Conny Aerts & Andrew Tkachenko

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Rauer et al. (2024) for the latest mission information

PLATO Complementary Science

8% of the overall data rate

Belgian Science Policy Office

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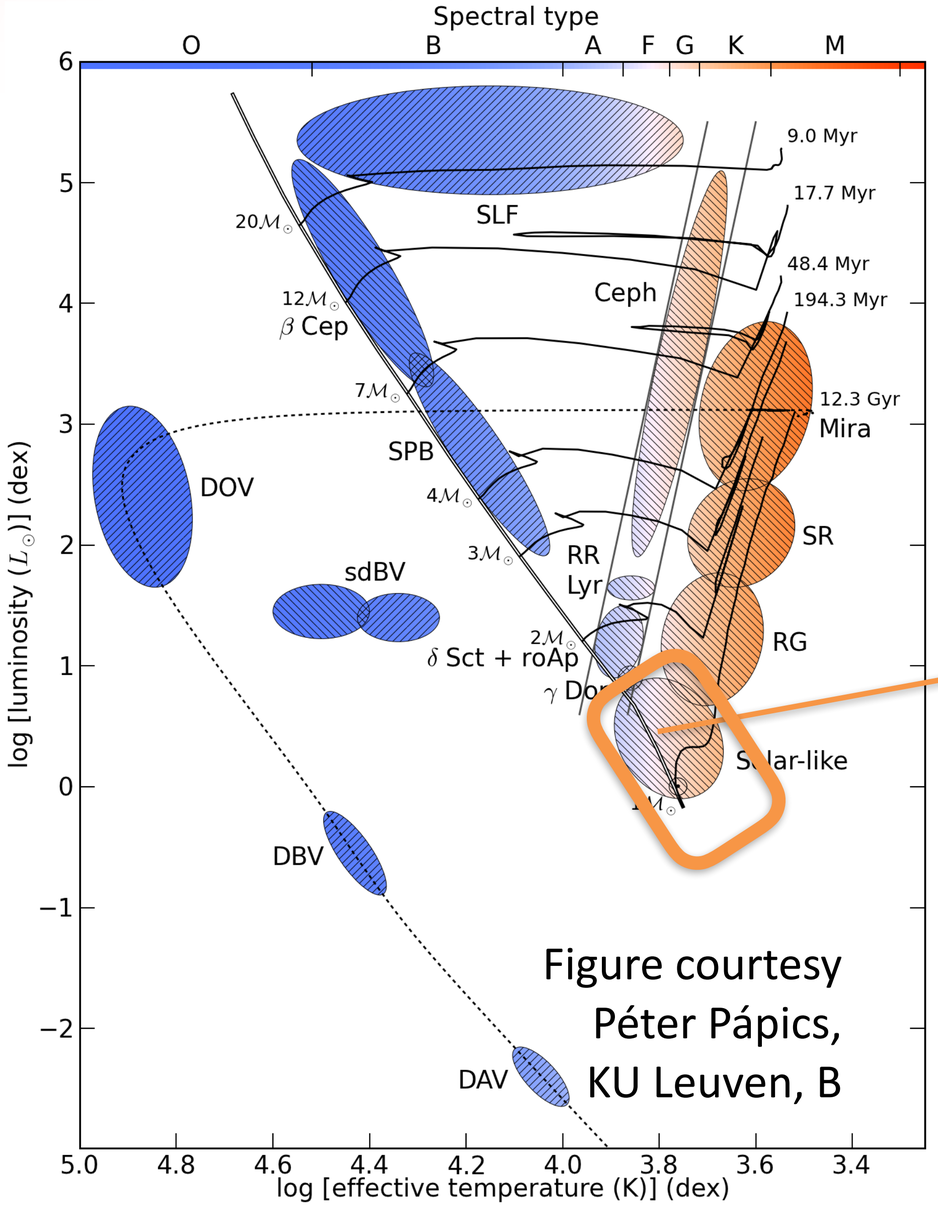
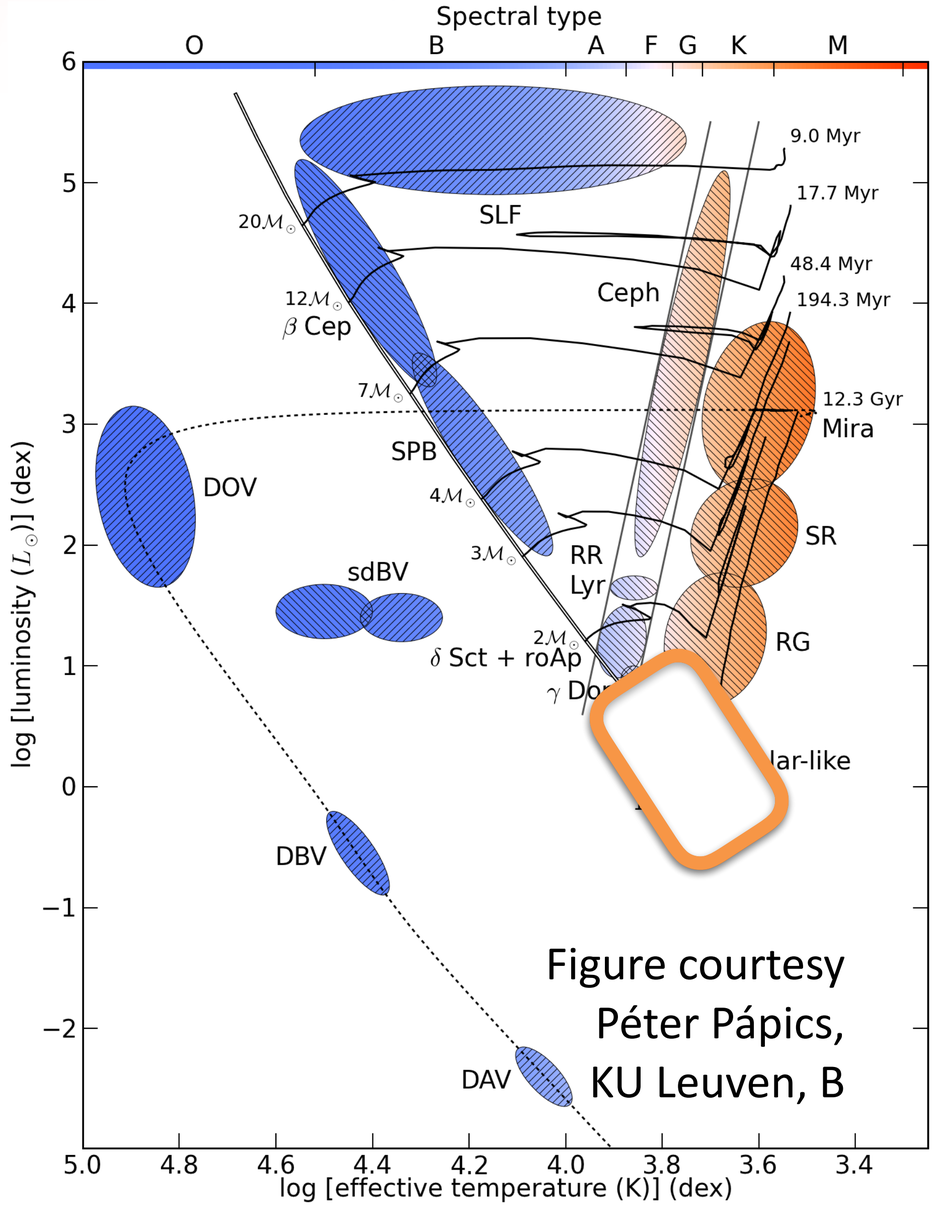
PLATO Core Science



Core Science:
asteroseismology of exoplanet hosts, i.e. F5-K7 stars
@ 2%Radius, 10% Age for 10000s of dwarfs & subgiants

(talk Kévin Belkacem)

PLATO Complementary Science



Complementary Stellar Science: all the rest, aside from F5-K7 stars

GO (8%) allows asteroseismology
+ magnetism/activity/flares
+ binarity/tides + rotation
+ distance scales + clusters
+ galactic archaeology
+ transients (GRB, SN, GW, AGN, …)

Locally funded; cannot drive mission design/operations

website: https://fys.kuleuven.be/ster/research-projects/plato-cs/home

PLATO Complementary Science

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Manager and Spokesperson
Andrew Tkachenko
(Andrew.Tkachenko@kuleuven.be)

Objectives

- Scientific programmes distinct from the Core Science
- Unique database of variable phenomena

How

- **Guest Observer** (GO) programme (call and selection by ESA)
- GO is assigned **8% of the science data**

Task

Make sure community is ready for optimal GO proposal submission

160 **Stellar Variability Catalogue**
Andrew Tkachenko

161 **Binary & Multiple Stars**
John Southworth

162 **Pulsating Stars**
Conny Aerts

163 **Magnetic Stars & Rotational Variables**
Coralie Neiner

Stars with Mass Loss
Laurent Mahy

Young Stellar Objects & Stars with Debris Disks
Manuel Güdel

Galactic Structure
Saskia Hekker

Transient Phenomena & Extragalactic Science
Peter Jonker
Samaya Nissanke

Ground-Based Follow-Up
(Spectroscopy, Interferometry & Multicolour Photometry)
Ennio Poretti

PLATO-CS: topics from you!

