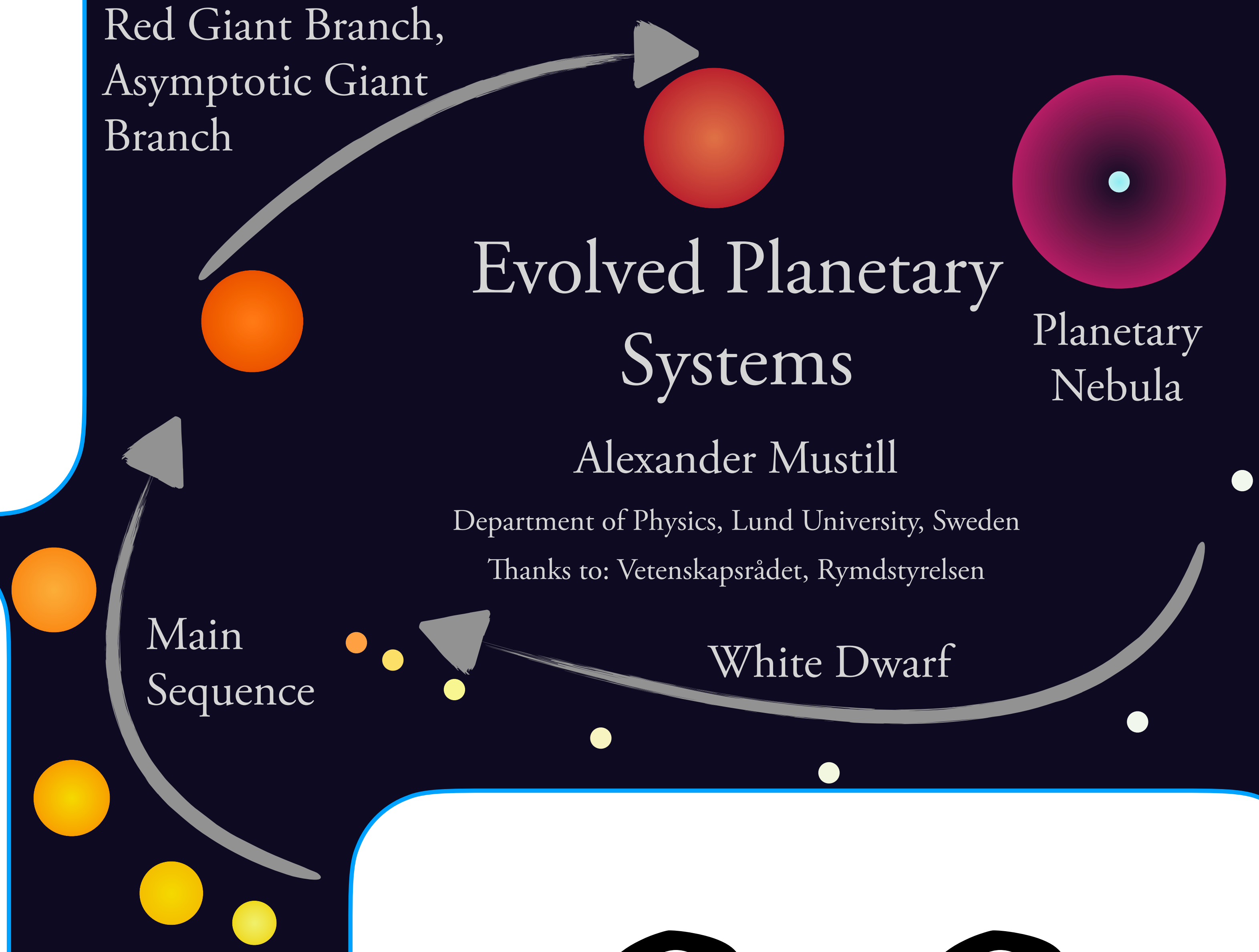
Evolved Planetary Systems

Alexander Mustill

Department of Physics, Lund University, Sweden

Thanks to: Vetenskapsrådet, Rymdstyrelsen



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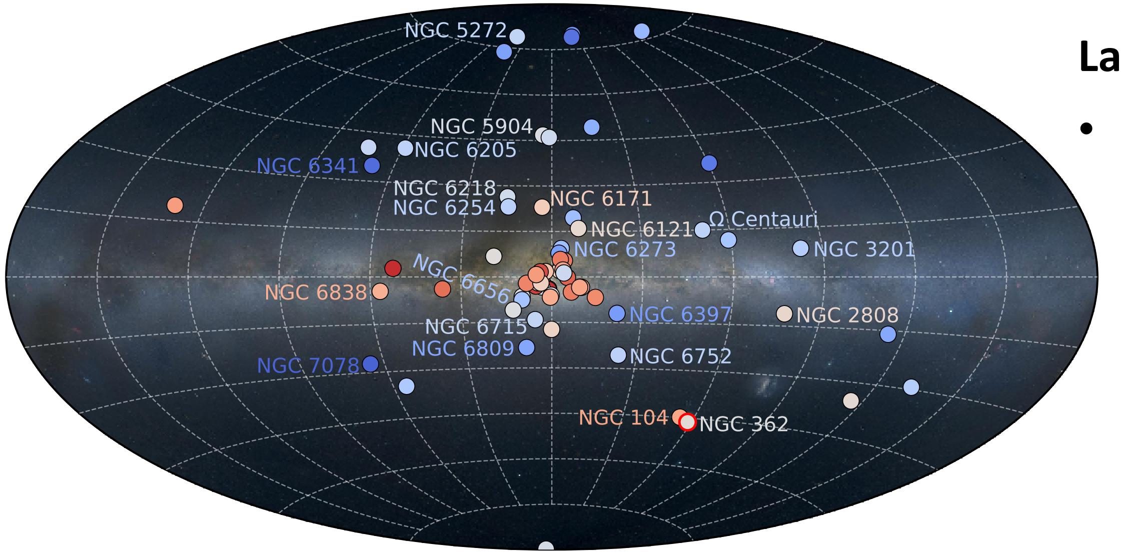
Multiple Populations in Globular Clusters

