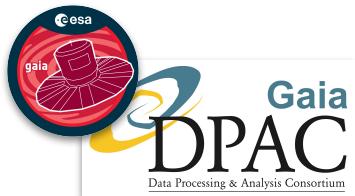


The *Gaia* Focused Product Release Catalog of LPV candidates

Michele Trabucchi

Nami Mowlavi, Thomas Lebzelter

Gaia Collaboration, DPAC CU7+CU6



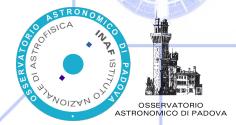
UNIVERSITÉ
DE GENÈVE



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



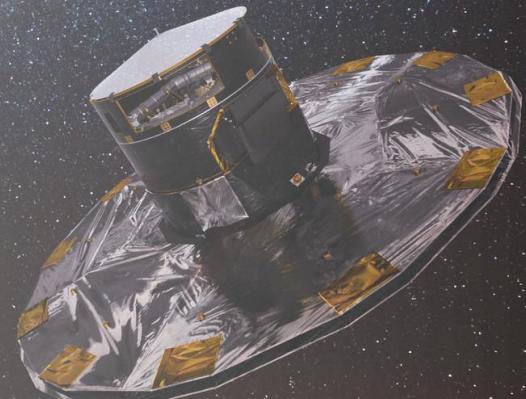
Dipartimento
di Fisica
e Astronomia
Galileo Galilei



Outline

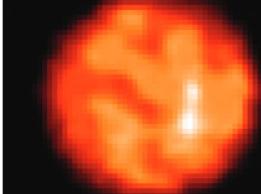
1. Catalog Contents
2. Applications

Gaia FPR: Radial velocity time series of long-period variables
2023 | Astronomy & Astrophysics, Volume 680, id.A36, 38 pp.



Long-Period Variables

Paladini + 2018



AGB / RSG



Freytag & Höfner 2023

PULSATION



convective
mixing

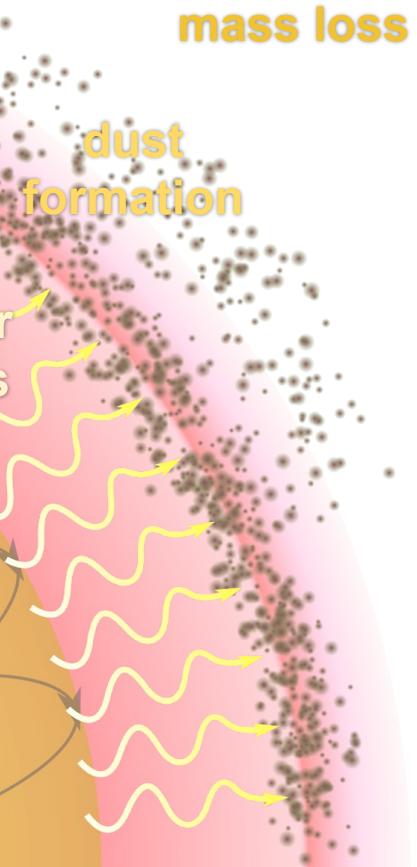


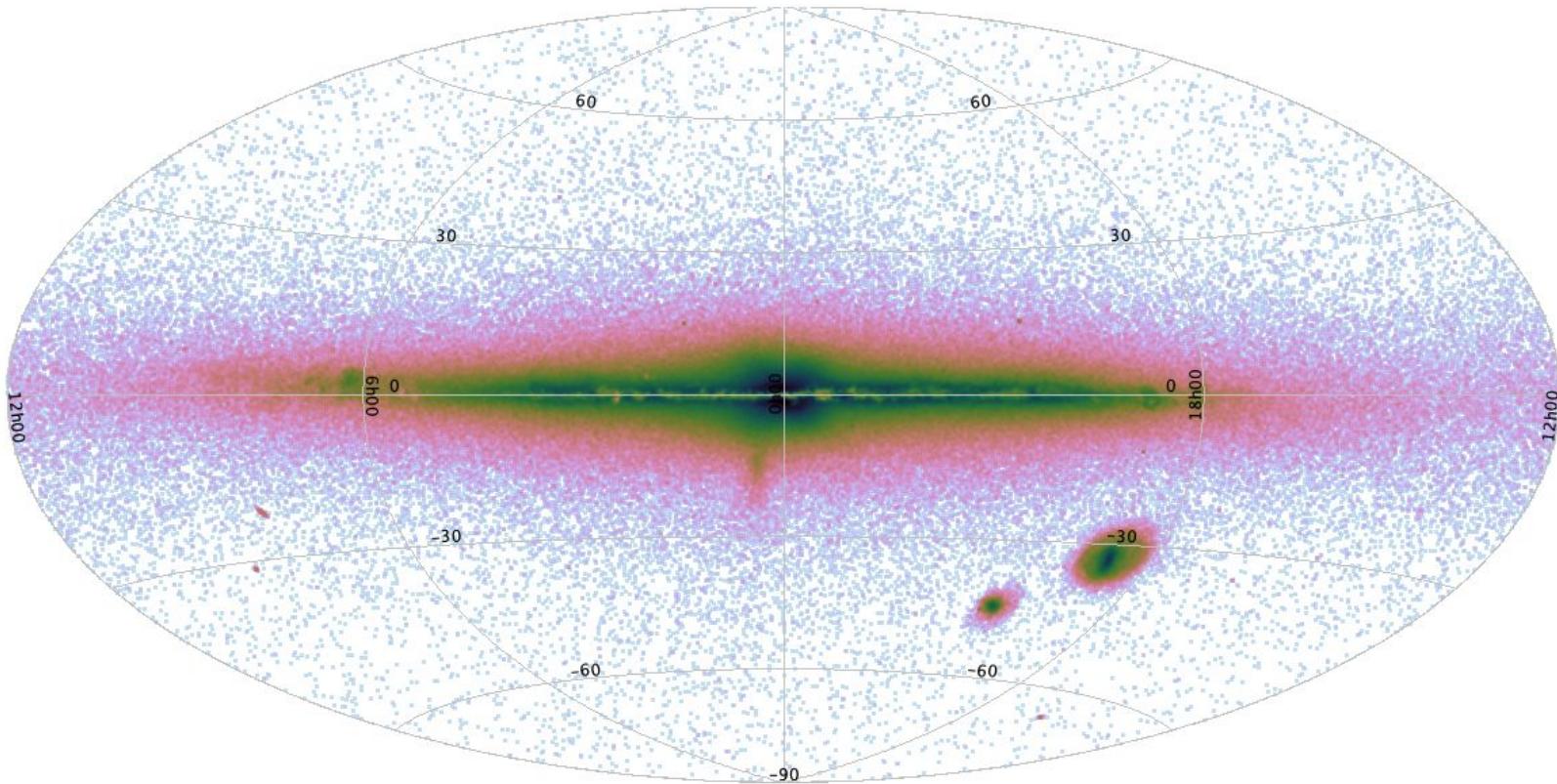
Illustration © Michele Trabucchi

The diagram consists of three nested circles. The innermost circle is blue and labeled "Gaia DR2 151'761". The middle circle is light green and labeled "Gaia DR3 1'720'588 (2'326'297)". The outermost circle is yellow and labeled "Gaia DR4 ???".