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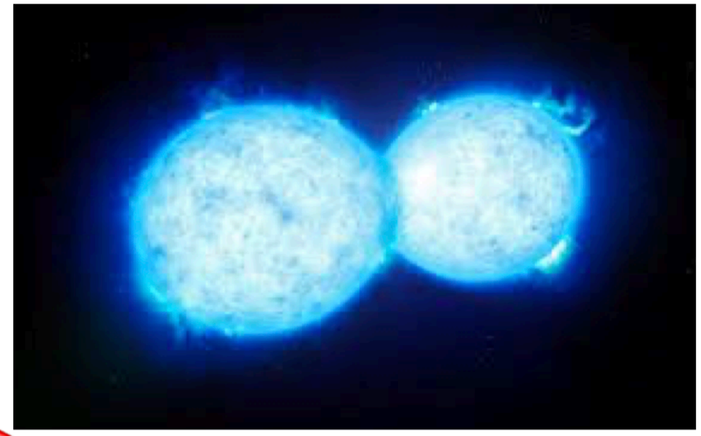
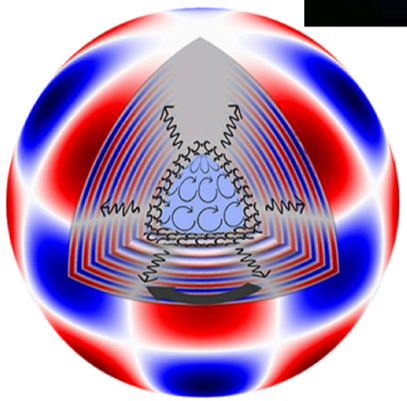
Clusters, associations, star forming regions

Binary and multiple stars systems



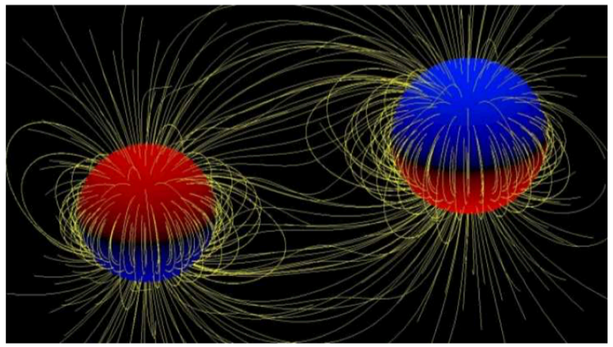
Extragalactic science

Milky Way, Galactic archaeology



Pulsating stars

Stellar magnetism



Stars with mass loss and winds

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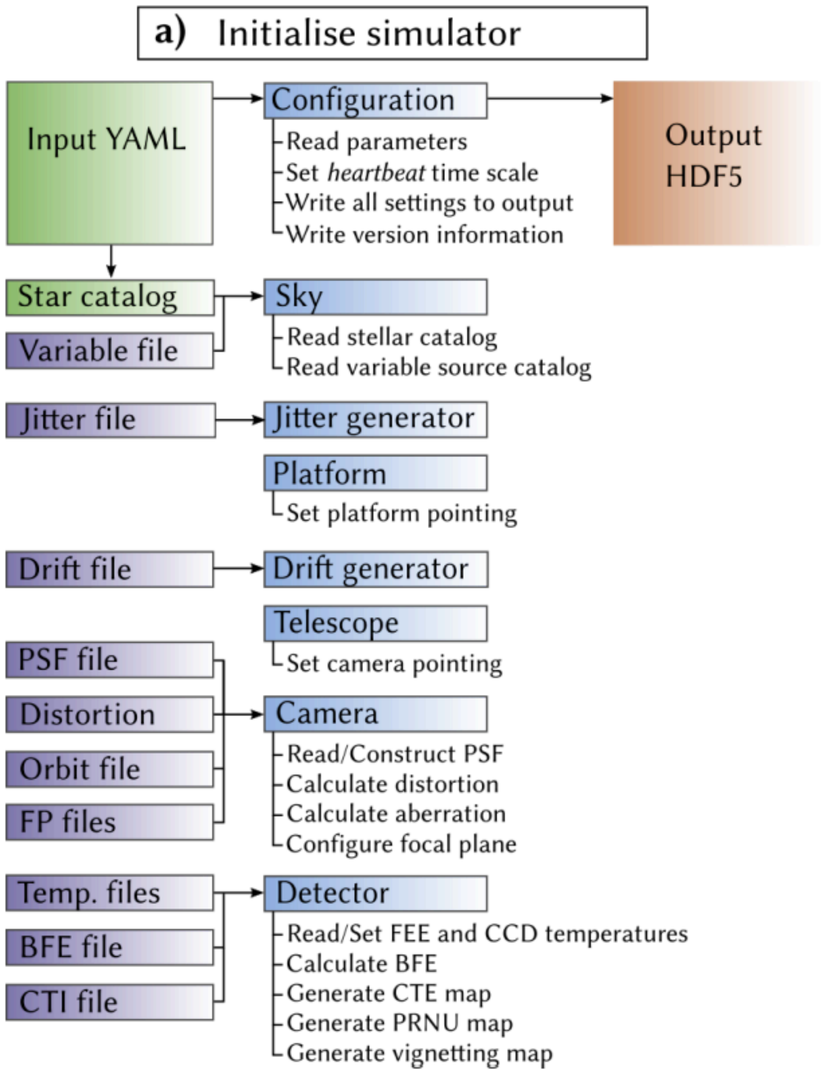
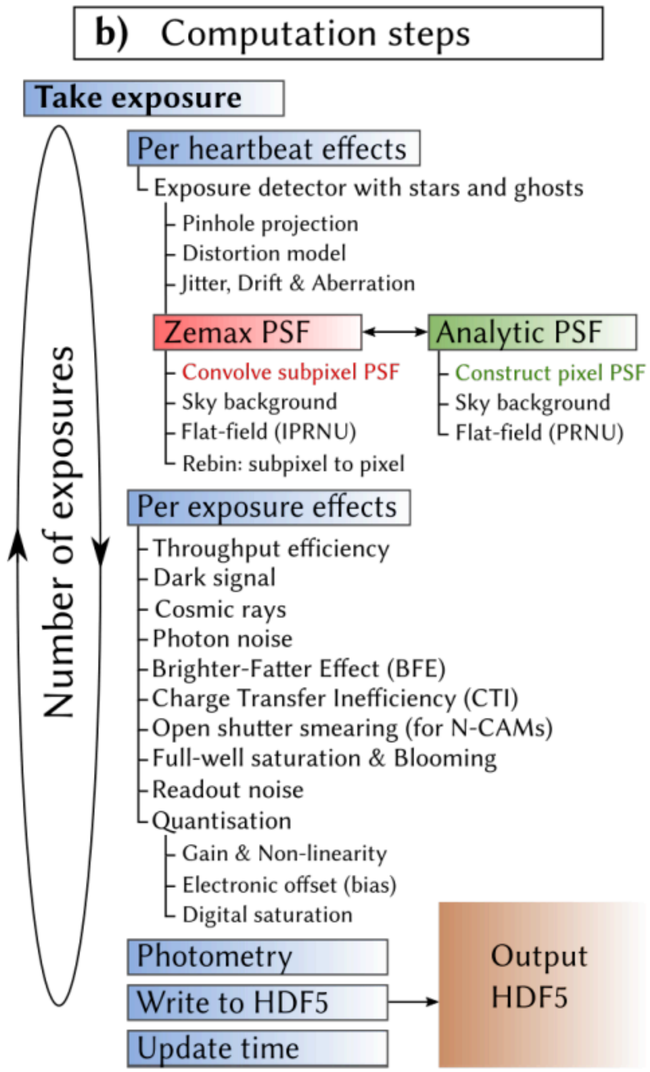
Data Rate for GO: 8% open time

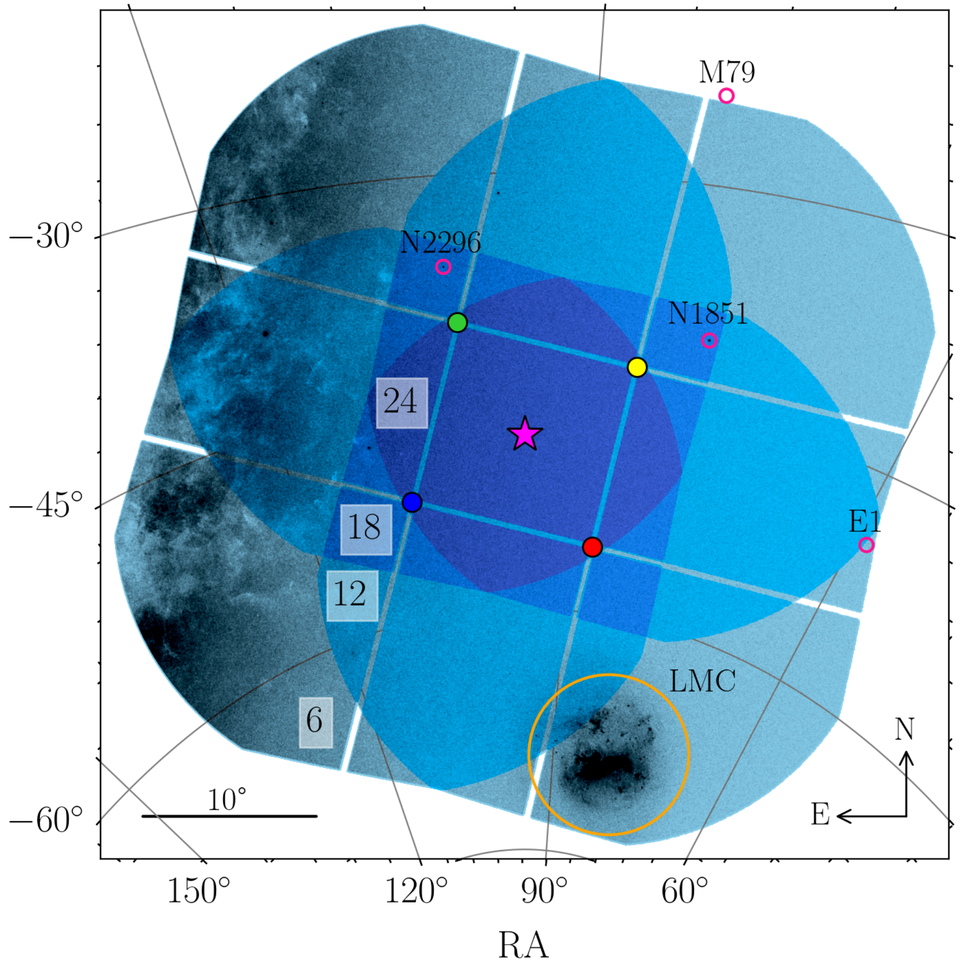
1. Any **feasible** science case = welcome for GO
2. PLATO offers best of *Kepler* & TESS merged **+ more**:
   long pointings (2+ yr) for high frequency precision,
   large FoV (e.g., incl. Magellanic Clouds in LOPS)
3. 2 colours with cadence 2.5s, imagettes (masks)@25s,
   onboard LC@10m all available if argued
4. ESA Call: 9 months prior to launch (**spring 2026, tbc**)