A manual re-analysis of APOGEE spectra

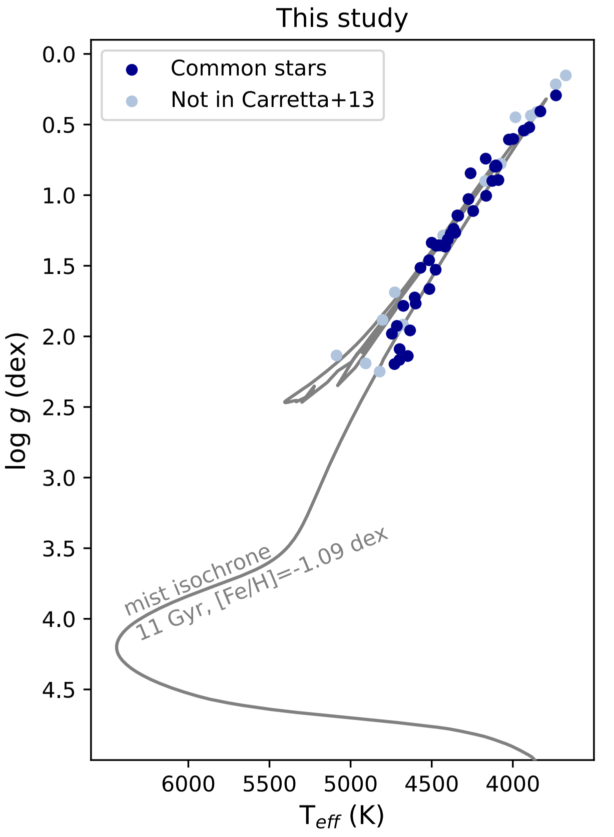
Jess Kocher, Henrik Jönsson, Valentina D'Orazi, Martina Loriga, Emanuele Dalessandro

MALMÖ UNIVERSITY



Large, homogeneously analyzed data set

- **6017 spectra** in **70** galactic globular clusters



Why "Manual re-analysis"?

- Pipelines are unreliable
- Careful selection of spectral lines
- Manually inspecting every spectrum!

Near-infrared spectroscopic variability of post-AGB stars

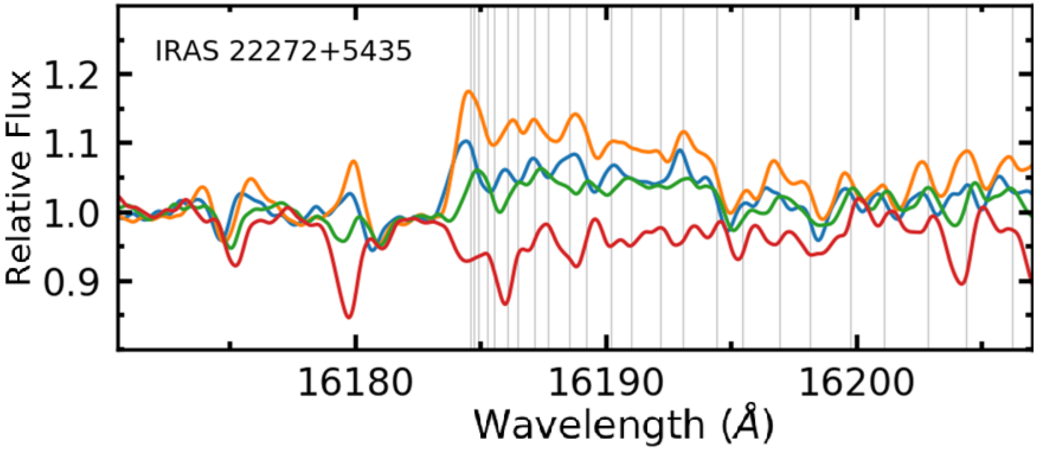
Kārlis Puķītis, University of Latvia

- ❑ **Post-AGB stellar wind properties are unknown**
- ❑ **The wind affects stellar evolutionary rate and shaping of PNe**