Gaia DR3
1'720'588
(2'326'297)

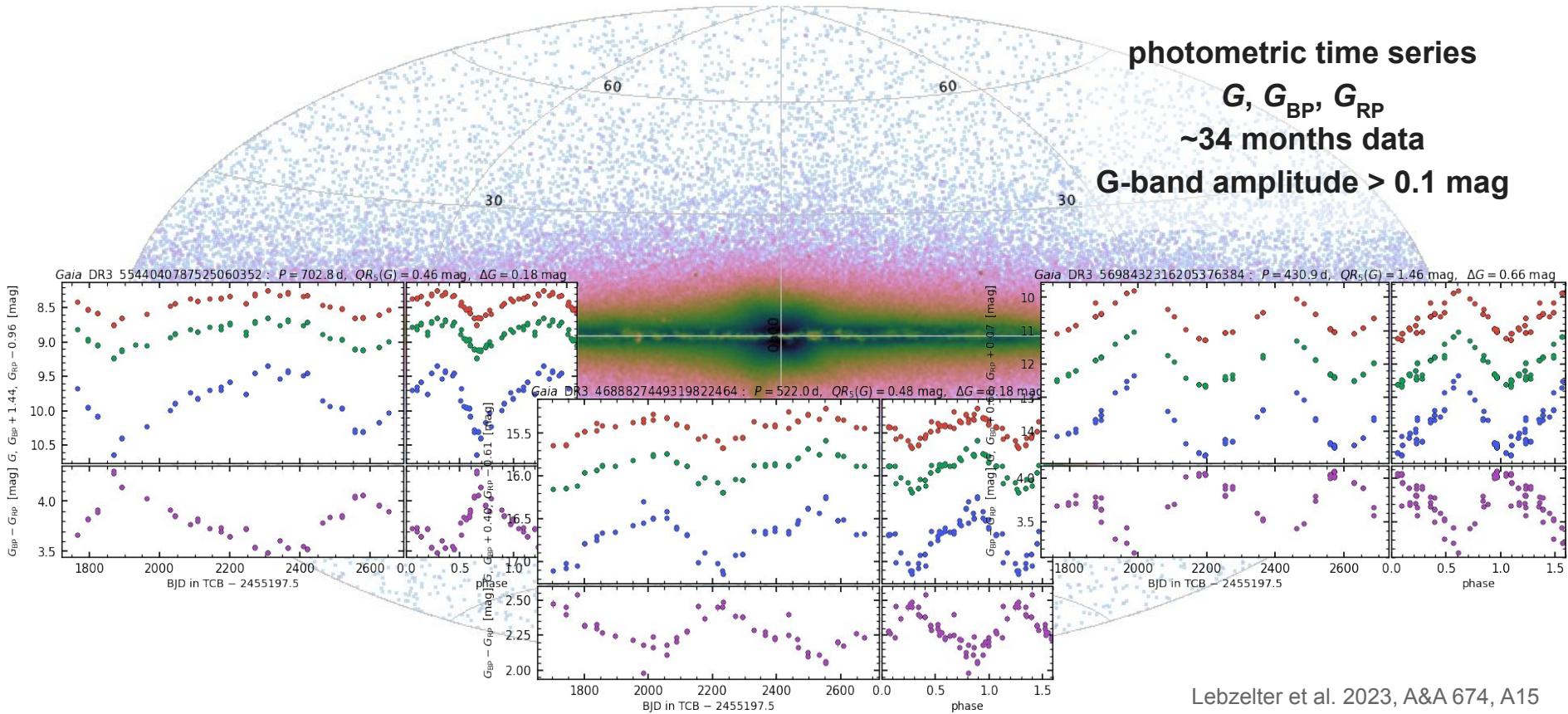
Gaia DR4
???