Helpful tool: PLATOSim



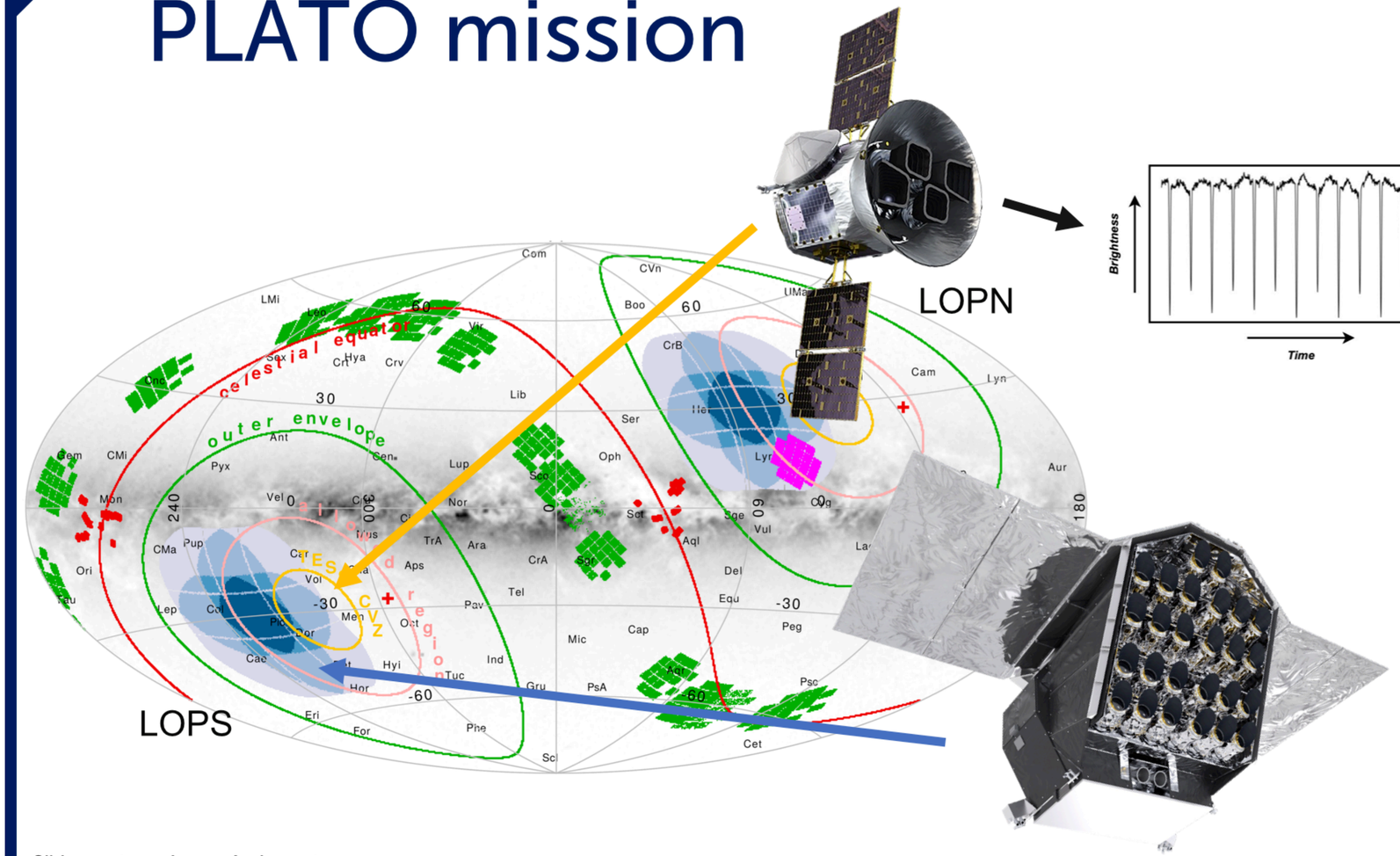


PlatoSim (Jannsen et al. 2024)



Helpful tool: variability catalogue

TESS classifications to inform ESA PLATO mission



Classifications

?

Informs PLATO community which stars to observe

Slide courtesy: Jeroen Audenaert

Helpful tool: variability catalogue

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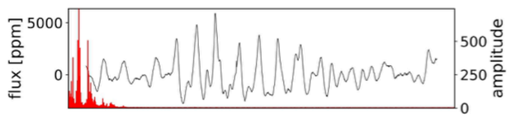
Machine Learning Architecture

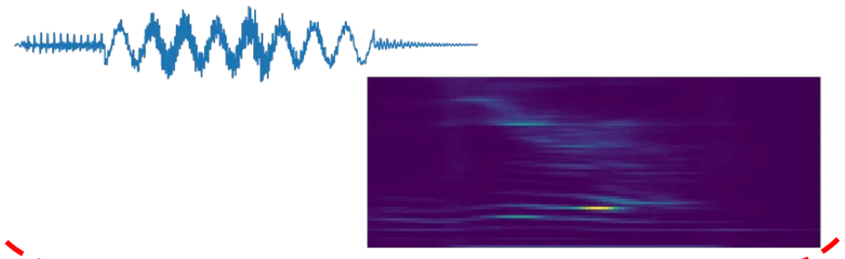
Slide courtesy: Jeroen Audenaert

1. Light Curve

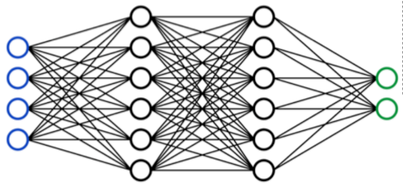


2. Creating a representation of the light curve (latent space)

Wavelet Scattering Transform



3. Output layer



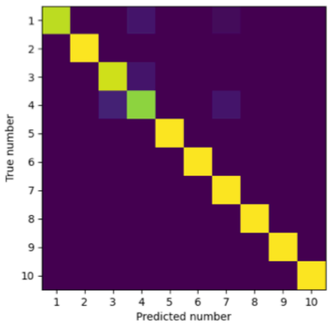
Training a fully connected neural network to map latent space to the variability classes

4. Predictions

Predicting the class for each light curve

Probabilistic classifications

80%	*γ Dor*
4%	*δ Sct*
3%	*hybrid (γ Dor/δ Sct)*
10%	*rotational variables*
3%	*other*



Kymatio - Andreux et. al (2019) - arXiv 1812.11214

Celis (2021); Audenaert et al. (in prep.)

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Rauer et al. (2024) for the latest mission information

PLATO-CS: TESS example studies

(g-mode pulsators in PLATO FoV: talk by Nicholas Jannsen)
(young open cluster asteroseismology: P23 by Dario Fritzewski)

Confronting Gaia DR3 & Kp LCs

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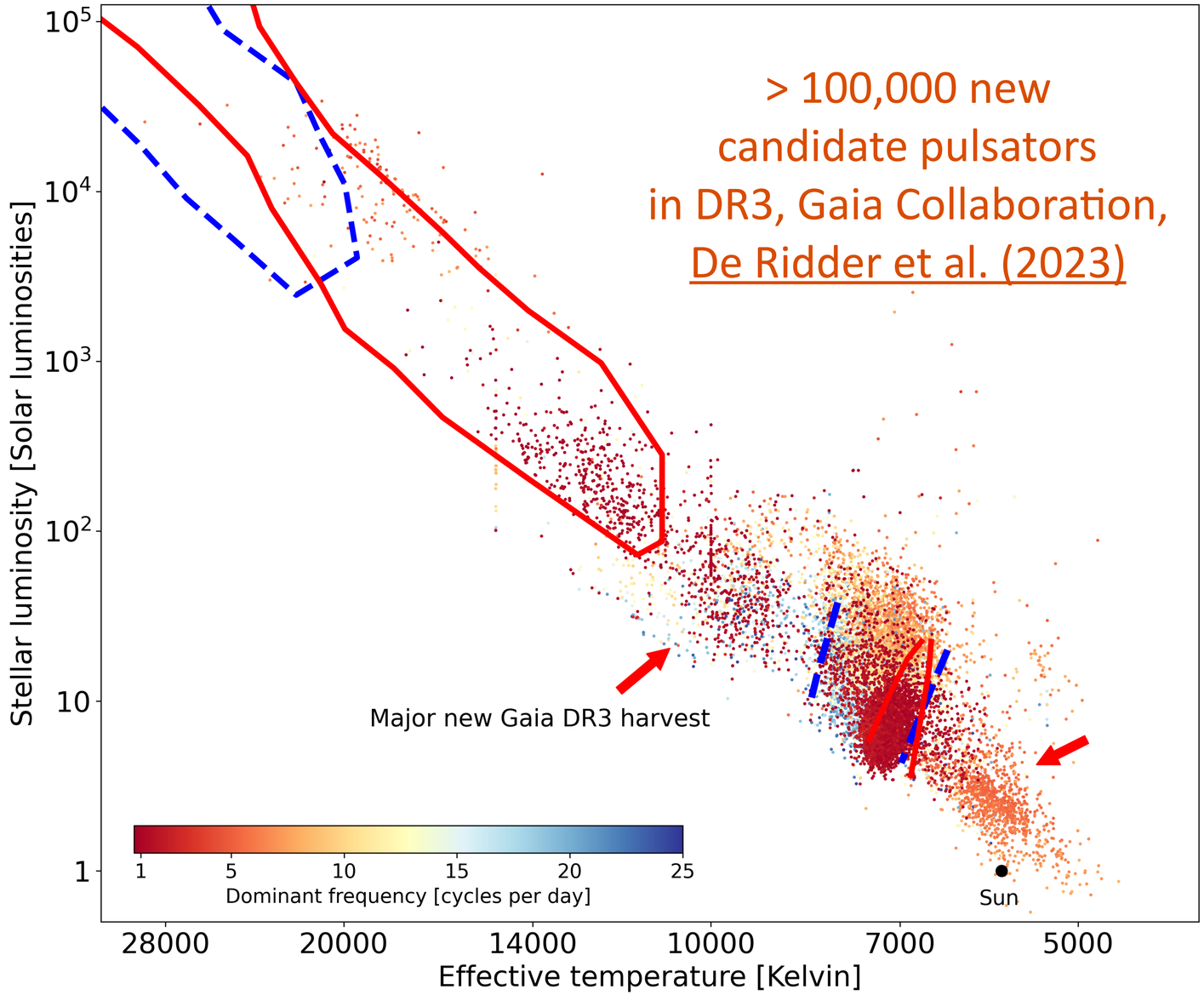

