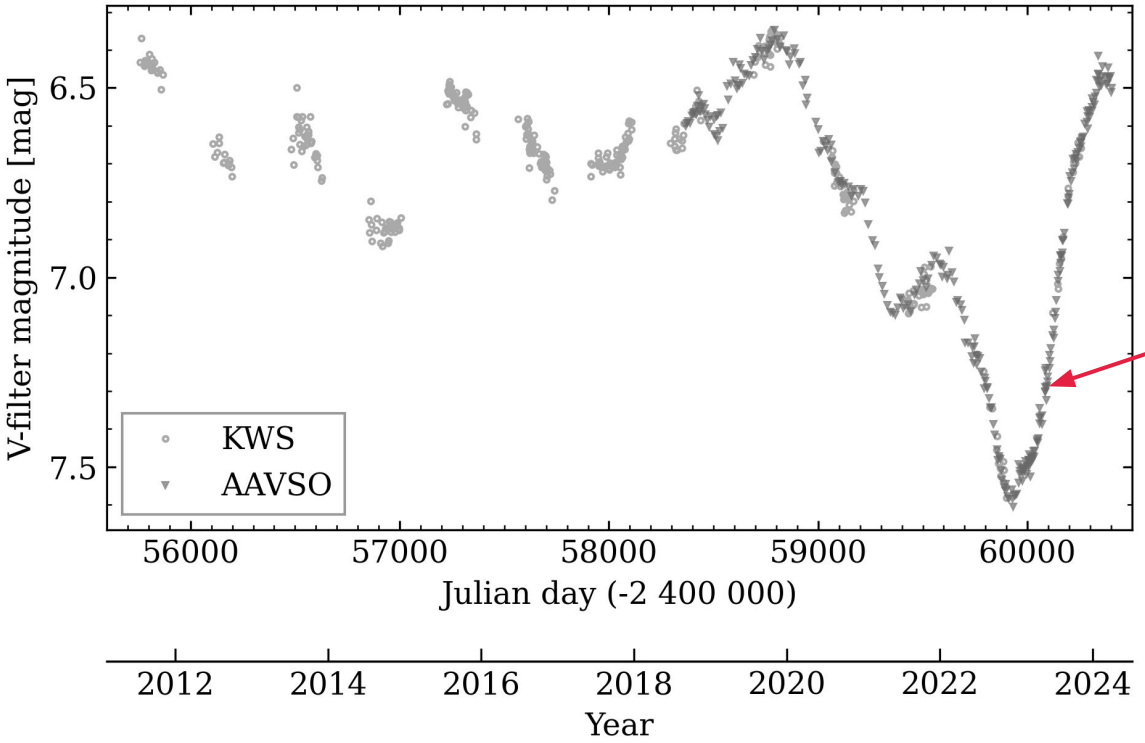

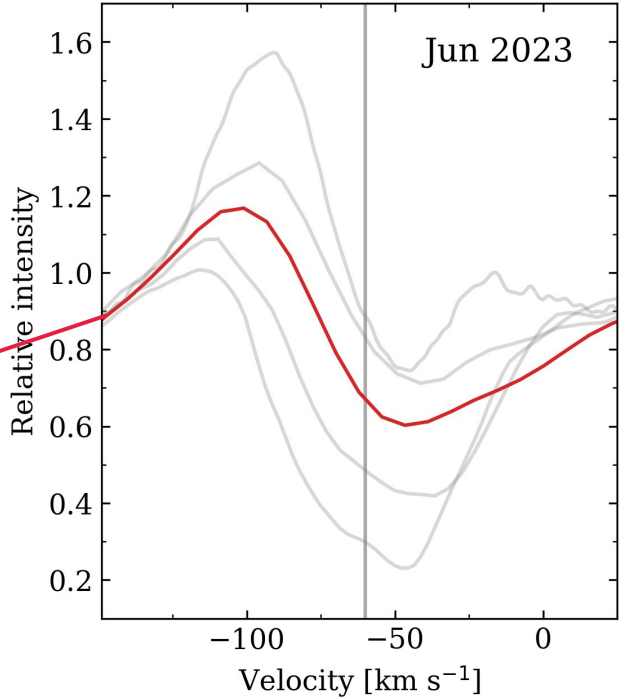