Gaia DR3 catalog of long-period variables



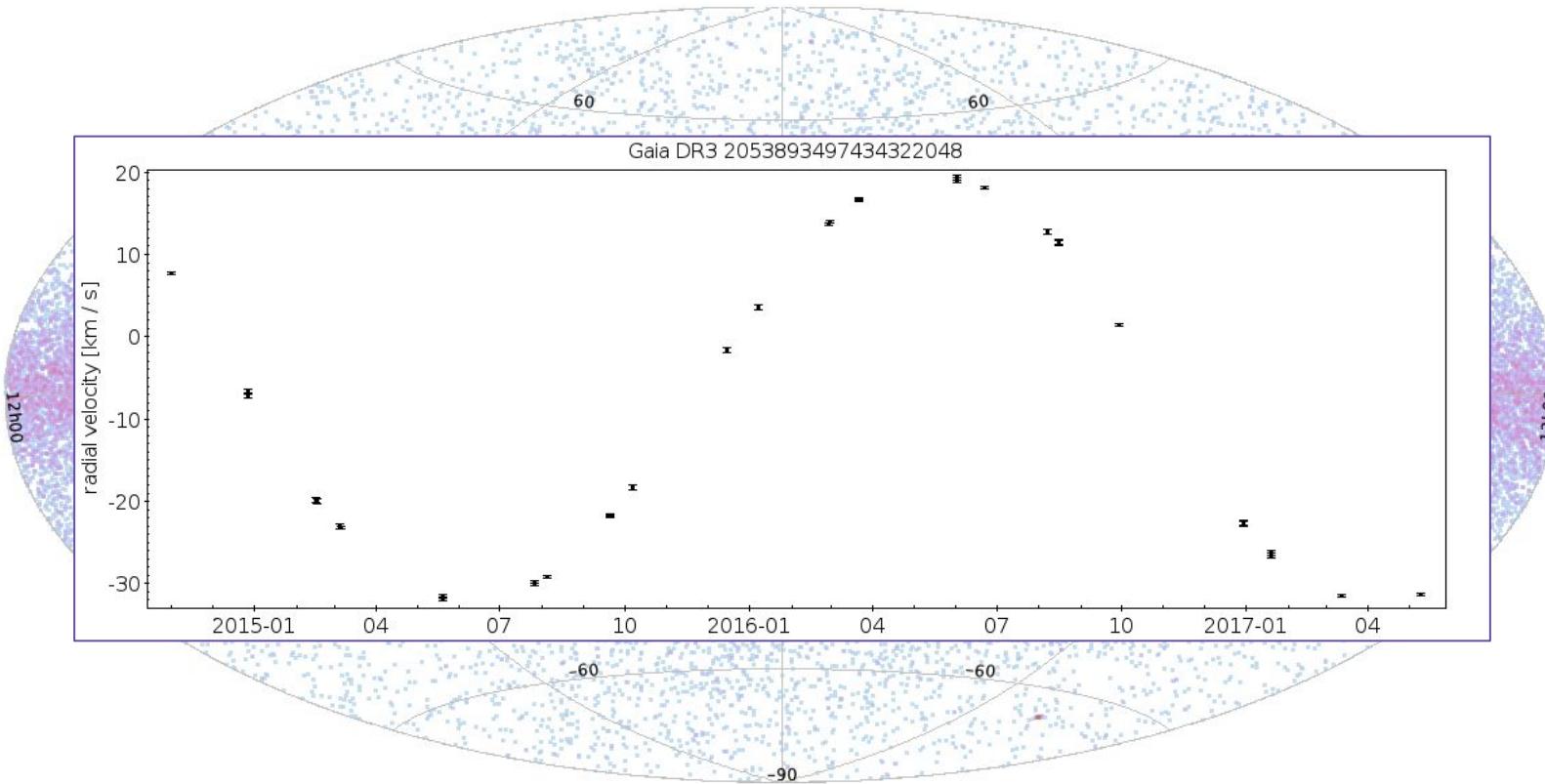
Lebzelter et al. 2023, A&A 674, A15

Gaia DR3 catalog of long-period variables



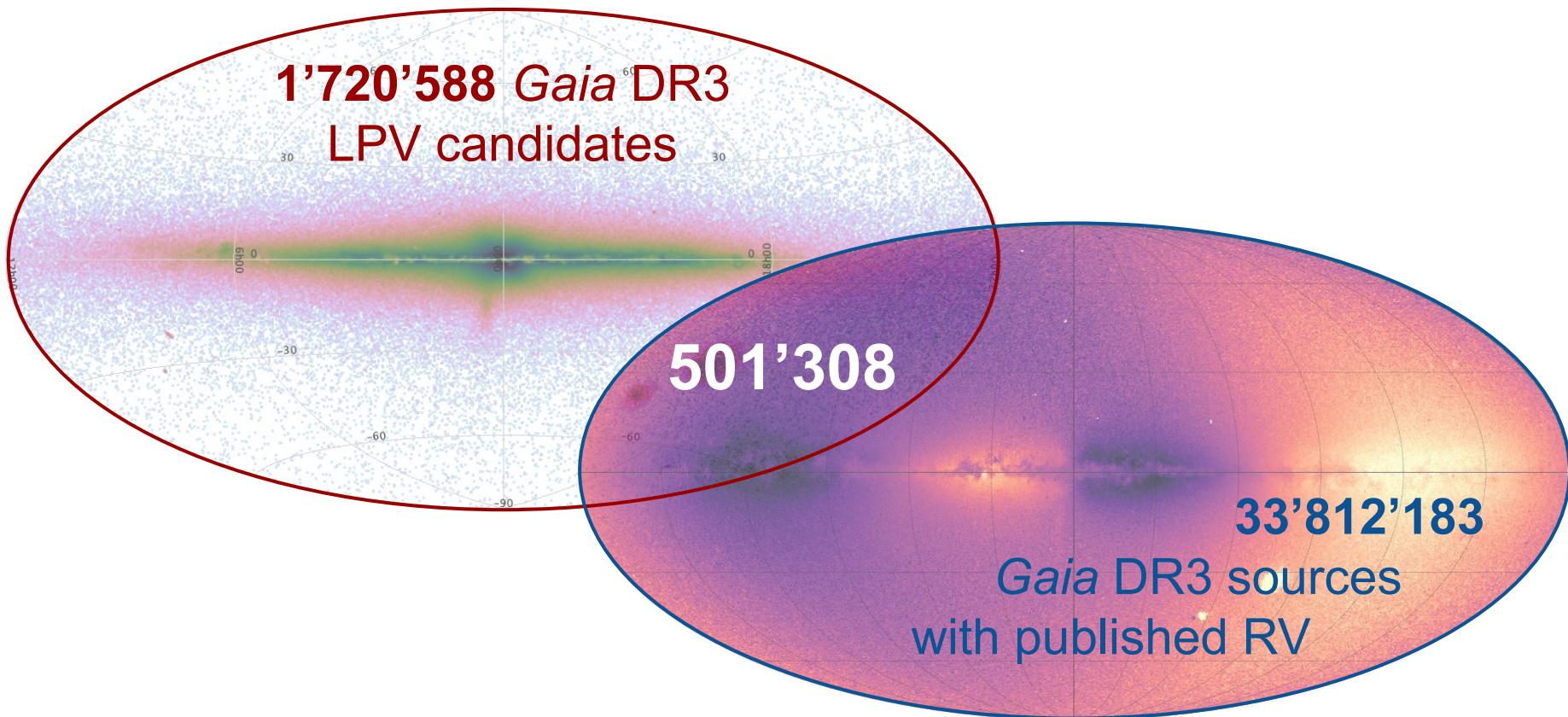
Lebzelter et al. 2023, A&A 674, A15

Gaia DR3 catalog of long-period variables

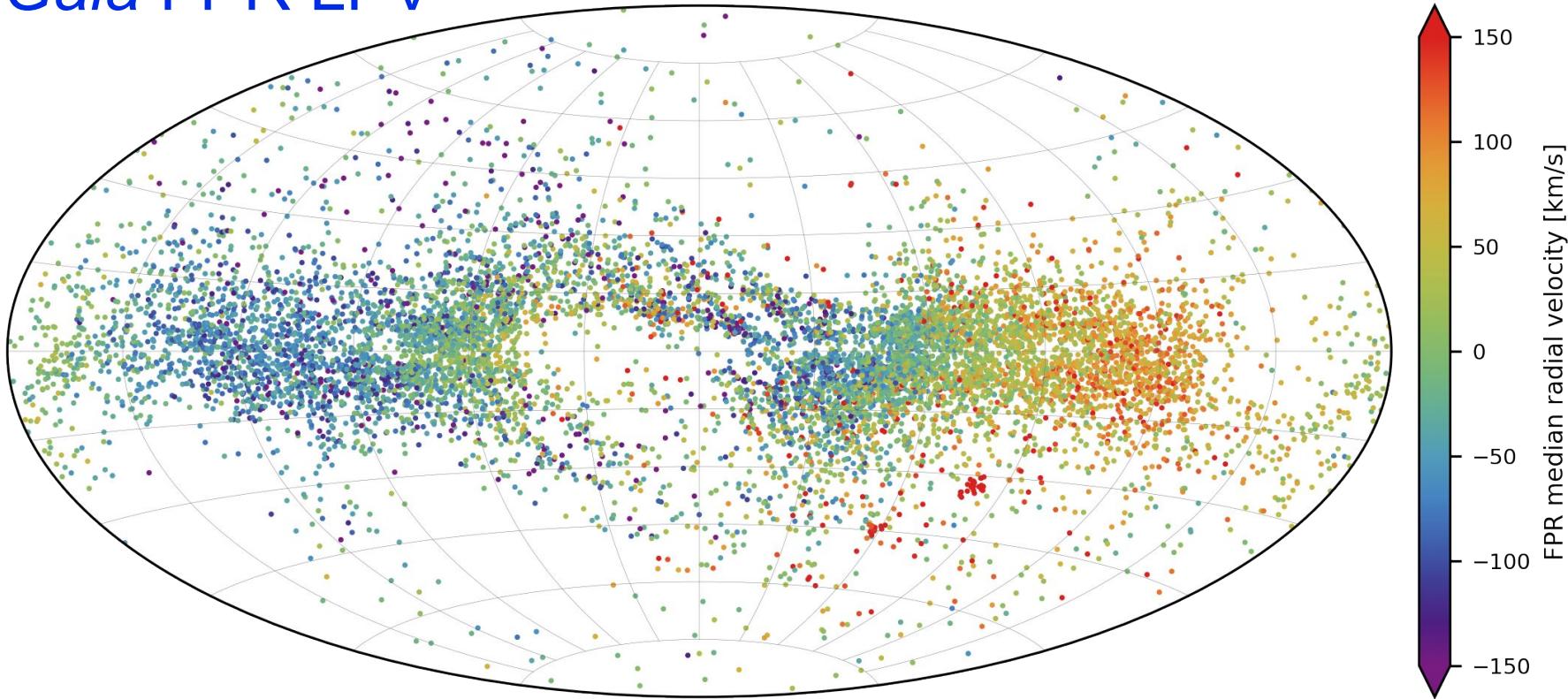


Lebzelter et al. 2023, A&A 674, A15

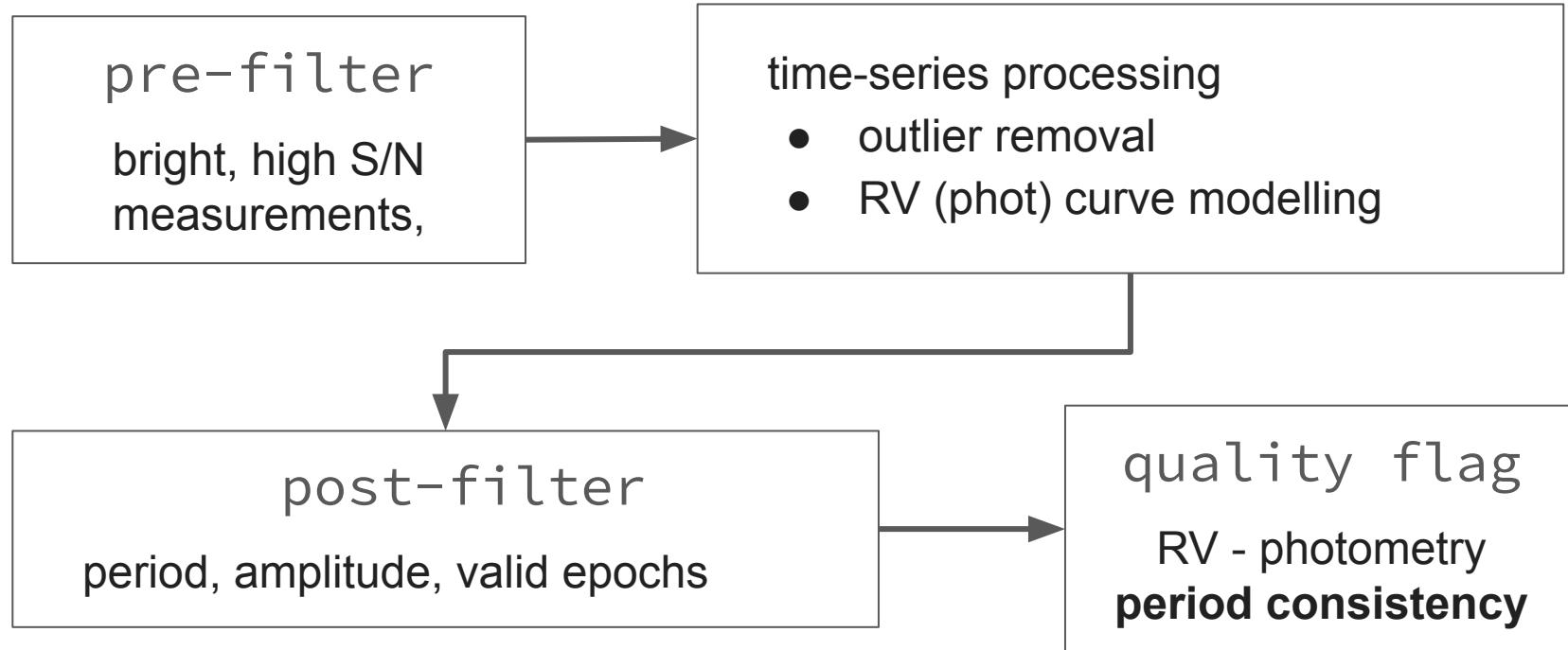
Gaia FPR LPV: Catalog construction



Gaia FPR LPV



FINAL SAMPLE: **9'614**



FPR content:

9'614

Top Quality Sample:

6'093

Data tables

gaiafpr.vari_long_period_variable

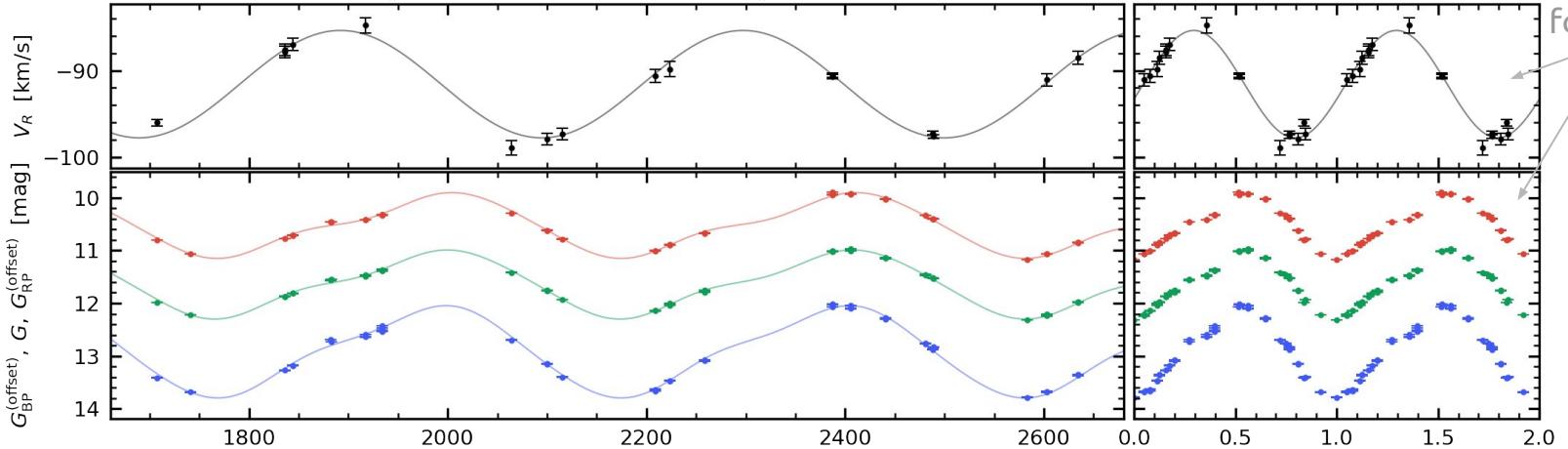
- frequency_rv
- frequency_error_rv
- amplitude_rv
- flag_rv

gaiafpr.vari_epoch_radial_velocity

gaiafpr.vari_rad_vel_statistics

The screenshot shows the Gaia Archive search interface. The top navigation bar includes links for European Space Agency, About ESAC, Sign In, and a bell