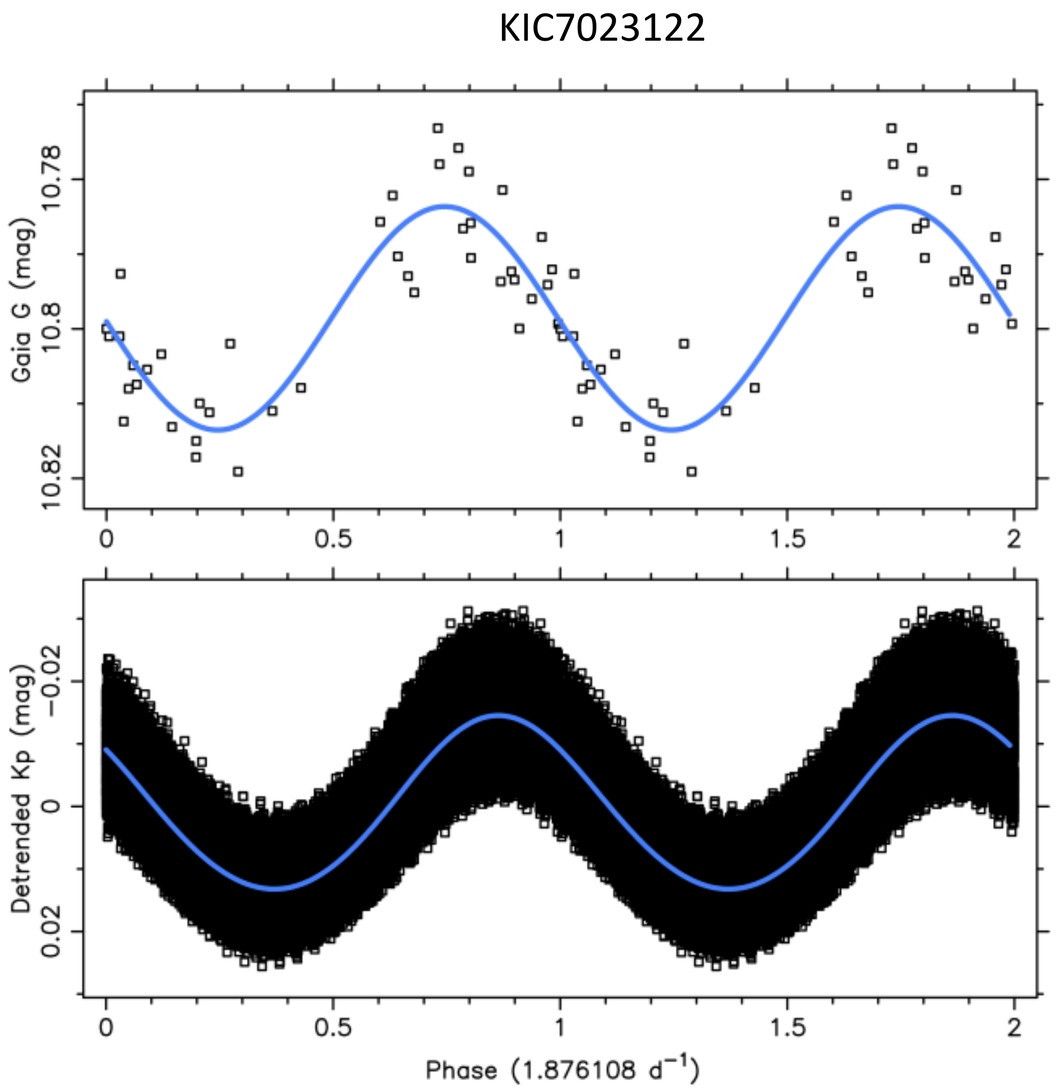

Confronting Gaia DR3 & Kp LCs

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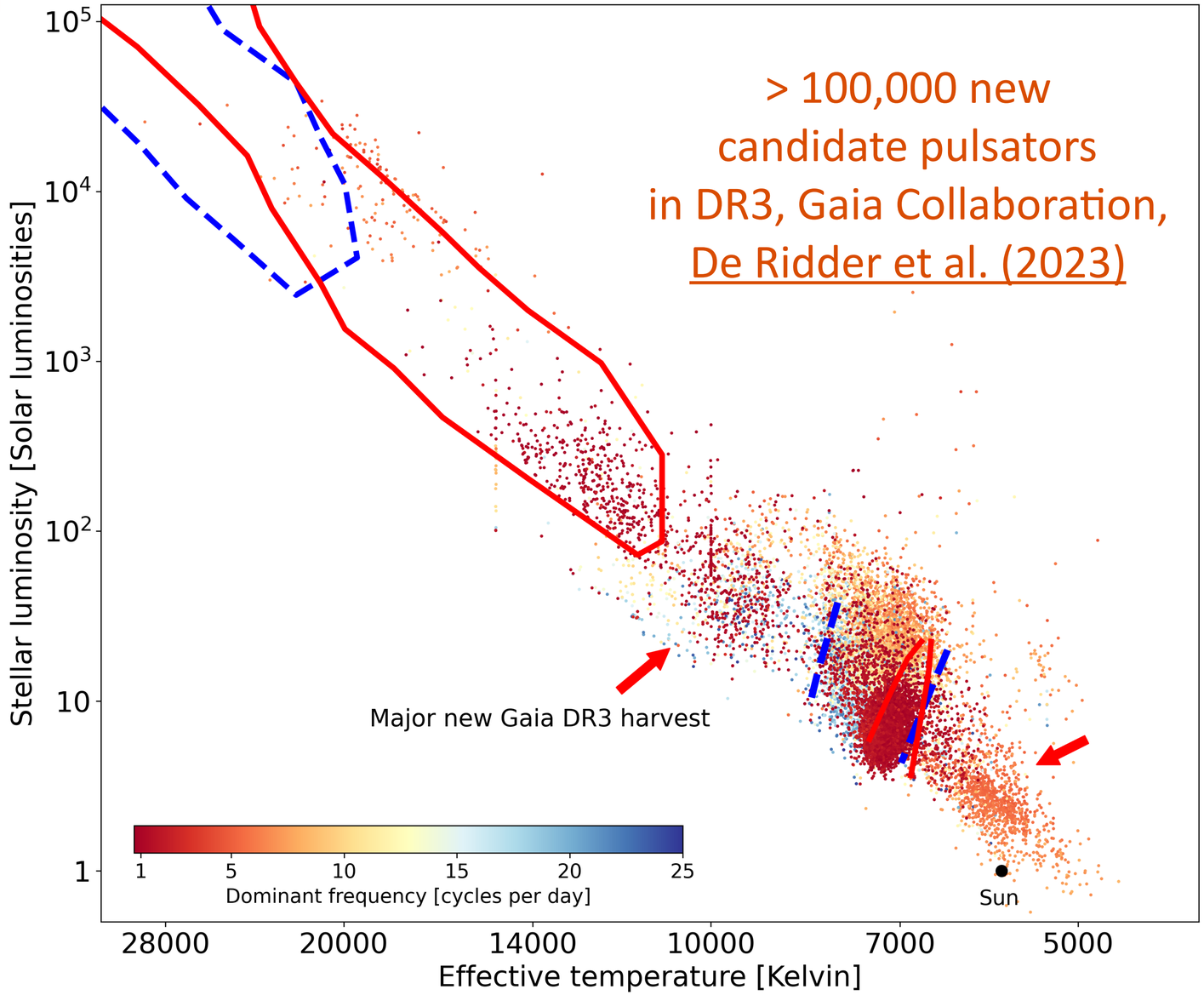