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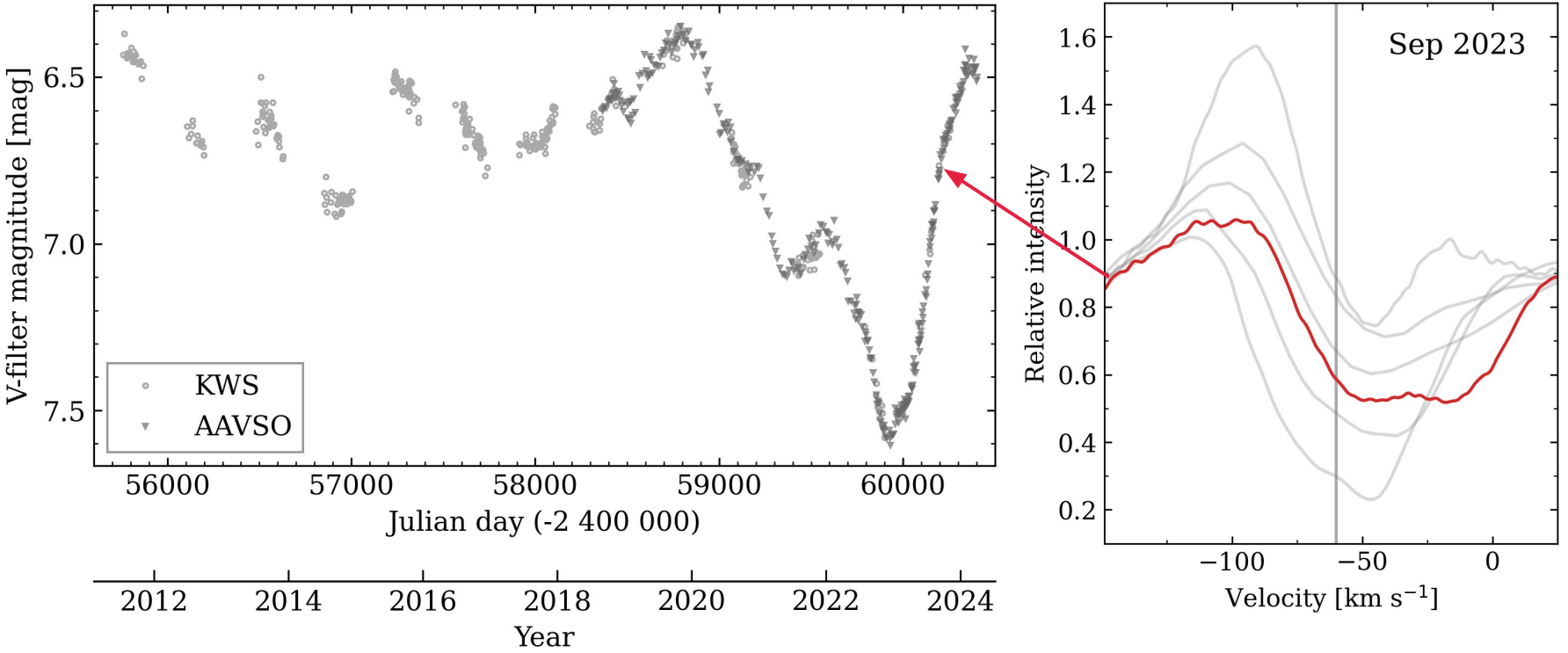