icon. The main header says "gaia archive". Below it, there are tabs for HOME, SEARCH, SINGLE OBJECT, VISUALISATION, and HELP, with "Advanced (ADQL)" being the active tab. A search bar contains the text "gaia". To the right of the search bar is a "Job name:" input field and a "Query examples" link. The main content area shows a table with one row, labeled "1". The table has columns for Status, Job, Creation date, Num. rows, and Size. The status column shows "No results found". At the bottom of the interface, there are buttons for "Reset Form" and "Submit Query", along with a "Ctrl+Space for query autocompletion" note. The bottom right corner features a "Cookie policy" link and a "v3.3.2" version indicator.

246183406538091776: $P_{V_R} = 405.2$ days, $P_G = 408.0$ days, $A_{V_R} = 6.18$ km/s, $A_G = 0.58$ mag

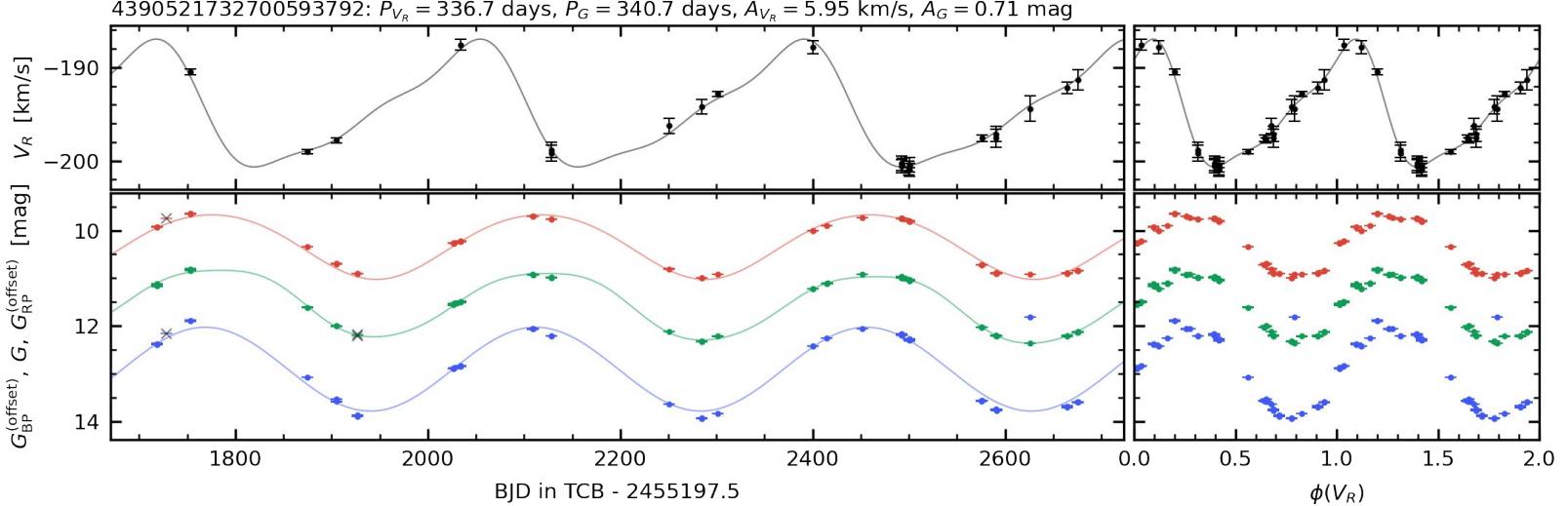


folded with RV period

example time series:

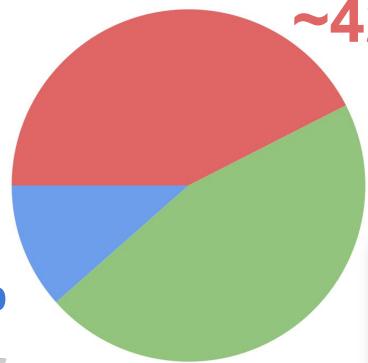
Mira variables
pulsating stars

4390521732700593792: $P_{V_R} = 336.7$ days, $P_G = 340.7$ days, $A_{V_R} = 5.95$ km/s, $A_G = 0.71$ mag



FPR content by variability types

Total ^(a)		
LPV	Pulsation	4084
	LSP	4421
ELL		1109
Total		9614



ELL
~12%

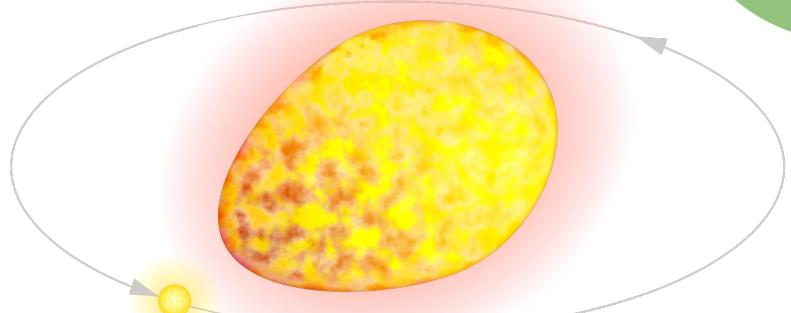


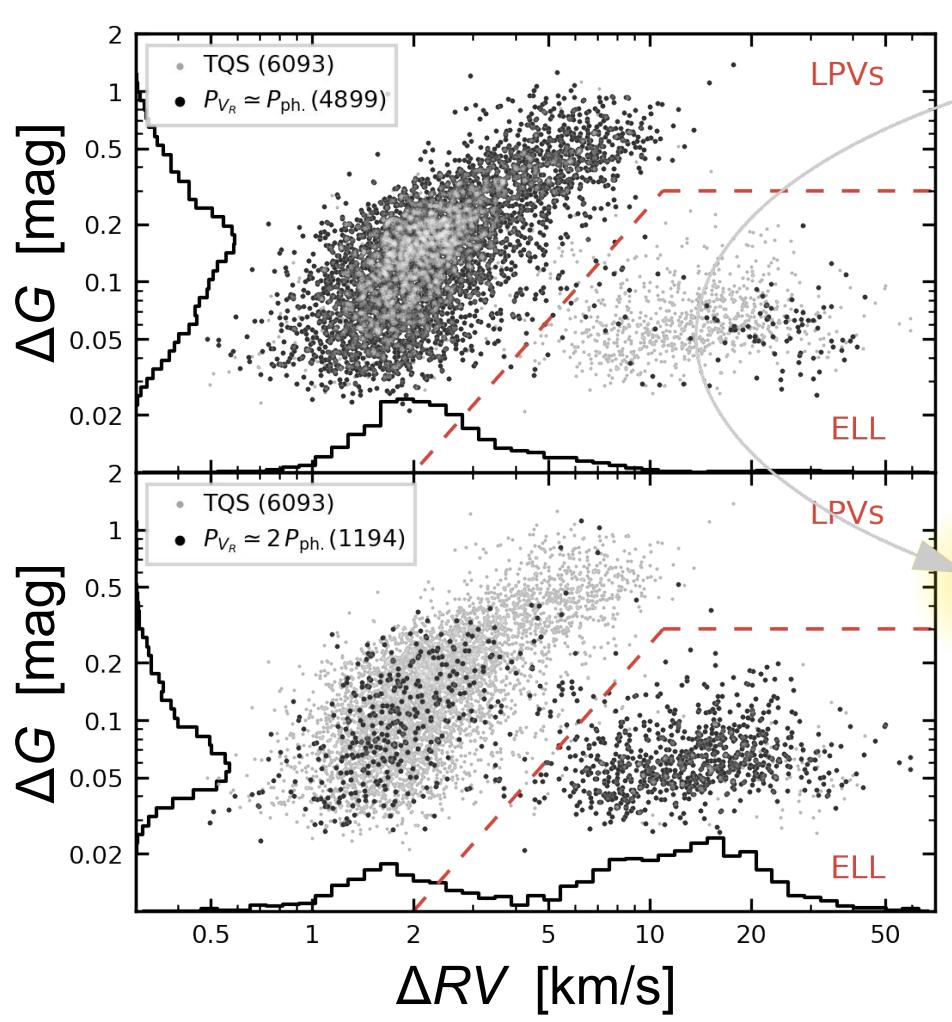
Illustration © Michele Trabucchi

Puls.
~42%

LSP
~46%

Artist's Impression
© Matylda Soszyńska





ellipsoidal red giant variables of various types

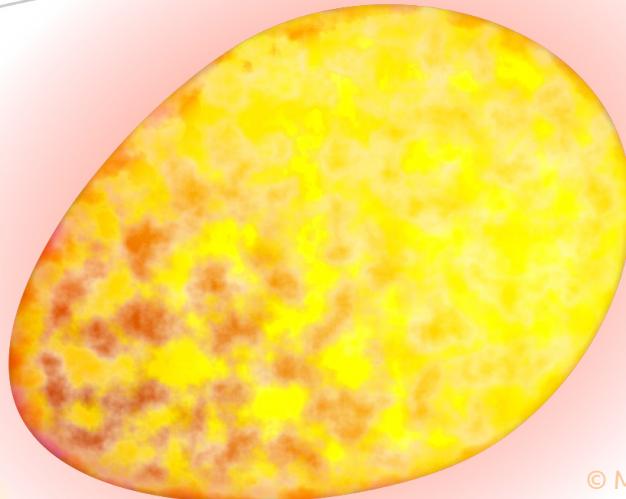
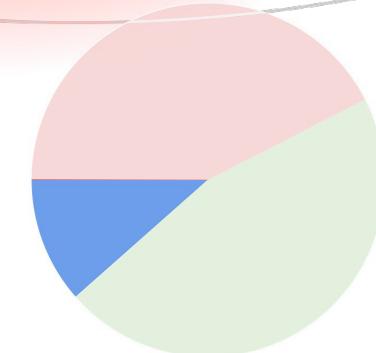
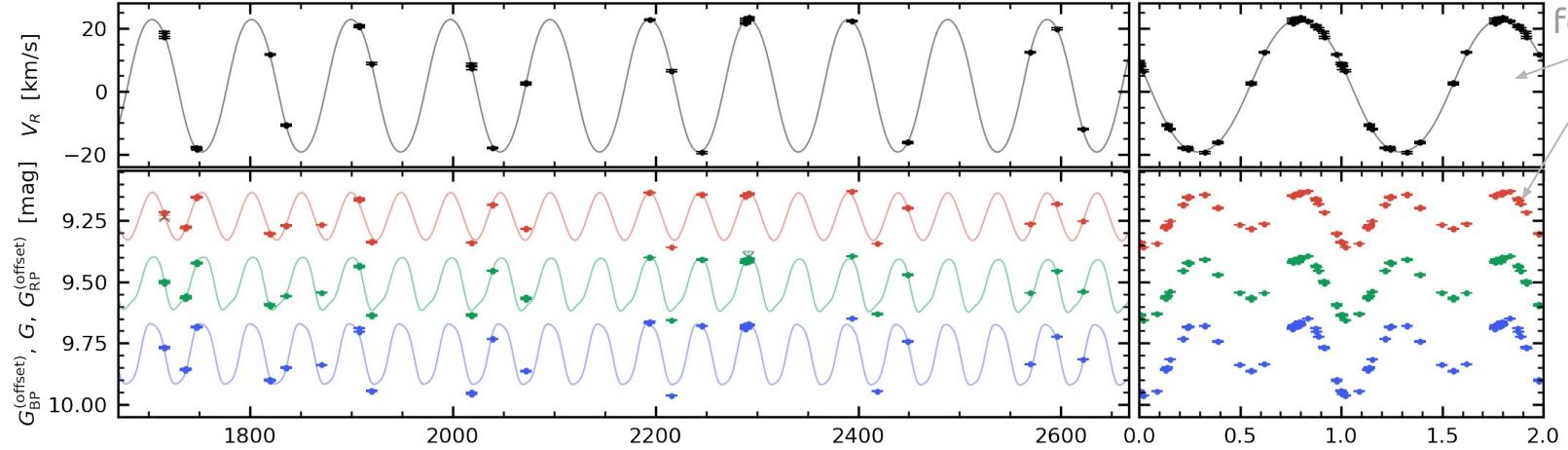