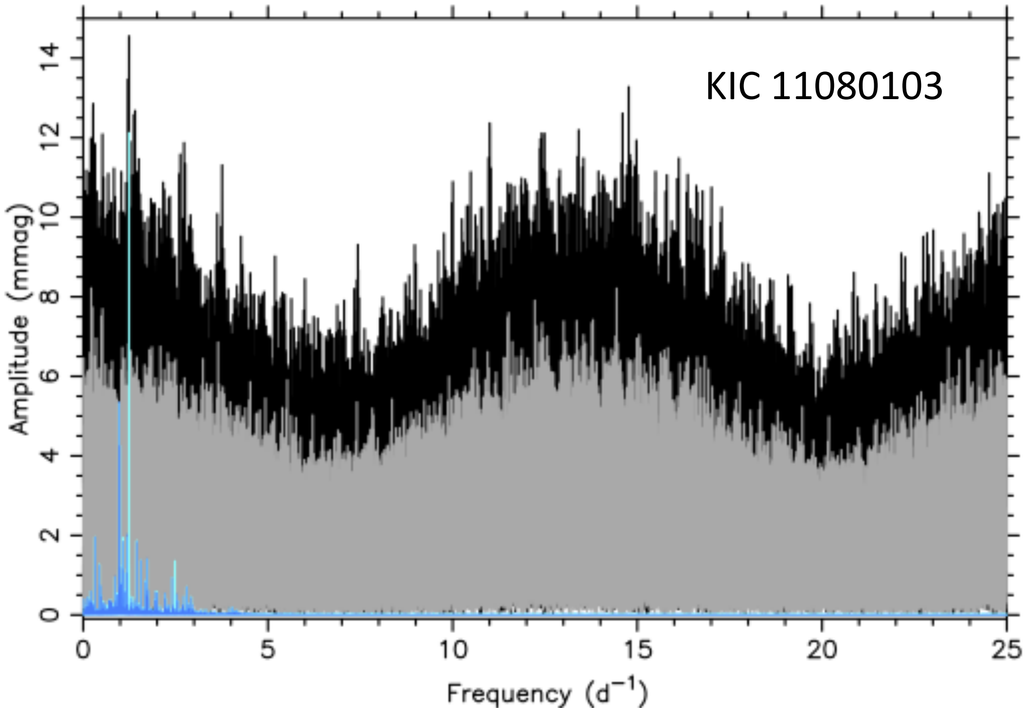

Onwards to seismic population studies of OBAF-type stars across the Milky Way

Confronting Gaia DR3 & TESS LCs

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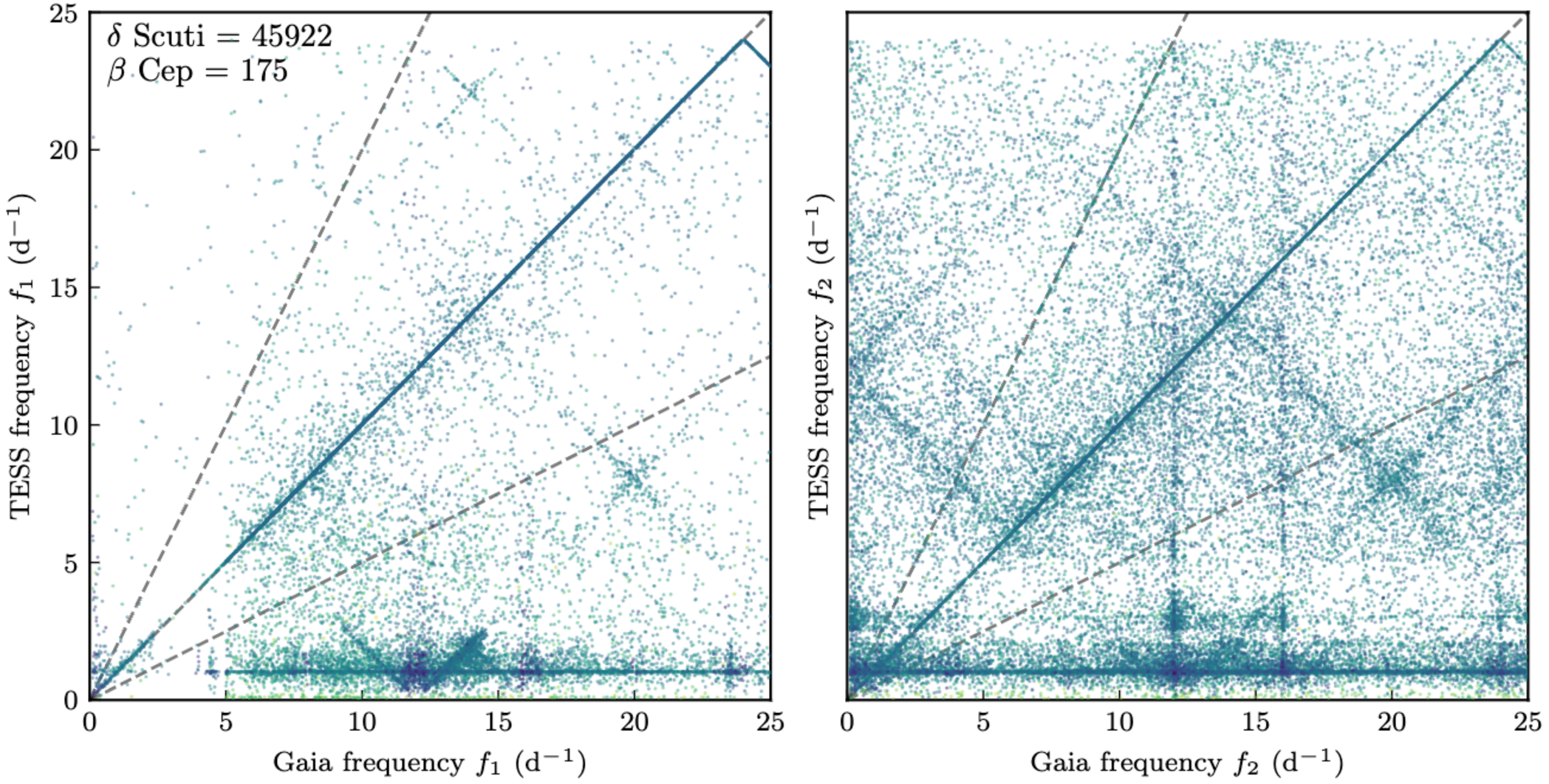
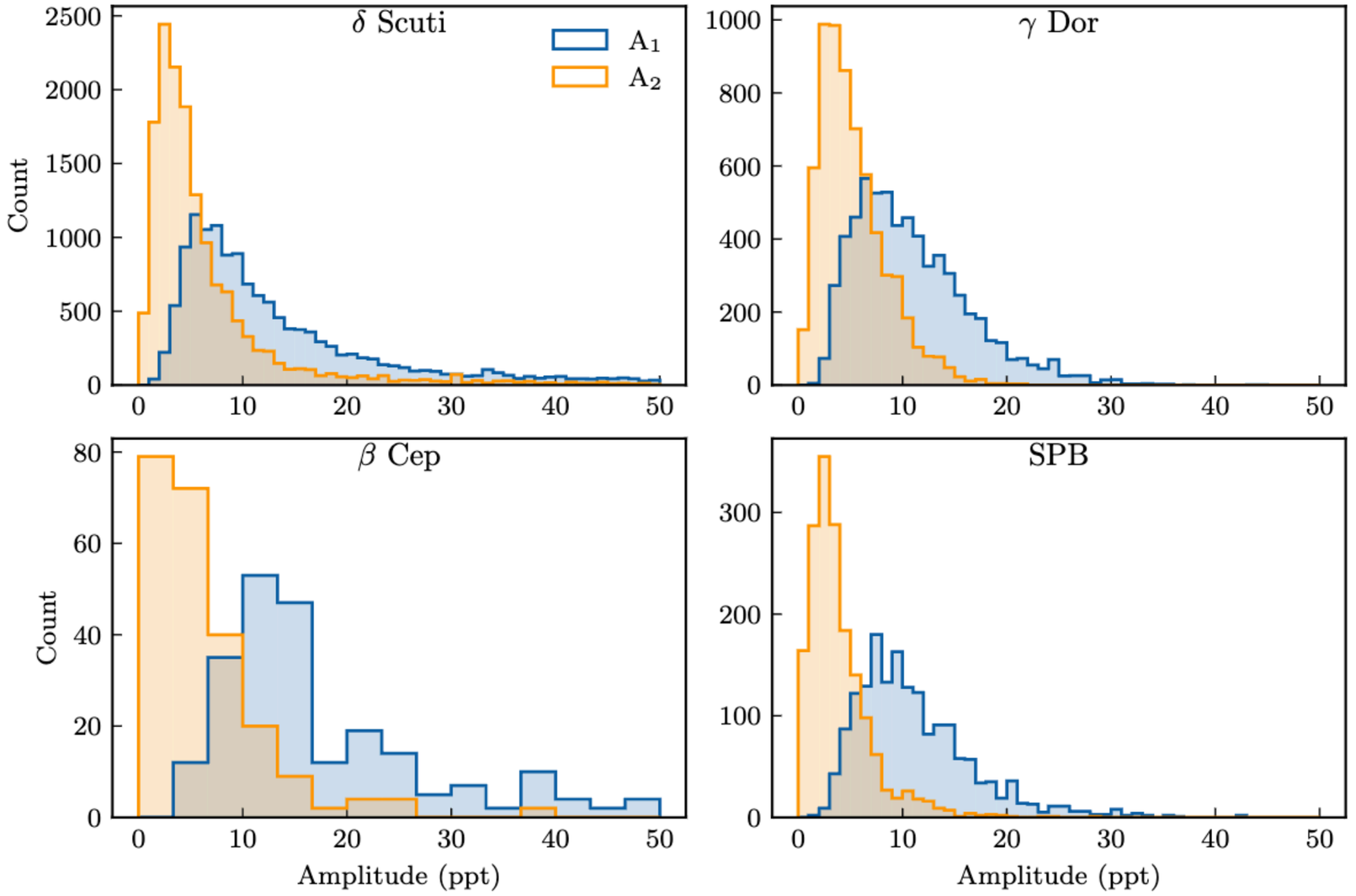
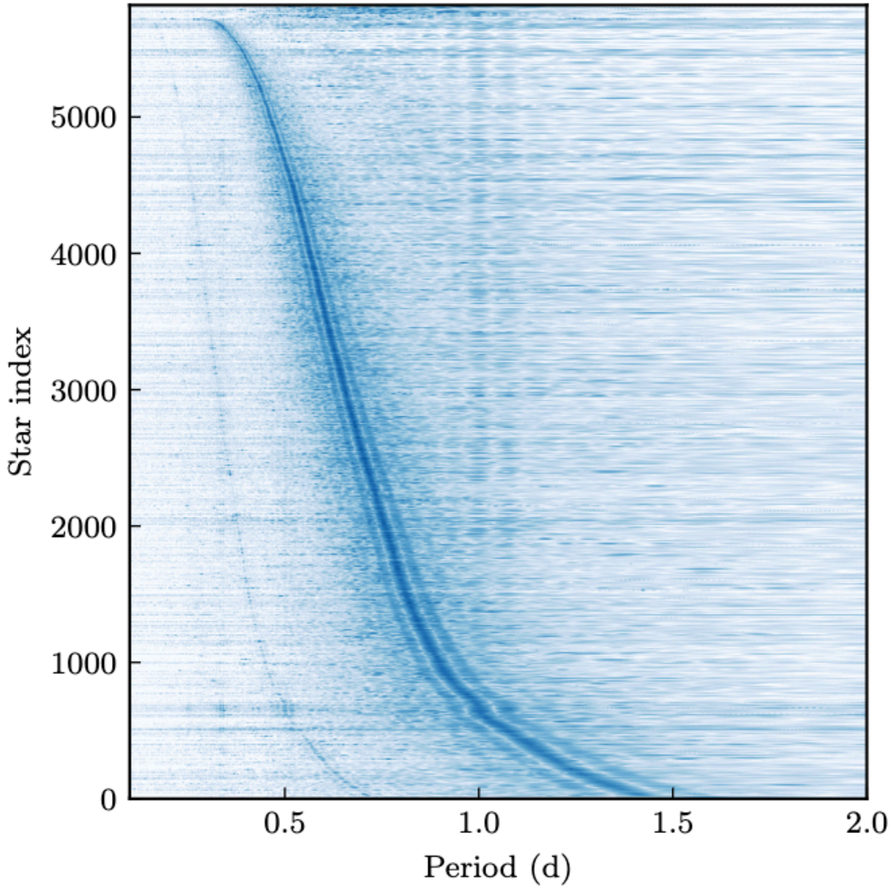
60,000 confirmed Gaia DR3 BAF-type pulsators (Hey & Aerts 2024)



Population amplitude distributions

60,000 confirmed Gaia DR3 BAF-type pulsators (Hey & Aerts 2024)