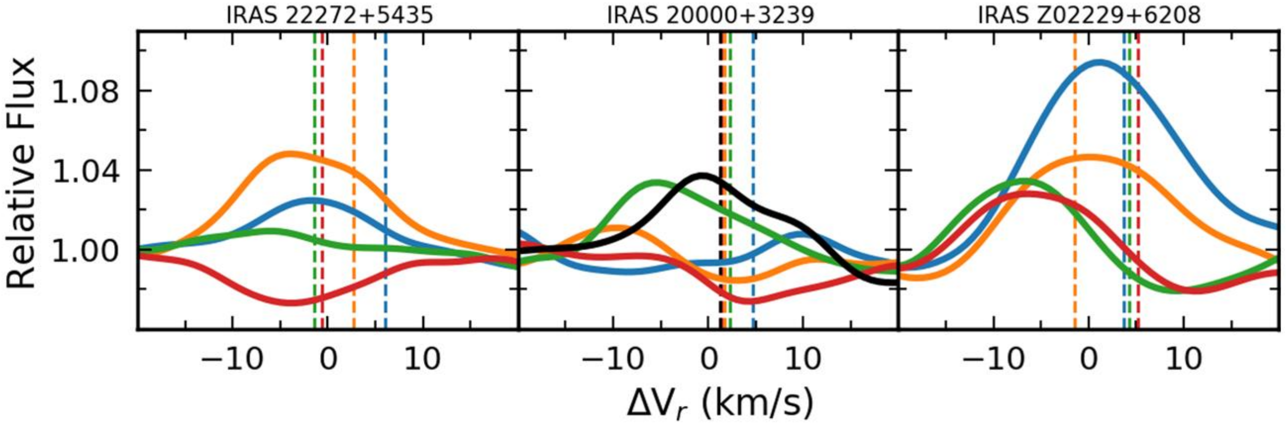
- ❑ **CARMENES NIR spectroscopic monitoring of 3 post-AGB stars**
- ❑ **CO line variability caused by a shock in the extended dynamic atmosphere**

- ❑ **More stars are being monitored**
- ❑ **Modelling is necessary!**

CO (6,3) bandhead



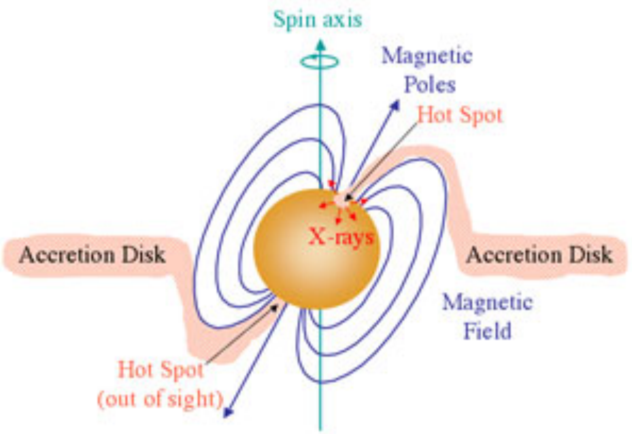
CO (3,0) 15971.11 Å line



Propeller Effect in Action: Unveiling Quenched Accretion in 4U 0115+63

Hua Xiao, S. S. Tsygankov, V. F. Suleimanov, A. A. Mushtukov, L. Ji, J. Poutanen

UNIVERSITY OF TURKU



Background

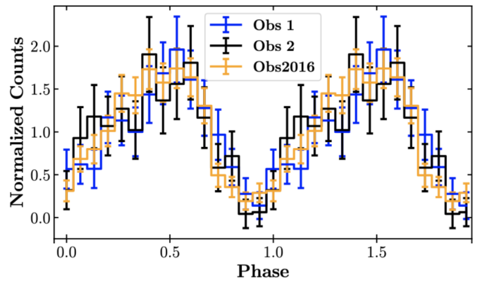
Be/X-ray pulsars host highly magnetized neutron stars (NS, B ~ 10^12 G). As the accreted material approaches the NS magnetosphere, it couples to the magnetic field lines and is funneled onto magnetic poles produces **pulsed X-ray emission**.

Theoretical prediction: when $L < L_{\rm prep}$, the **propeller effect** inhibits accretion via the centrifugal barrier.

Observations indicate that pulsations can still be detected even when $L < L_{\rm prep}$.

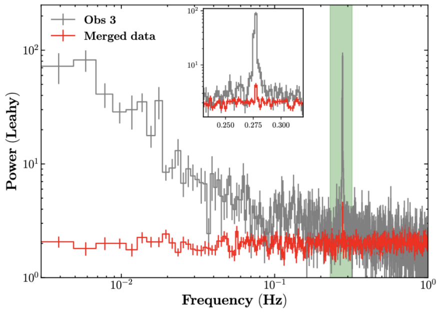
Observational Results of 4U 0115+63

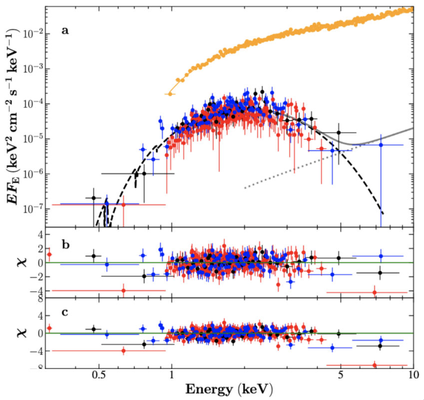
★ Clear pulsations correspond to the NS spin frequency



★ No signs of accretion

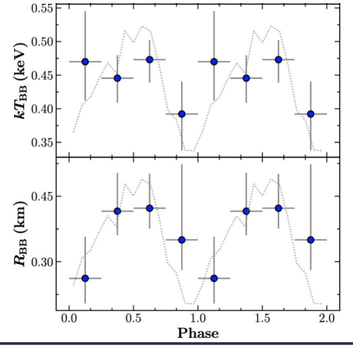
- **Absence of red noise** in the power density spectrum.
- Spectra are better described by a **single blackbody model** than by non-thermal models.