Illustration
© Michele Trabucchi

ELL
~12%



4457549301558370048: $P_{V_R} = 98.1$ days, $P_G = 49.0$ days, $A_{V_R} = 21.69$ km/s, $A_G = 0.11$ mag

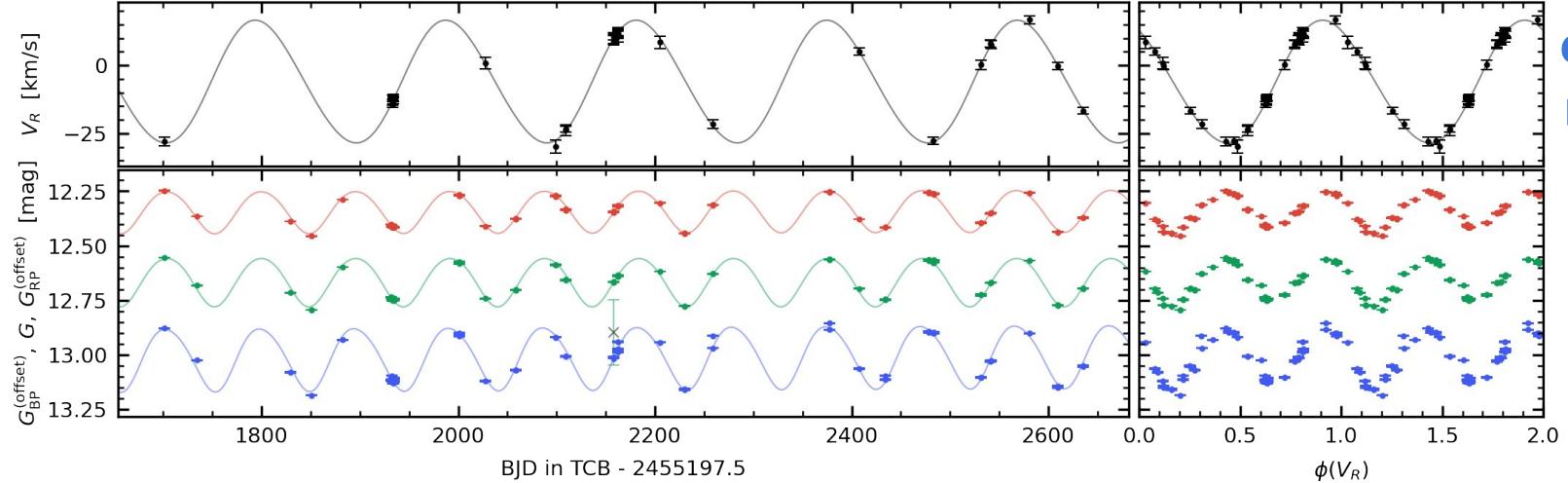


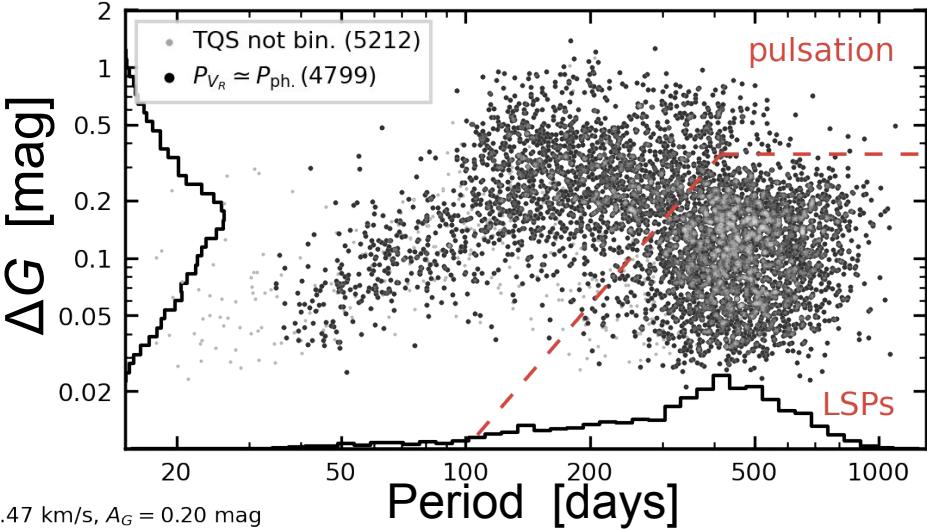
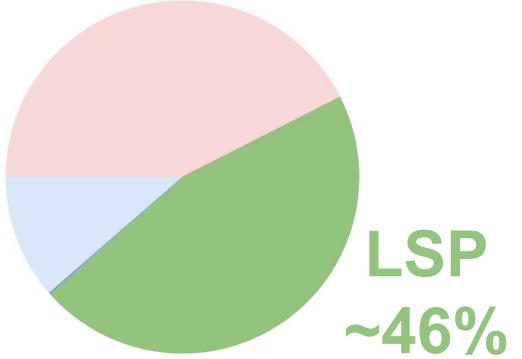
folded with RV period

example
time
series:

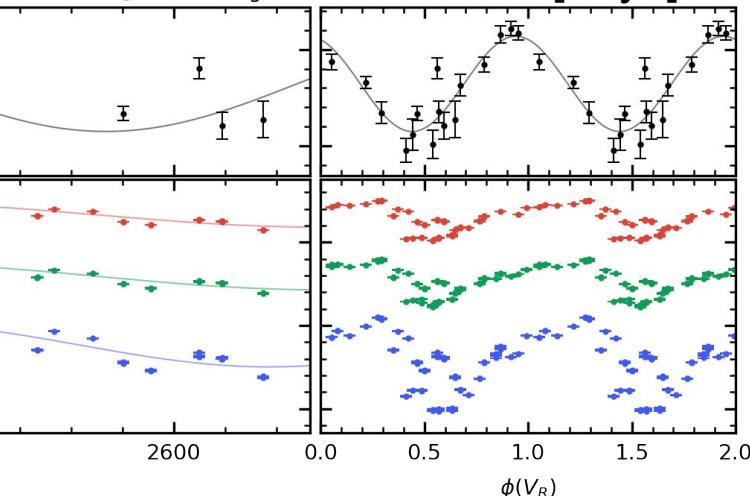
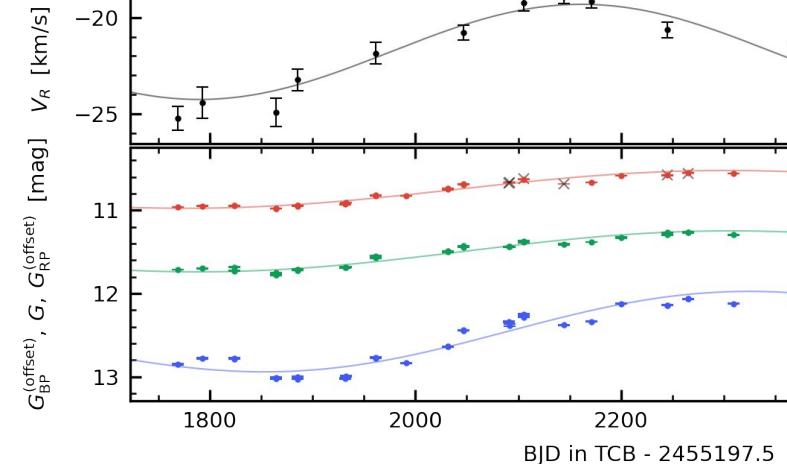
**ellipsoidal
red giants**