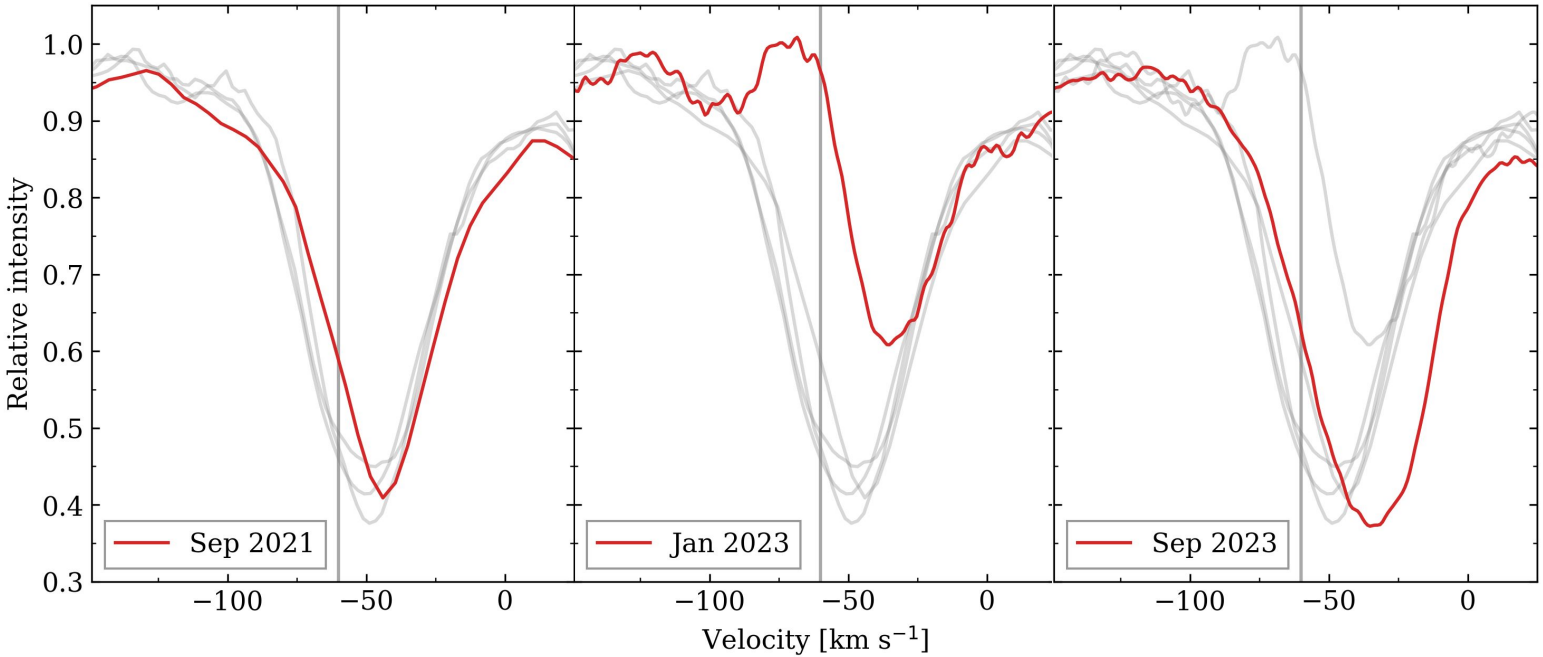
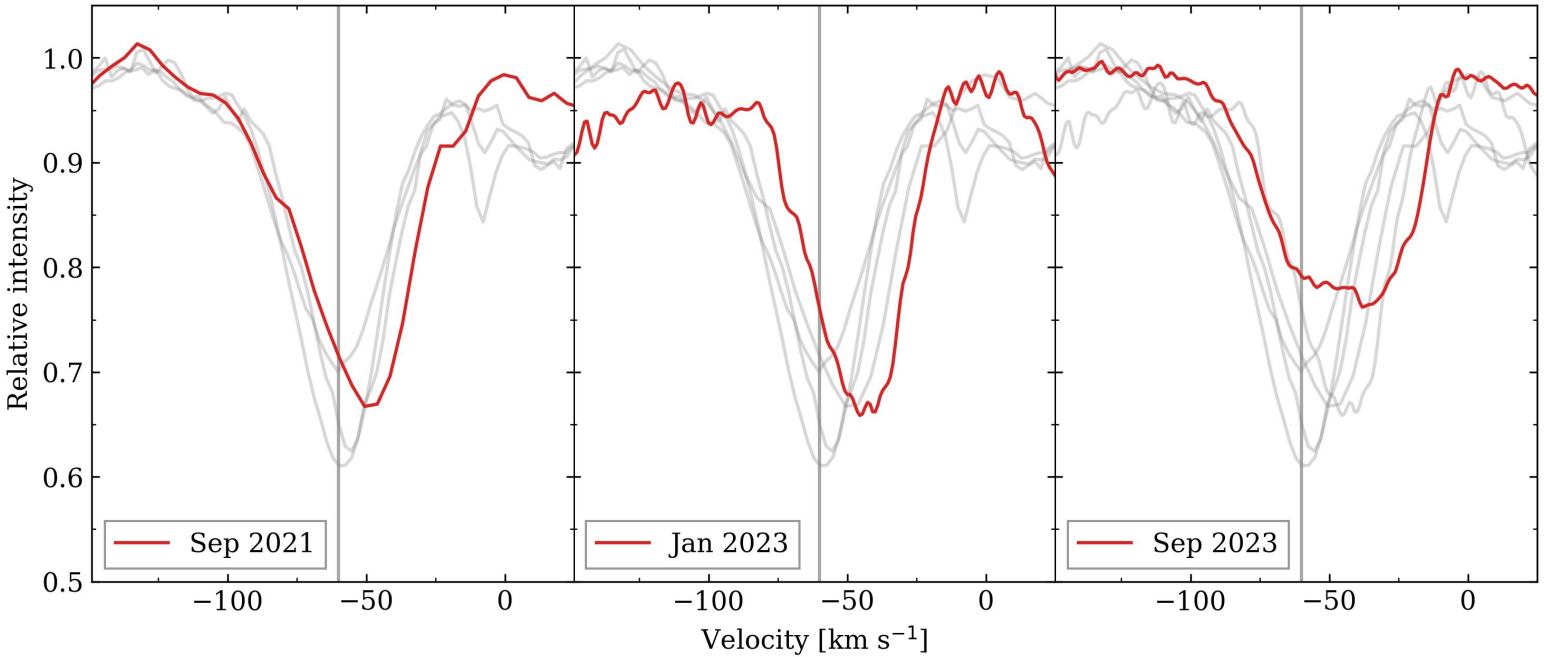