★ Temperature-Flux Correlation

- Phase-resolved spectroscopy revealed a **positive correlation** between blackbody temperature and flux.



Discussion & Summary

1. X-ray pulsations at the spin frequency persist in the propeller regime.
2. Single blackbody spectrum with small emitting area suggests a cooling NS crust.

→ X-ray pulsations in the propeller regime originate the anisotropic cooling of NS crust.

Nordic-Baltic Astronomy Days Conference–May 28, 2026

The History of C, N, and O in the Galaxy

Š. Mikolaitis[1], R. Smiljanic[2], A. Drazdauskas[1], M. Ambrosch[1], C. Viscasillas Vázquez[1], B. Bale[1], B. Ćurjurić[1], V. Bagdonas[1], H. Ernandes[2]

[1]Vilnius University, Faculty of Physics, Institute of Theoretical Physics and Astronomy, Saulėtekio av. 3, LT-10257 Vilnius, Lithuania
[2]Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences, ul. Bartycka 18, 00-716 Warsaw, Poland

- Carbon, Nitrogen and Oxygen
- Life-building elements
- Very abundant
- Indicators of stellar evolution
- History and Spread in the Galaxy not well understood
- Studied in molecular bands in FGK stars
- Heterogeneous data across surveys

- Careful usage of Benchmark stars
- Bringing data to the same scale
- Observing more spectra of stars to cover data gaps in Molėtai AO

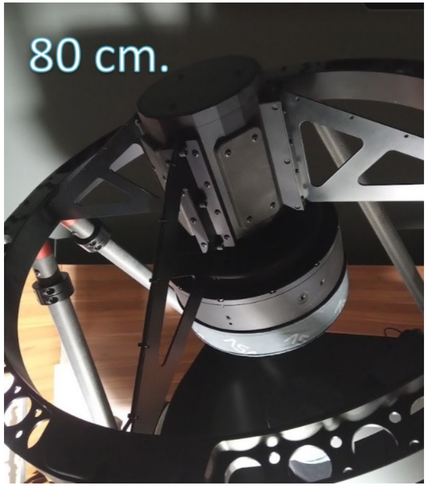
Ćurjurić et al. 2026 accepted
Smiljanic et al. 2026 in prep.

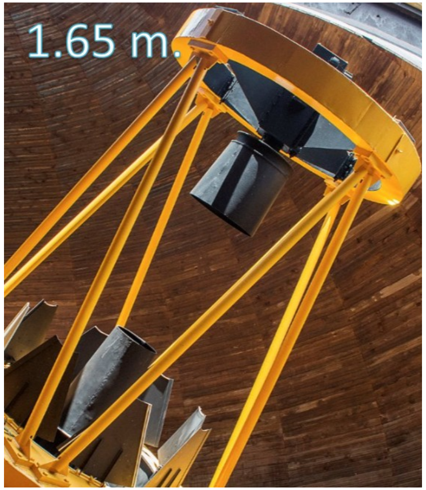
DAINA 3 programme supporting Polish–Lithuanian scientific collaboration (project No. S-LL-24-4)

Molėtai astronomical observatory
Vilnius University, Lithuania

Apply for observing time https://mao.tfai.vu.lt

- 165, 80, 35/51 cm. telescopes
- HR spectroscopy: R~ 68000, 48000, 36000
- Photometry: SOPHIA 4096, 4k sensor