6064470392933416448: $P_{V_R} = 193.7$ days, $P_G = 96.0$ days, $A_{V_R} = 22.42$ km/s, $A_G = 0.11$ mag





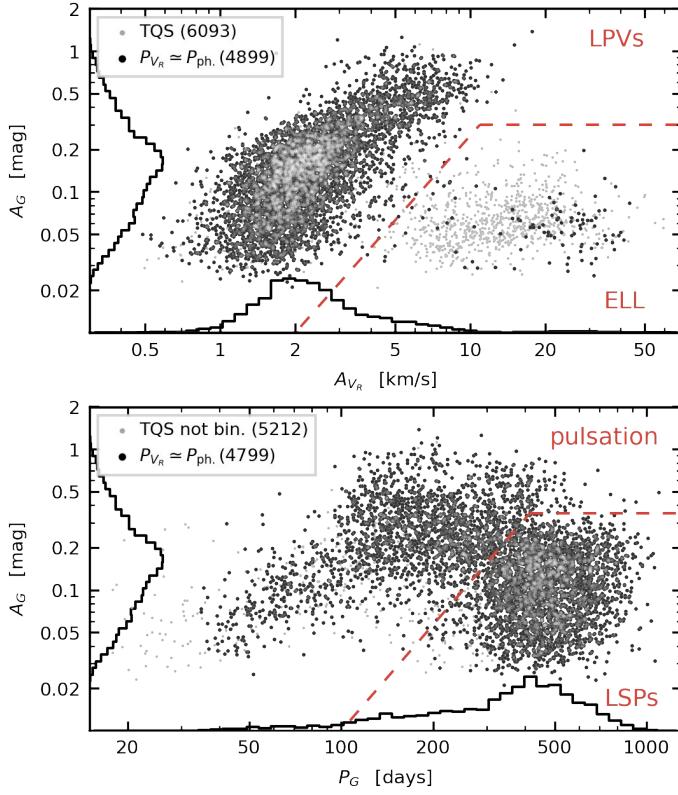
1968599531437522176: $P_{V_R} = 743.9$ days, $P_G = 955.8$ days, $A_{V_R} = 2.47$ km/s, $A_G = 0.20$ mag



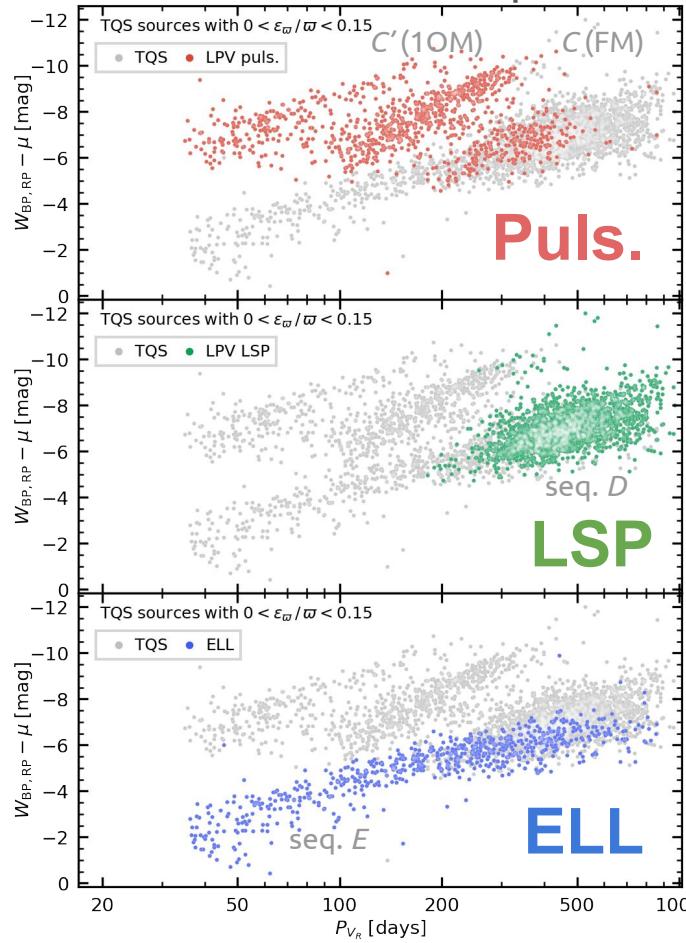
example
time
series:

long
secondary
period
variability

Classification on P , ΔG , ΔV_R ...



... consistent with P sequences



parallax
uncertainty
better than
15%
+
top quality
sample

**High mass function
ellipsoidal variables in the
Gaia Focused Product
Release: searching for
black hole candidates in
the binary zoo**

Dominick M. Rowan, Todd A.

Thompson, Tharindu

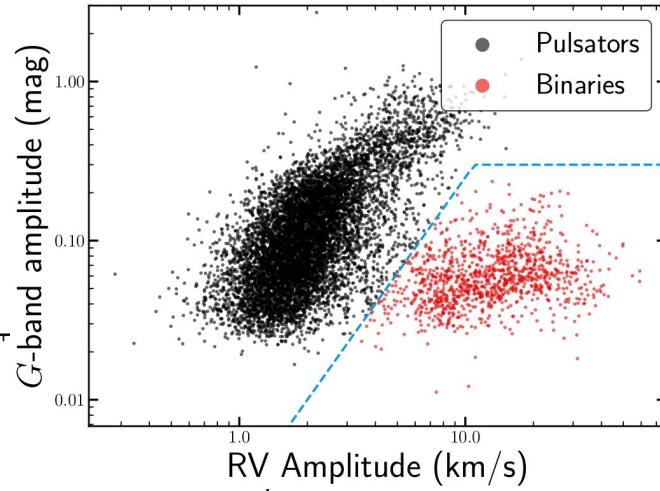
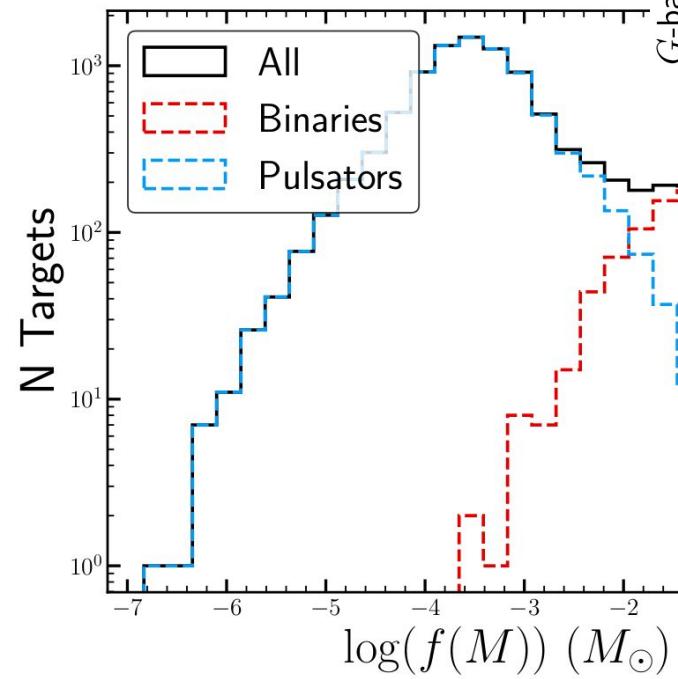
Jayasinghe, Christopher S.