Emission in Fe I



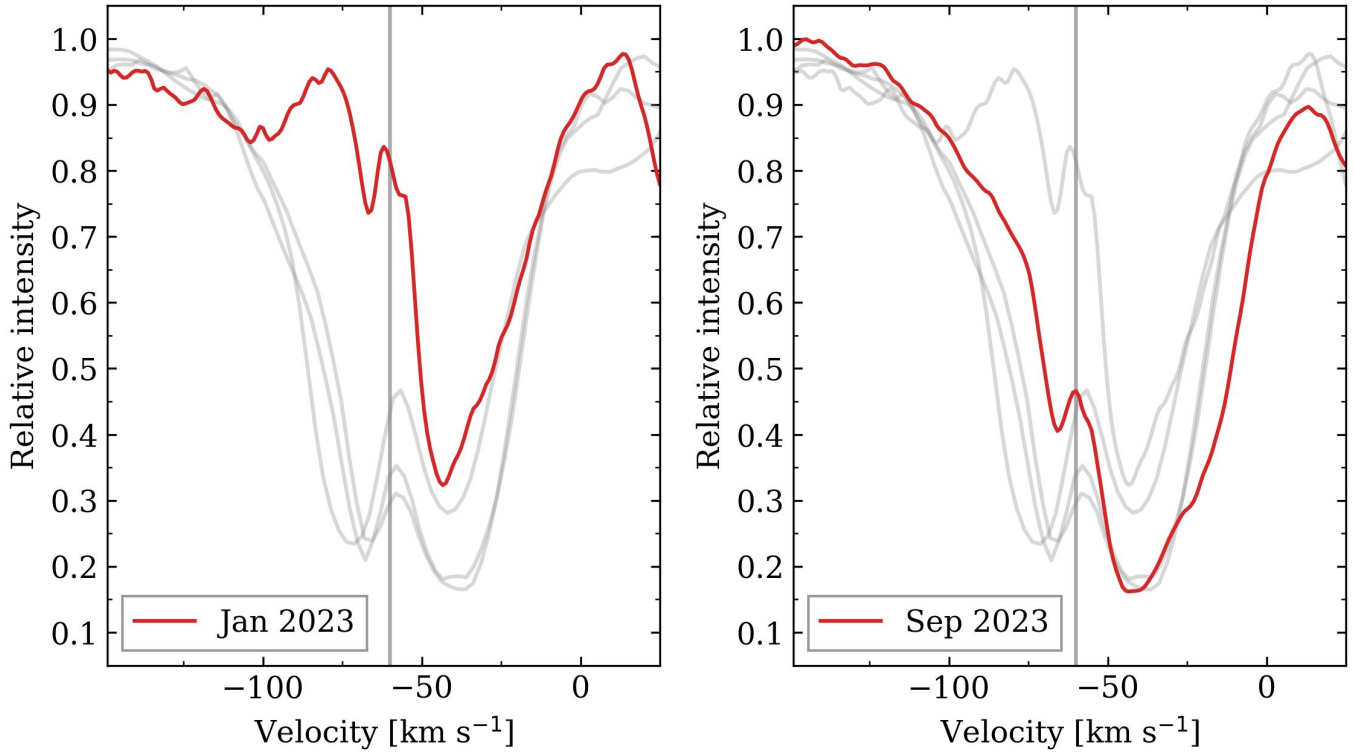
Fe I 6677 Å, E_{low} = 2.69 eV

Emission in Fe I



Fe I 6581 Å, E_{low} = 1.48 eV

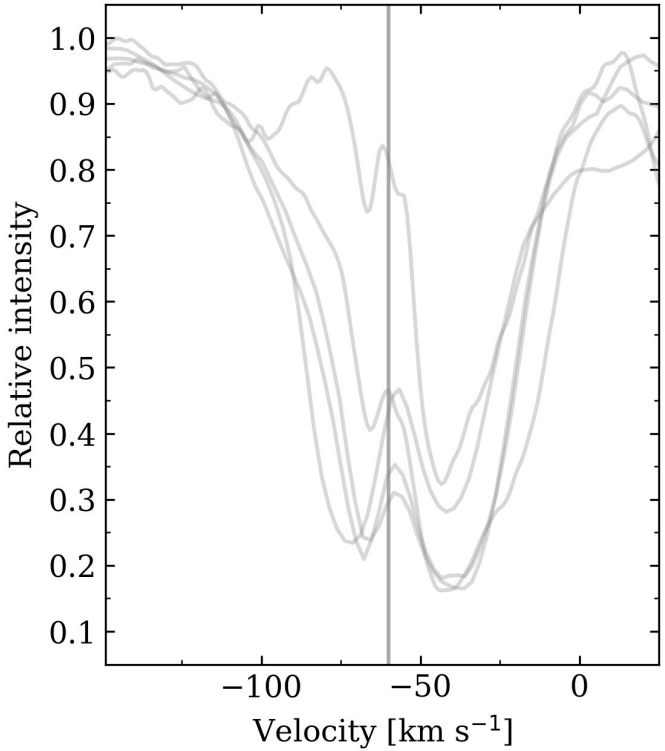