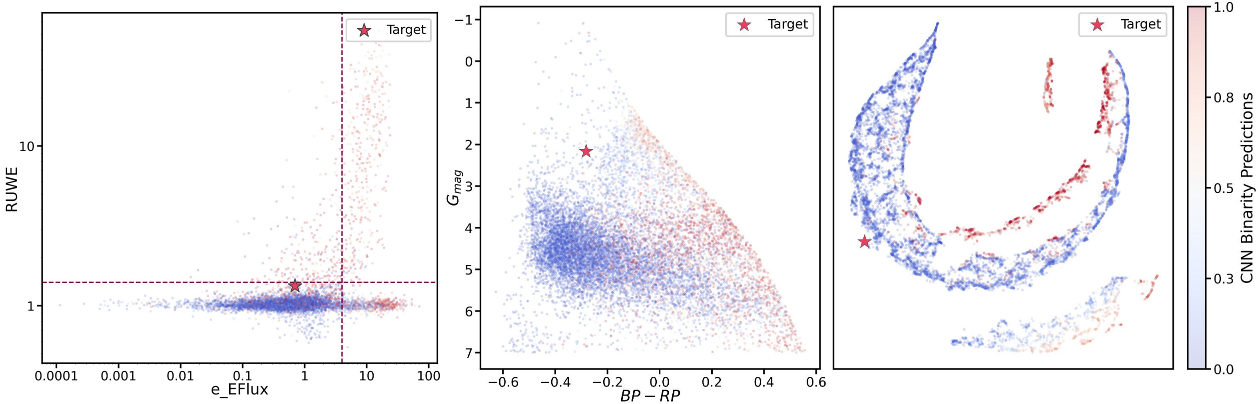


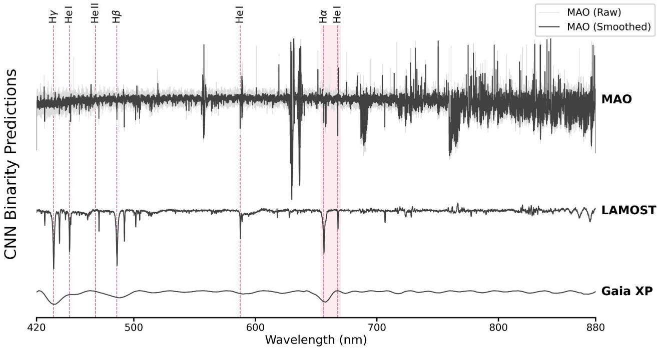


Vilniaus universitetas

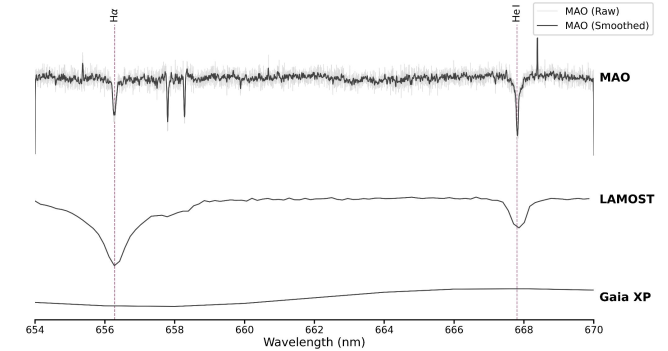
High-Resolution Spectroscopy of Hot Subdwarfs with VUES: Benchmarking Gaia XP and LAMOST Classifications

V. Šatas, C. Viscasillas Vázquez, M. Ambrosch, A. Ulla, E. Solano, Š. Mikolaitis, E. Pérez-Fernández





Instrument	Resolution (R)	Wavelength Range [nm]	Aperture [m]
Gaia BP/RP	50	330 – 1050	1.20
LAMOST LRS	1 800	370 – 900	4.00
MAO VUES	30 000 / 45 000 / 60 000	400 – 880	1.65



hot sds

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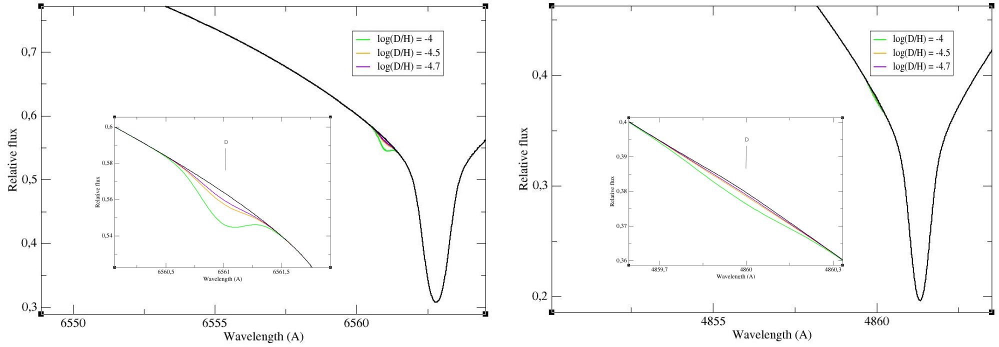
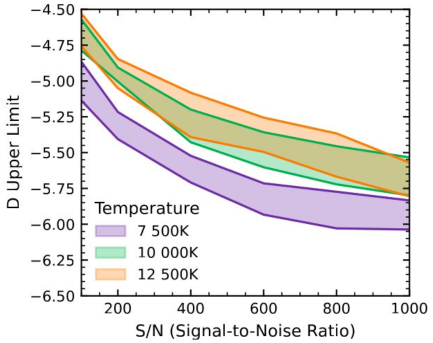
Detectability of Deuterium in the Spectra of A-type Stars

Veronika Mitrokhina [1], Colin Folsom [1], Mihkel Kama [1,2], Anna Aret [1]