Identification dominant mode

Population of Gaia/TESS g-mode pulsators

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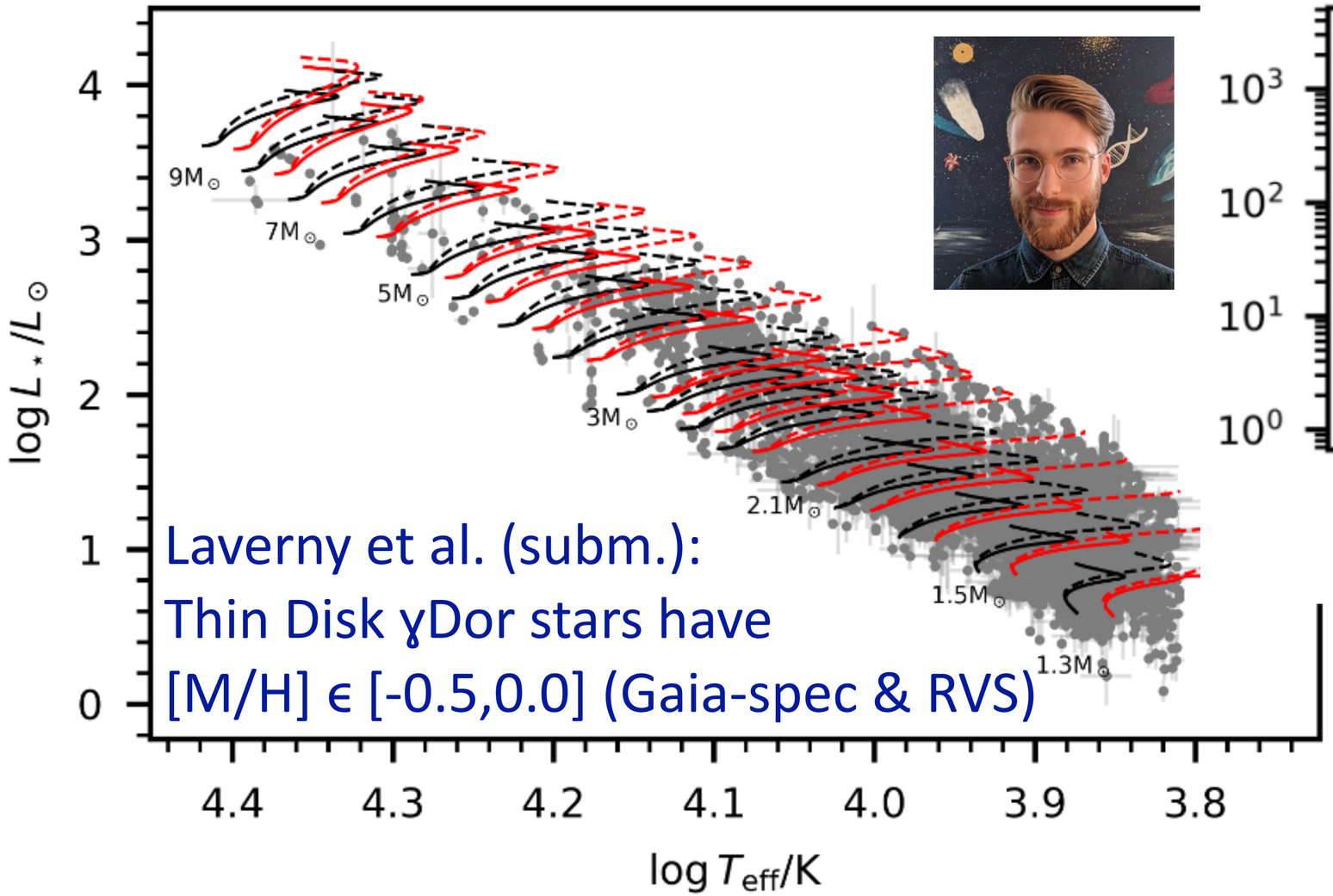
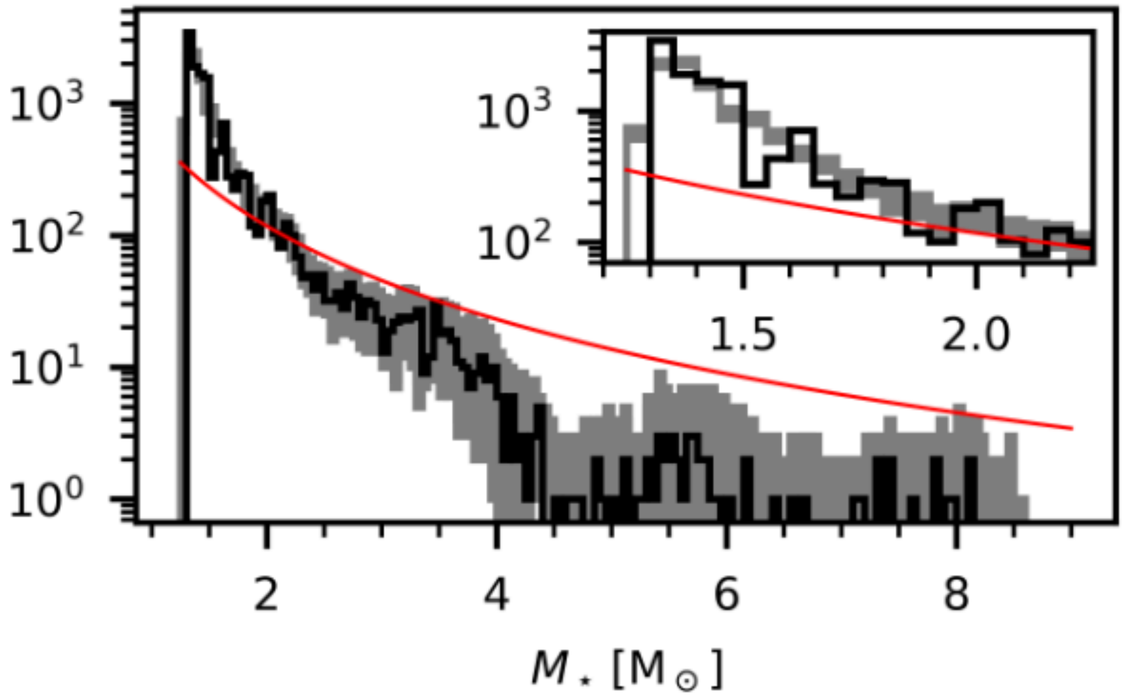
10,801 re-classified g-mode pulsators (Mombarg et al., submitted)



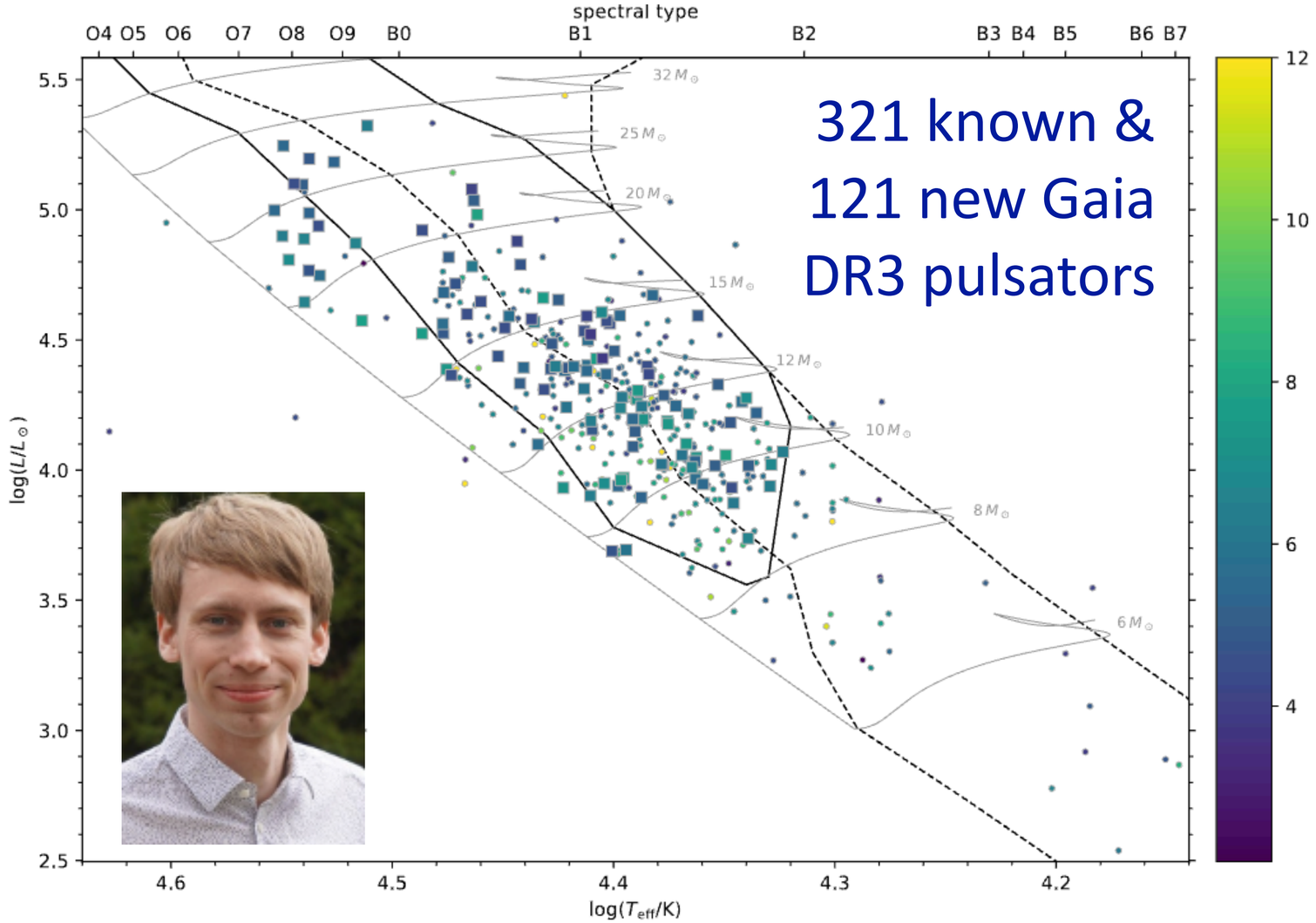
Laverny et al. (subm.):
Thin Disk ɣDor stars have
[M/H] ϵ [-0.5,0.0] (Gaia-spec & RVS)