Emission in Ba II



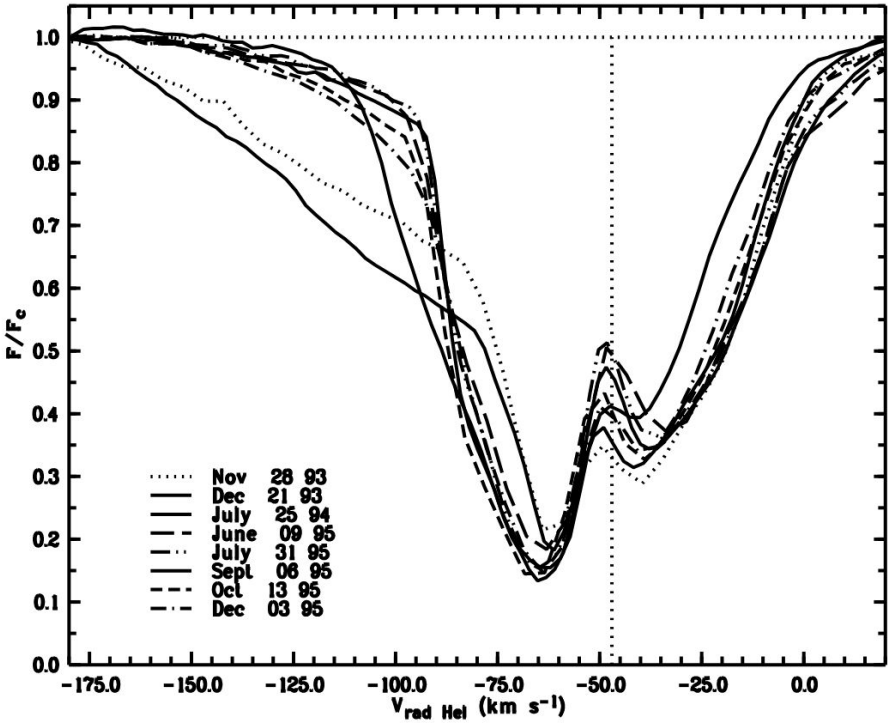
Ba II 6141 Å, E_{low} = 0.70 eV

Emission in Ba II

RW Cep

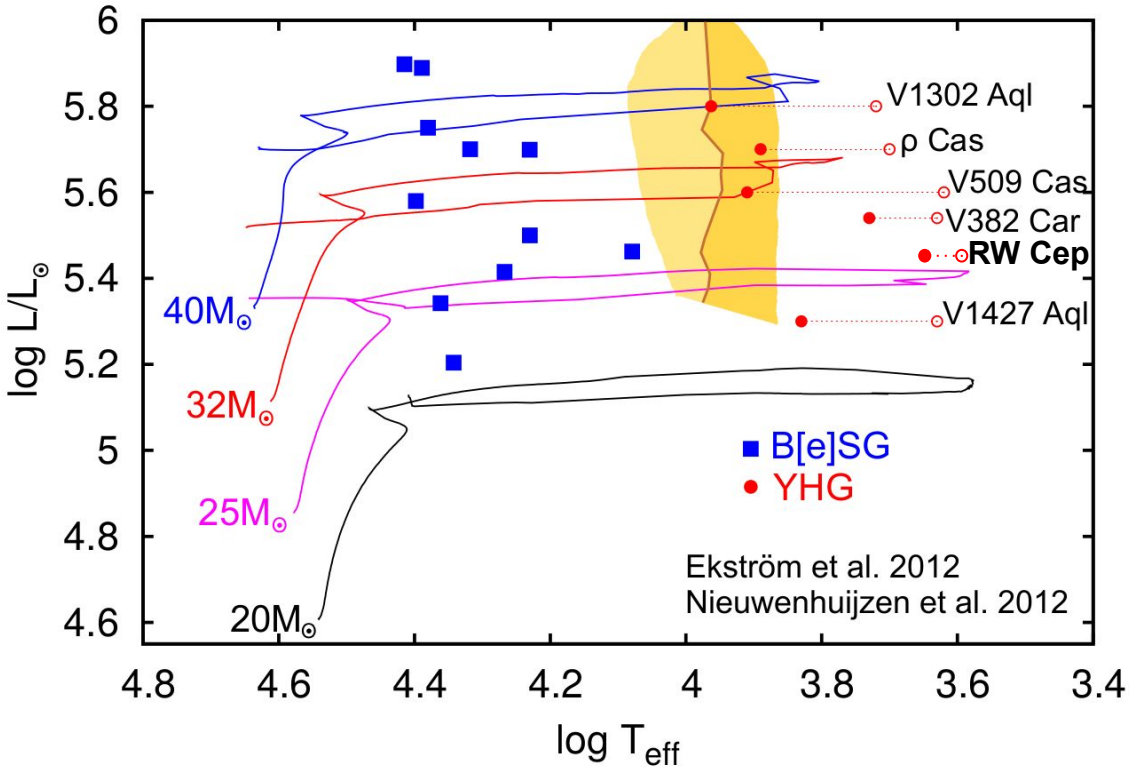


ρ Cas



Credit: Lobel et al. (1998)

As a yellow hypergiant…



Credit: Aret et al. (2017), RW Cep data: Jones et al. (2023) & Anugu et al. (2023)