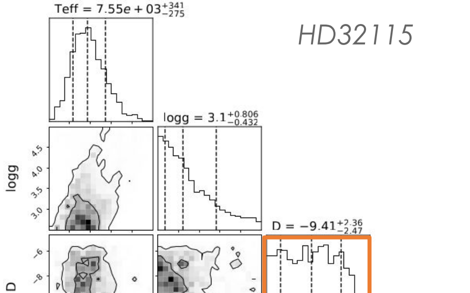
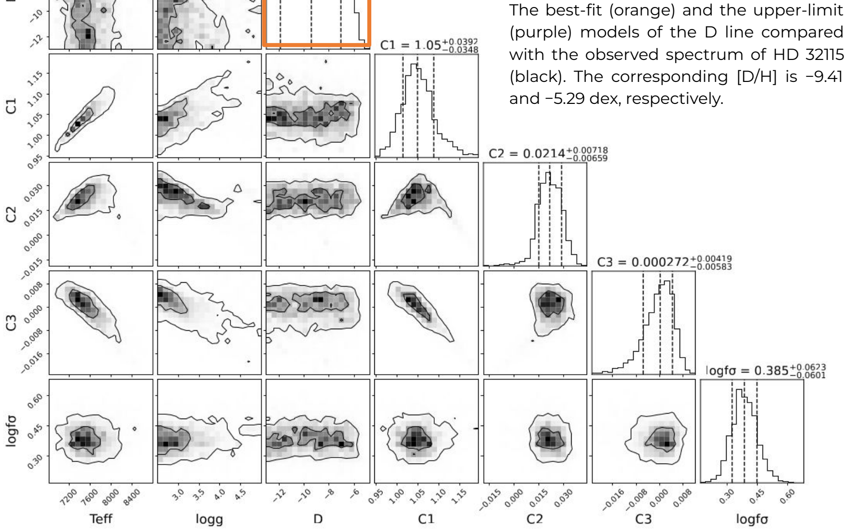
[1] Tartu Observatory, University of Tartu, Observatooriumi 1, Tõravere 61602, Estonia
[2] Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK

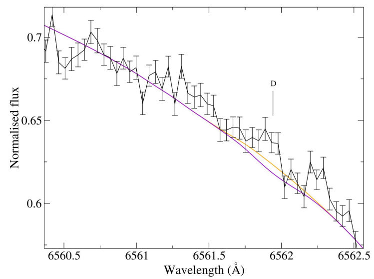


The appearance of the deuterium feature in the Hα (*left*) and Hβ (*right*) regions, considering three relative deuterium abundances: log(D/H) = -4, -4.5, and -4.7 dex for T_{eff} = 10 000 K.



Upper limit of deuterium detection (99 - 99.9% confidence) as a function of T_{eff} and S/N.



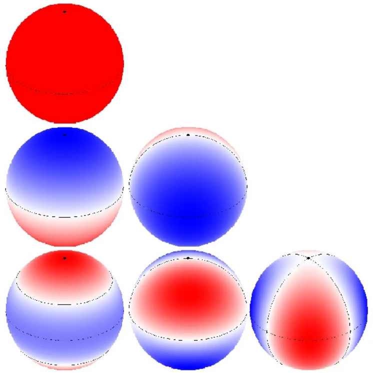
The best-fit (orange) and the upper-limit (purple) models of the D line compared with the observed spectrum of HD 32115 (black). The corresponding [D/H] is −9.41 and −5.29 dex, respectively.

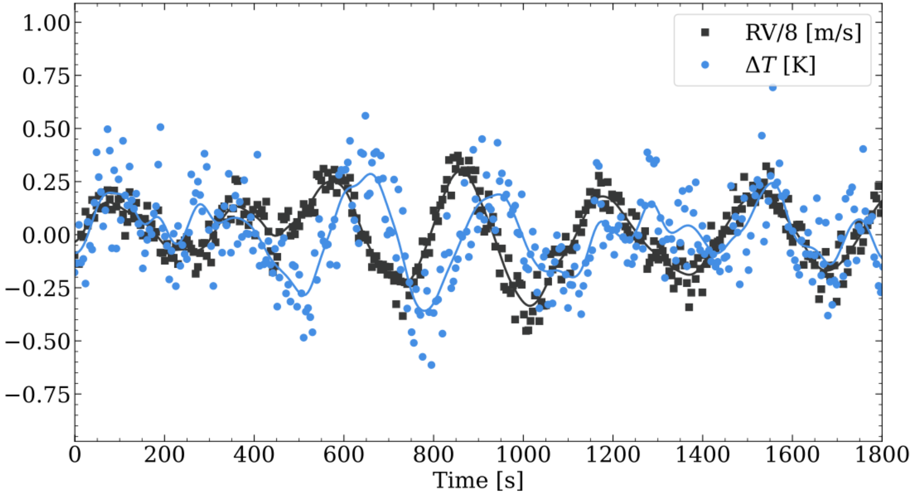
Measuring Solar Oscillations using High-Precision Temperature Variations from SONG Spectra