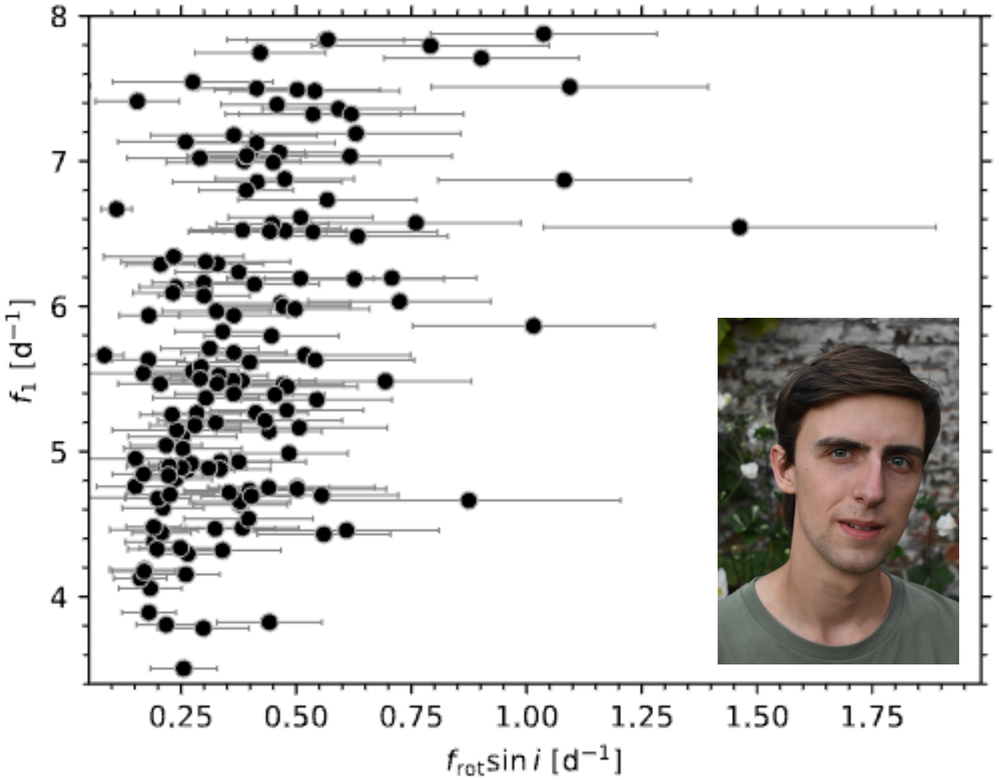
(core) masses, radii, ages from "*Kepler*-informed" seismic models

Population of Gaia/TESS βCep stars

215 Gaia-discovered/TESS confirmed βCep stars (Fritzewski et al. 2024)



321 known &
121 new Gaia
DR3 pulsators



167/215 stars have DR3 vbroad

Gaia DR3 mode id. for βCep stars

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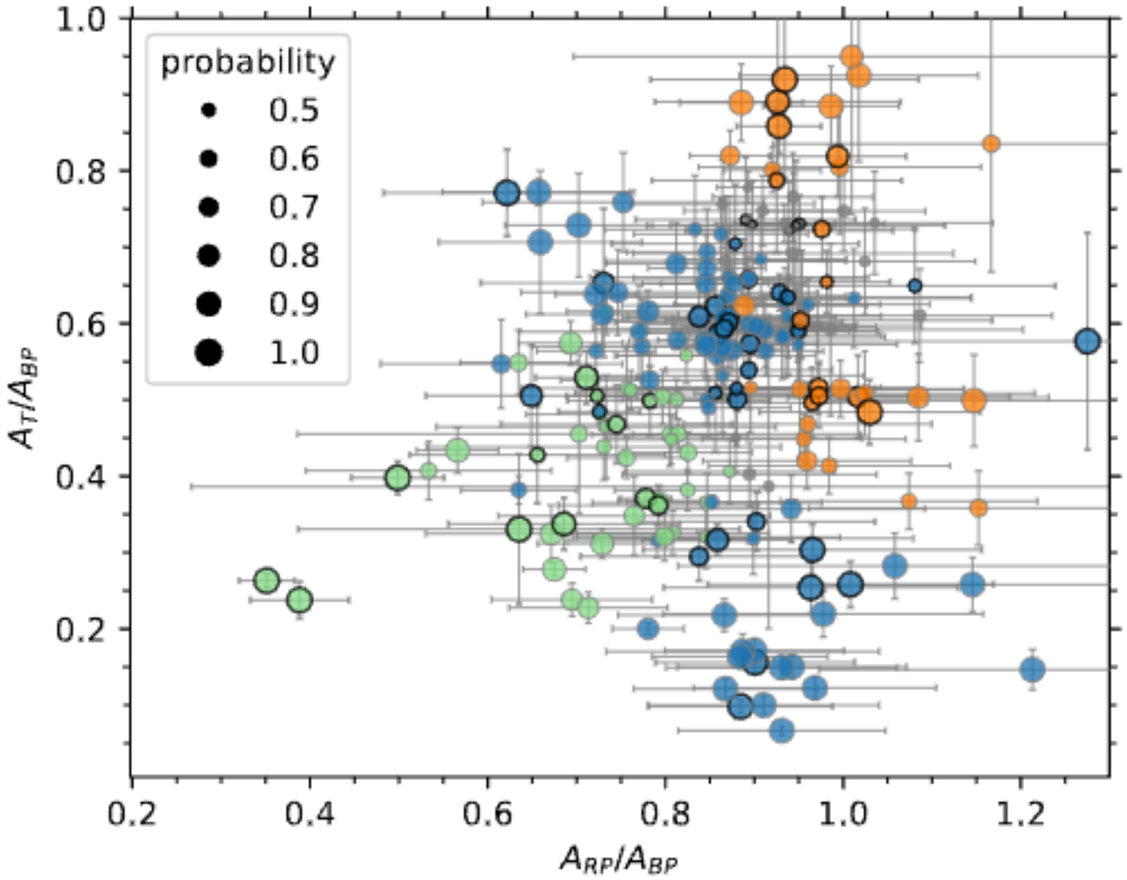
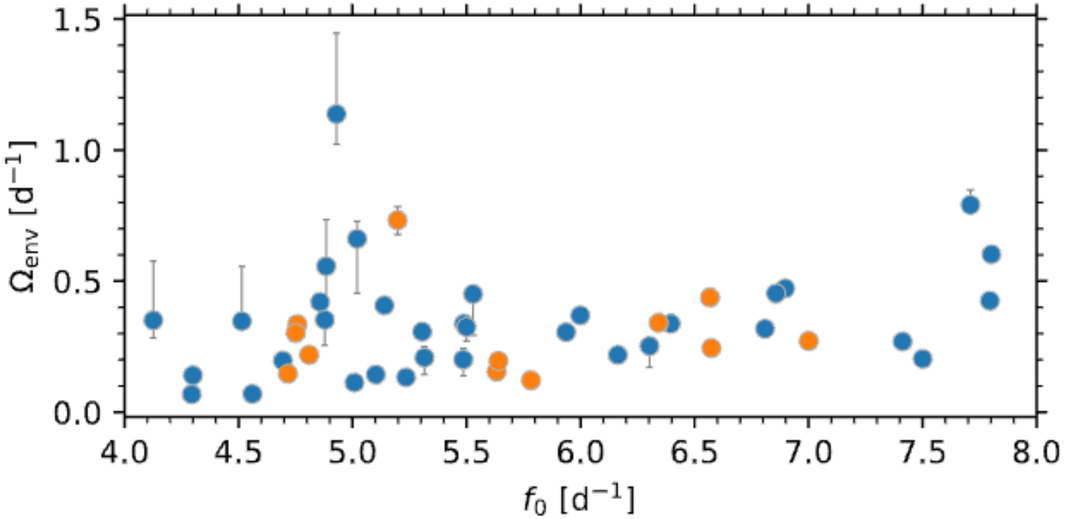
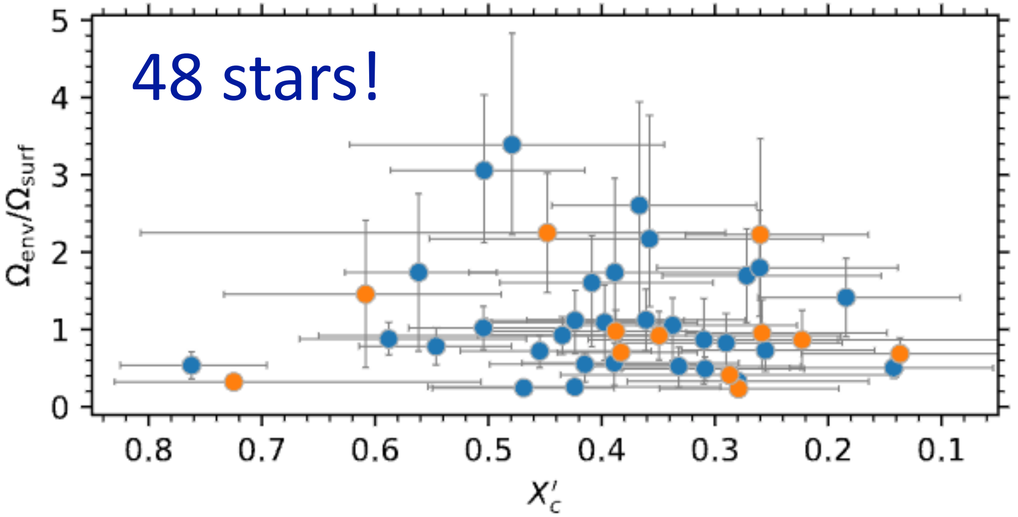
Gaia/TESS population study of βCep stars (Fritzewski et al. 2024)