Summary

- Spectroscopic look into the Great Dimming of RW Cep
- Strong emission in Hα during the dimming minimum
- The spectral line profiles are not only reshaped by the emission, but also affected by temperature change
- Peculiar spectrum and large-scale turbulence in the atmosphere foreshadow a future as a yellow hypergiant

Summary

- Spectroscopic look into the Great Dimming of RW Cep
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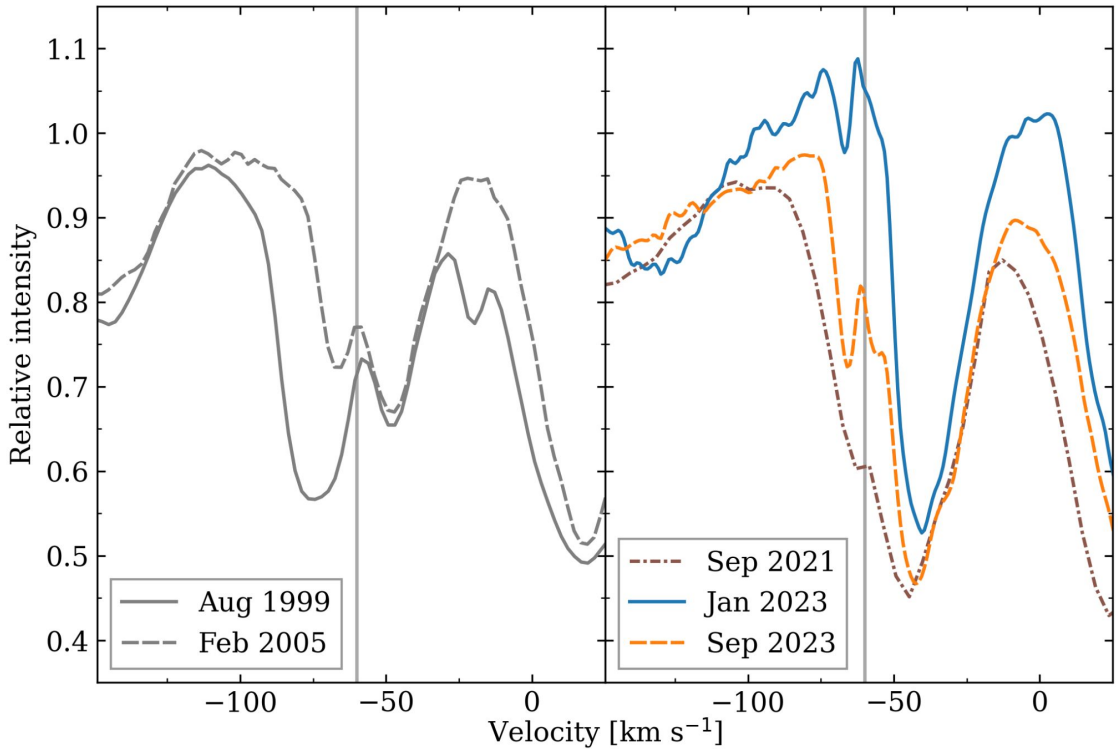
Thank you!

Extra: Ca I resonance line



Ca I 6572 Å, E_{low} = 0.00 eV

Papers cited

- Anugu, N., Baron, F., Gies, D. R., et al. 2023, The Astronomical Journal, 166, 78
- Aret, A., Kraus, M., Kolka, I., and Maravelias, G. 2017, “The Yellow Hypergiant - B[e] Supergiant Connection”, in *Stars: From Collapse to Collapse*, vol. 510, p. 162
- Jones, T. J., Shenoy, D., & Humphreys, R. 2023, Research Notes of the AAS, 7, 92, publisher: The American Astronomical Society
- Lobel, A., Israelian, G., de Jager, C., et al. 1998, Astronomy and Astrophysics, 330, 659
- Merrill, P. W. & Wilson, O. C. 1956, The Astrophysical Journal, 123, 392

Image credits:

- Pretty observatory picture - Viljo Allik
- RW Cep dimming - Anugu et al. (2023)

  https://news.gsu.edu/2024/01/08/a-colossal-star-erupts-examining-one-of-the-largest-stars-in-the-milky-way-as-it-fades-from-view/