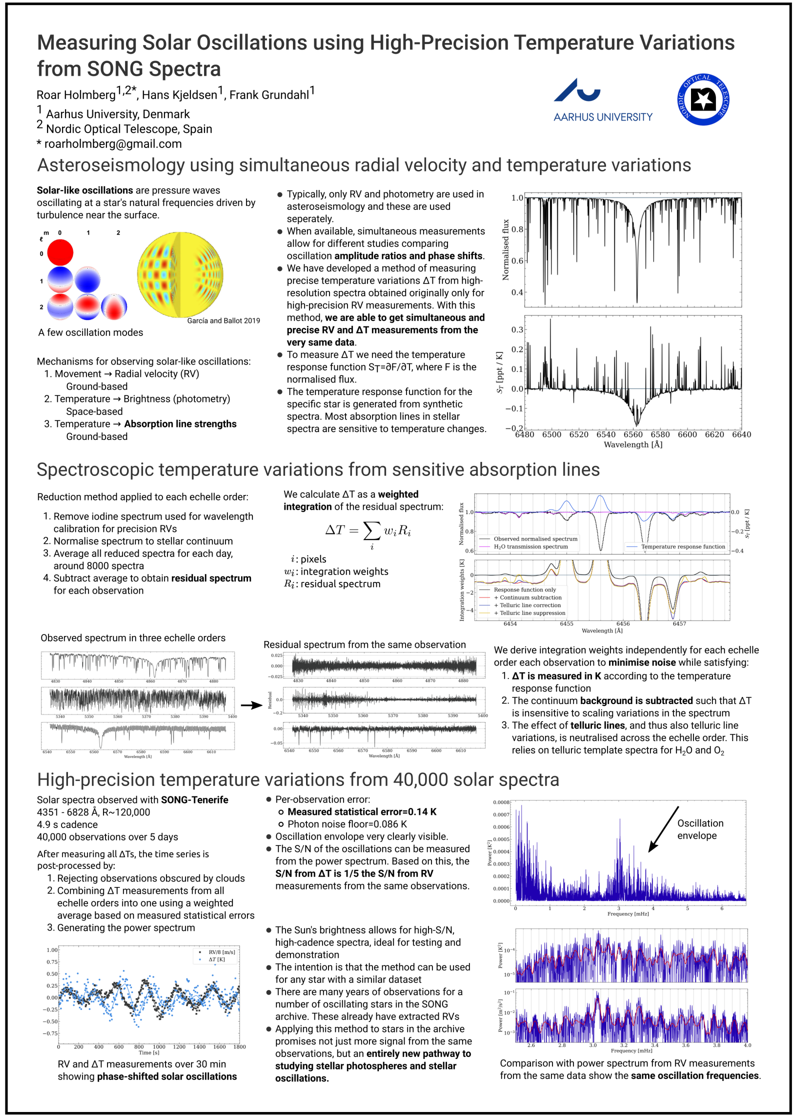
Roar Holmberg[1,2], Hans Kjeldsen[1], Frank Grundahl[1]

[1] Aarhus University, Denmark
[2] Nordic Optical Telescope, Spain

- Solar-like oscillations are usually observed in **RV** or **photometry**.
- Here: measure both RV and **ΔT** from the very same high-resolution spectra.







Measuring Solar Oscillations using High-Precision Temperature Variations from SONG Spectra

Roar Holmberg[1,2*], Hans Kjeldsen[1], Frank Grundahl[1]
[1] Aarhus University, Denmark
[2] Nordic Optical Telescope, Spain
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Asteroseismology using simultaneous radial velocity and temperature variations

Solar-like oscillations are pressure waves oscillating at a star's natural frequencies driven by turbulence near the surface.

García and Ballot 2019

A few oscillation modes

Mechanisms for observing solar-like oscillations:
1. Movement → Radial velocity (RV)
   Ground-based
2. Temperature → Brightness (photometry)
   Space-based
3. Temperature → **Absorption line strengths**
   Ground-based

- Typically, only RV and photometry are used in asteroseismology and these are used seperately.
- When available, simultaneous measurements allow for different studies comparing oscillation **amplitude ratios and phase shifts**.
- We have developed a method of measuring precise temperature variations ΔT from high-resolution spectra obtained originally only for high-precision RV measurements. With this method, **we are able to get simultaneous and precise RV and ΔT measurements from the very same data**.
- To measure ΔT we need the temperature response function $S_T=\partial F/\partial T$, where F is the normalised flux.
- The temperature response function for the specific star is generated from synthetic spectra. Most absorption lines in stellar spectra are sensitive to temperature changes.

Spectroscopic temperature variations from sensitive absorption lines

Reduction method applied to each echelle order:
1. Remove iodine spectrum used for wavelength calibration for precision RVs
2. Normalise spectrum to stellar continuum
3. Average all reduced spectra for each day, around 8000 spectra
4. Subtract average to obtain **residual spectrum** for each observation

We calculate ΔT as a **weighted integration** of the residual spectrum:

$$\Delta T = \sum_i w_i R_i$$

i: pixels
w_i: integration weights
R_i: residual spectrum

Observed spectrum in three echelle orders

Residual spectrum from the same observation

We derive integration weights independently for each echelle order each observation to **minimise noise** while satisfying:
1. **ΔT is measured in K** according to the temperature response function
2. The continuum **background is subtracted** such that ΔT is insensitive to scaling variations in the spectrum
3. The effect of **telluric lines**, and thus also telluric line variations, is neutralised across the echelle order. This relies on telluric template spectra for H_2O and O_2

High-precision temperature variations from 40,000 solar spectra

Solar spectra observed with **SONG-Tenerife**
4351 - 6828 Å, R~120,000
4.9 s cadence
40,000 observations over 5 days

After measuring all ΔTs, the time series is post-processed by:
1. Rejecting observations obscured by clouds
2. Combining ΔT measurements from all echelle orders into one using a weighted average based on measured statistical errors
3. Generating the power spectrum

RV and ΔT measurements over 30 min showing **phase-shifted solar oscillations**

- Per-observation error:
  - **Measured statistical error=0.14 K**
  - Photon noise floor=0.086 K
- Oscillation envolope very clearly visible.
- The S/N of the oscillations can be measured from the power spectrum. Based on this, the **S/N from ΔT is 1/5 the S/N from RV** measurements from the same observations.