205 stars with MI from
Gaia DR3 amplitude ratios

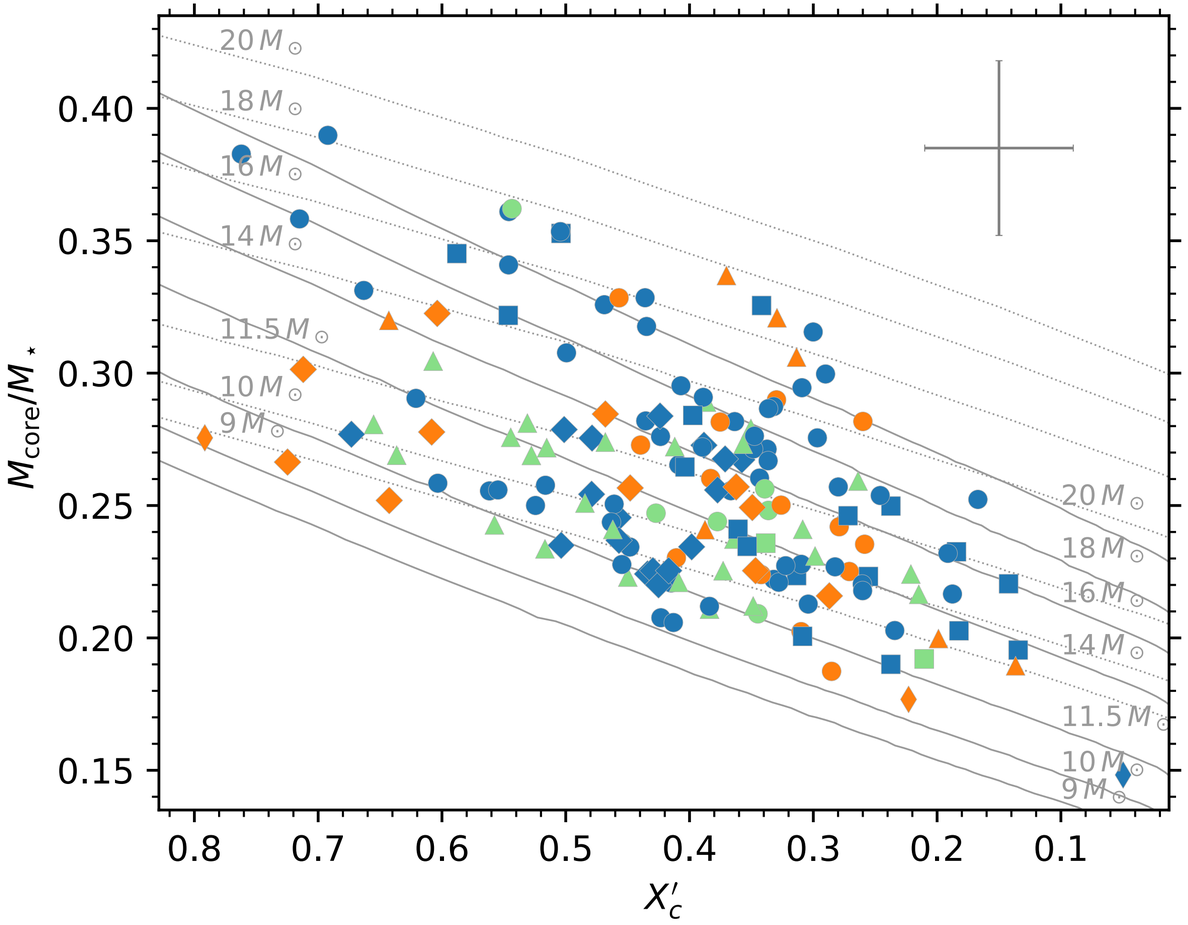
Upper Limit

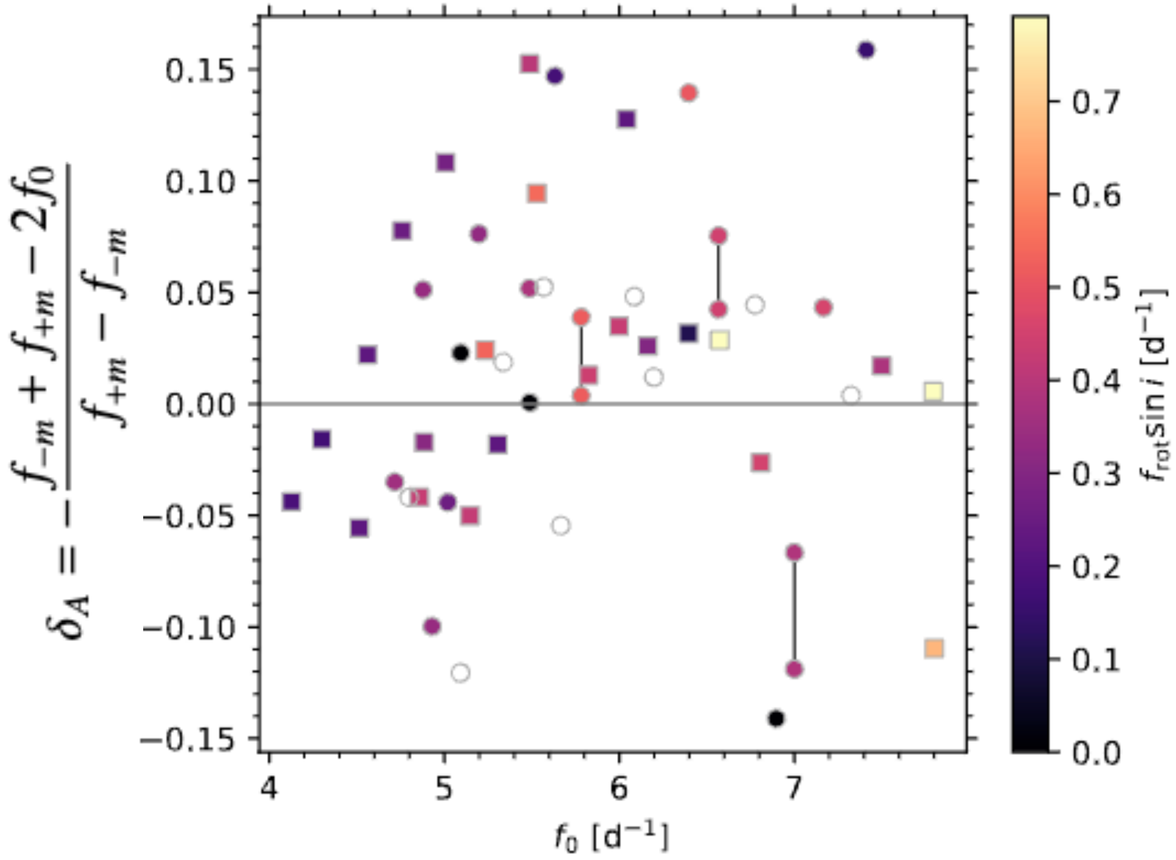




Core properties of βCep stars

Gaia/TESS asteroseismology of βCep stars (Fritzewski et al. 2024)

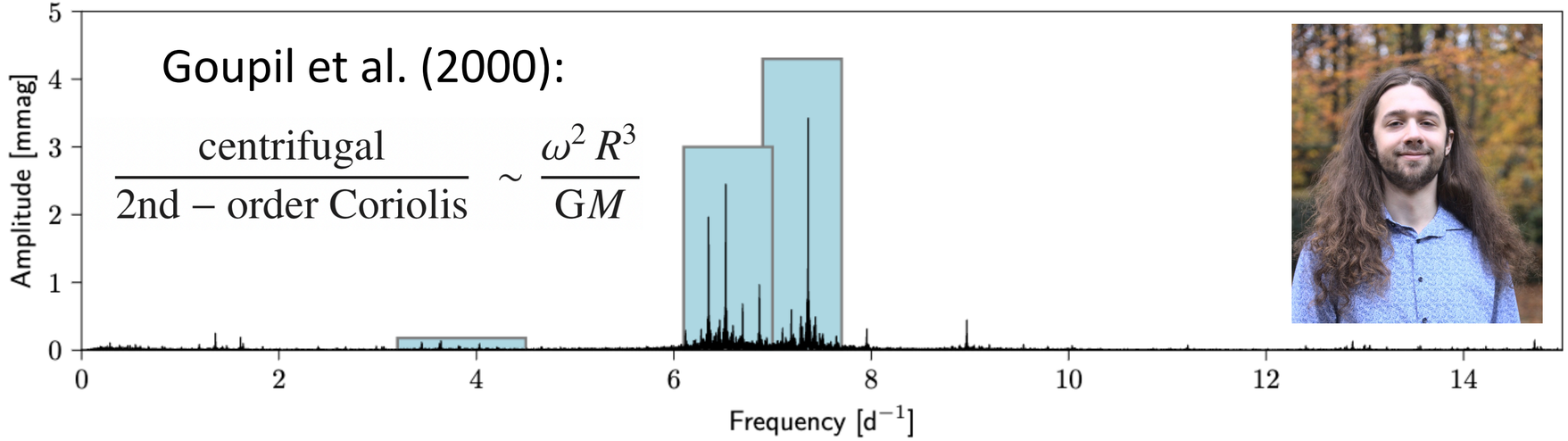


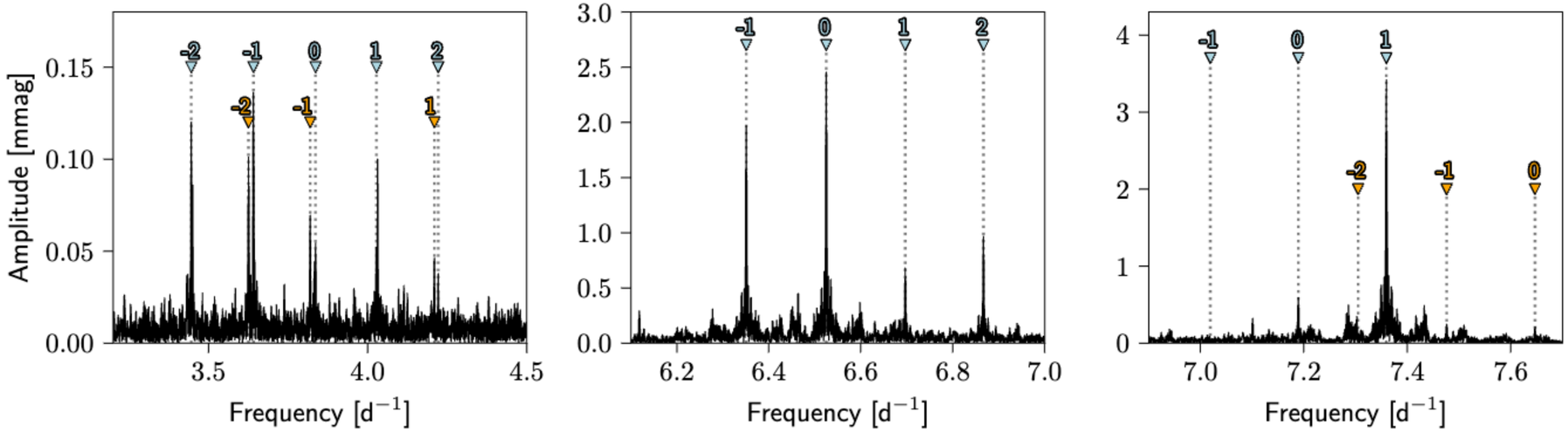


multiplet asymmetries of 48 stars

Asymmetric splittings in HD192575

TESS CVZ βCep star (Burssens et al. 2023), Vanlaer et al. (to be subm.)





P107: read & find out
1) (how) does 1 extra quintuplet peak change modelling?
2) rotation profile from inversion
3) do measured multiplet asymmetries require core magnetic field or not?

Back to preparation of PLATO-CS

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Coming Up

Wiki pages with all relevant information

Telecons and WG (e)meetings

Newsletter

Simulations

Feasibility of research projects

Test and validation of data analysis tools

Data challenges

We can't do it alone and need your help!

General catalogue of stellar variability in PLATO FoVs

Inform target selection

Register and join us now: https://fys.kuleuven.be/ster/research-projects/plato-cs/home