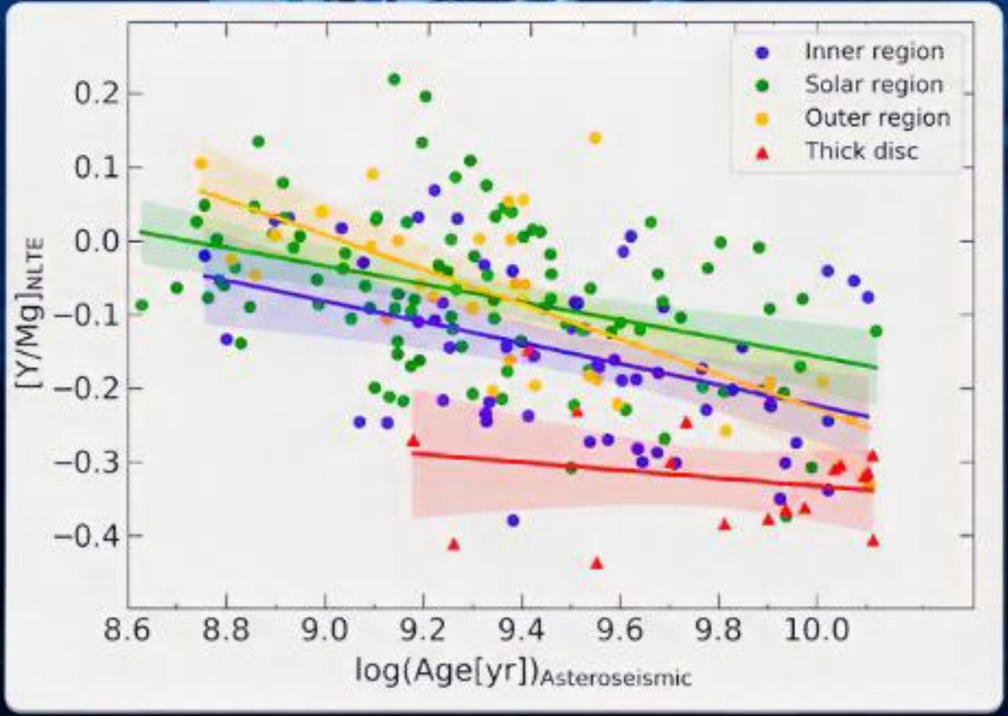
- The Sun's brightness allows for high-S/N, high-cadence spectra, ideal for testing and demonstration
- The intention is that the method can be used for any star with a similar dataset
- There are many years of observations for a number of oscillating stars in the SONG archive. These already have extracted RVs
- Applying this method to stars in the archive promises not just more signal from the same observations, but an **entirely new pathway to studying stellar photospheres and stellar oscillations.**

Oscillation envelope

Comparison with power spectrum from RV measurements from the same data show the **same oscillation frequencies**.

Revisiting the [Y/Mg]–age relation with NLTE abundances and TESS asteroseismic ages

- **Stellar ages** are essential, but **difficult to determine.**
- The combination of **Y and Mg** is extremely **sensitive to age** (produced on different timescales).
- First explored in the **solar neighbourhood** with **solar twins (e.g. Nissen 2015**).
- Previous studies showed that **not universal:**
  Viscasillas Vázquez et al. 2022, 2025b: radial variation (**thin disc**).
  Tautvaišienė, Viscasillas et al. 2021: flat relation (**thick disc**).
- In **Pakštienė et al. 2026** we revisited the **[Y/Mg]-Age** relation using **TESS asteroseismic ages**, and **NLTE abundances from VUES spectra at Molėtai Observatory.**
- We confirm our previous results: **[Y/Mg]–Age relation depends on Galactic environment.**



EARLY SOLAR PHOTOGRAPHY AT VILNIUS OBSERVATORY

THE SURVIVING DALLMEYER PHOTOHELIOGRAPH IMAGES

•More than **150 years ago**, Vilnius astronomers were already photographing the Sun.

•Installed in **1864**, the Vilnius Dallmeyer photoheliograph was one of the **earliest instruments of its kind in the world**.

•The project was soon marked by tragedy: the first two directors died in **1865** and **1866**.

•Regular solar imaging continued from **1868 to 1876**, producing ~**900 photographs**.

•The programme ended tragically in **1876**, when a devastating fire destroyed the instrument.

•Yet **283 solar images survived** through fires, wars, and lootings.

•Our study brings this forgotten chapter back to light, a unique legacy of **early solar physics and solar astrophotography**.

VILNIAUS UNIVERSITETAS • 1579 • UNIVERSITAS VILNENSIS

See more in:
Viscasillas Vázquez et al. (2026)
or visit our poster