Kochanek, Krzysztof Z.

Stanek

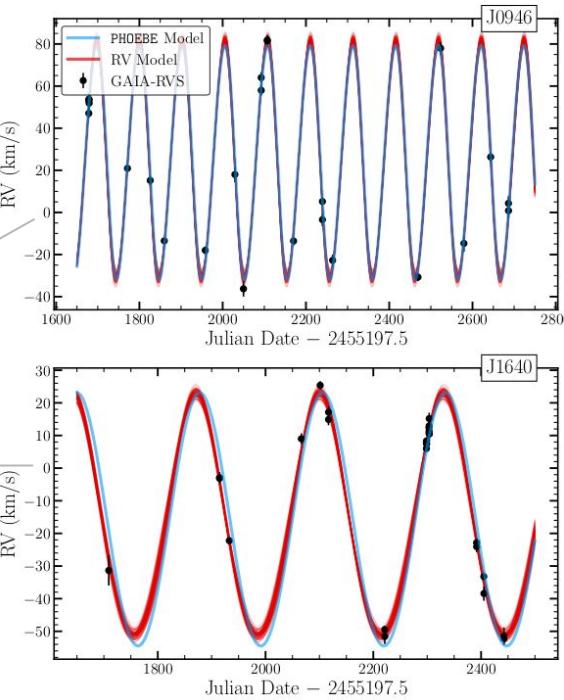
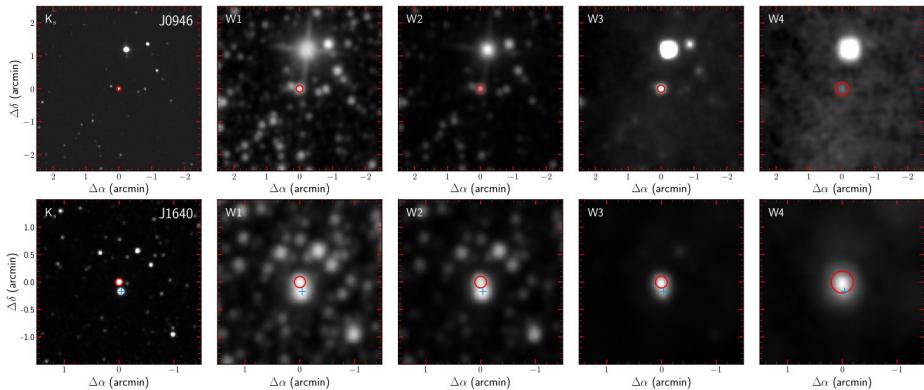
A search for massive
unseen stellar
companions variable star
systems found in Gaia
data.

The Open Journal of Astrophysics,
2024 | Vol. 7, id. 24



Candidates RGs with non-interacting, compact companion

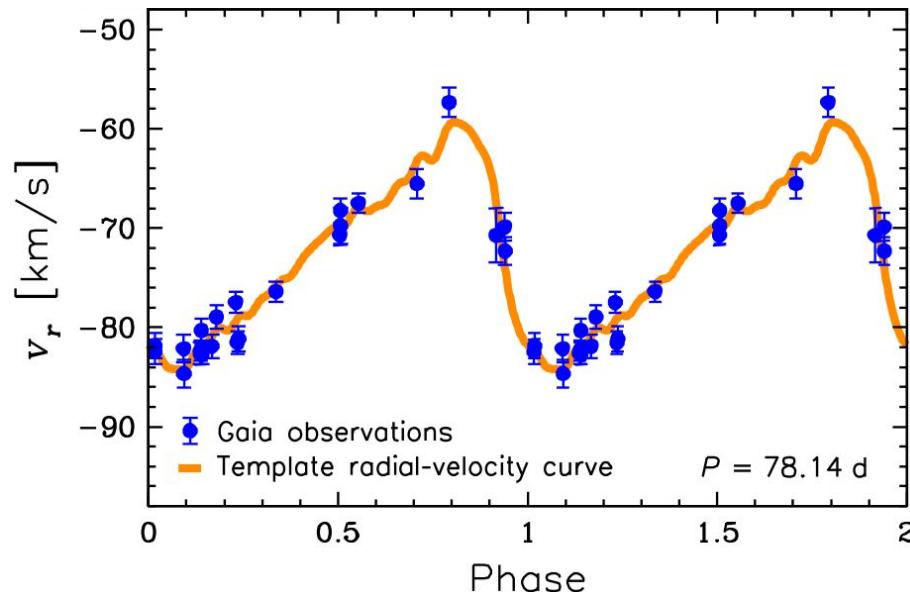
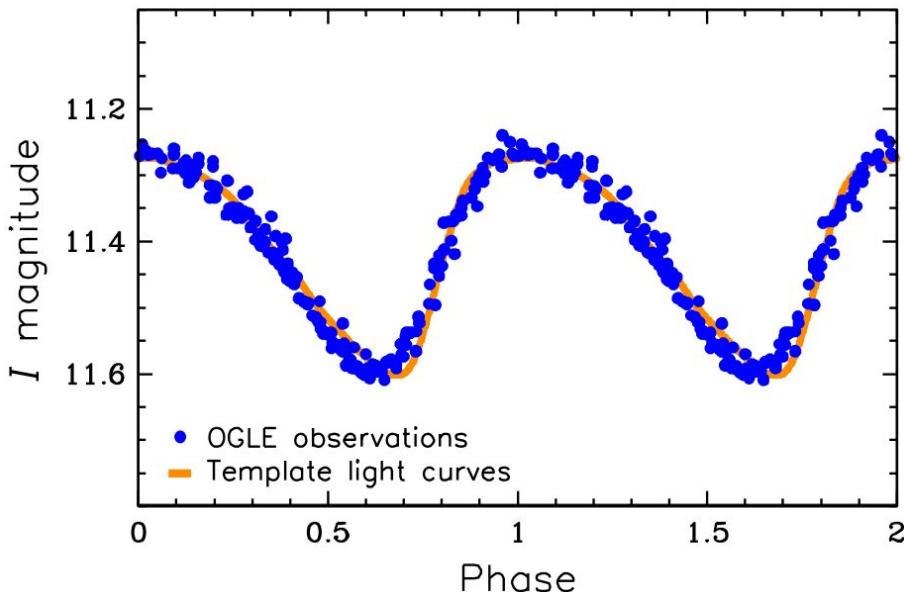
G (mag)	RUWE	P (day)	K (km/s)	$f(M)$ (M_\odot)	Distance (pc)	ELL
11.1	1.274	145.8	59.2	3.13	3600^{+200}_{-300}	\times
12.3	1.065	680.4	29.8	1.86	5300^{+600}_{-500}	✓
13.2	1.037	102.4	54.8	1.75	4300^{+200}_{-200}	✓
12.9	0.987	113.3	46.5	1.18	3800^{+300}_{-200}	\times
13.8	1.265	788.4	24.9	1.26	5600^{+1100}_{-700}	\times
13.2	1.559	229.8	36.6	1.17	3800^{+400}_{-400}	✓
7.7	2.262	670.7	26.4	1.28	1700^{+200}_{-200}	✓
10.6	1.181	289.6	34.8	1.27	2500^{+100}_{-100}	\times



Discovery of the Longest-period Classical Cepheid in the Milky Way

I. Soszyński¹ , D. M. Skowron¹ , A. Udalski¹ , P. Pietrukowicz¹ , M. Gromadzki¹ , M. K. Szymański¹ , J. Skowron¹ , P. Mróz¹ , R. Poleski¹ , S. Kozłowski¹ , P. Iwanek¹ , M. Wrona¹ , K. Ulaczyk^{1,2} , K. Rybicki^{1,3} , and M. Mróz¹ 

OGLE-GD-CEP-1884

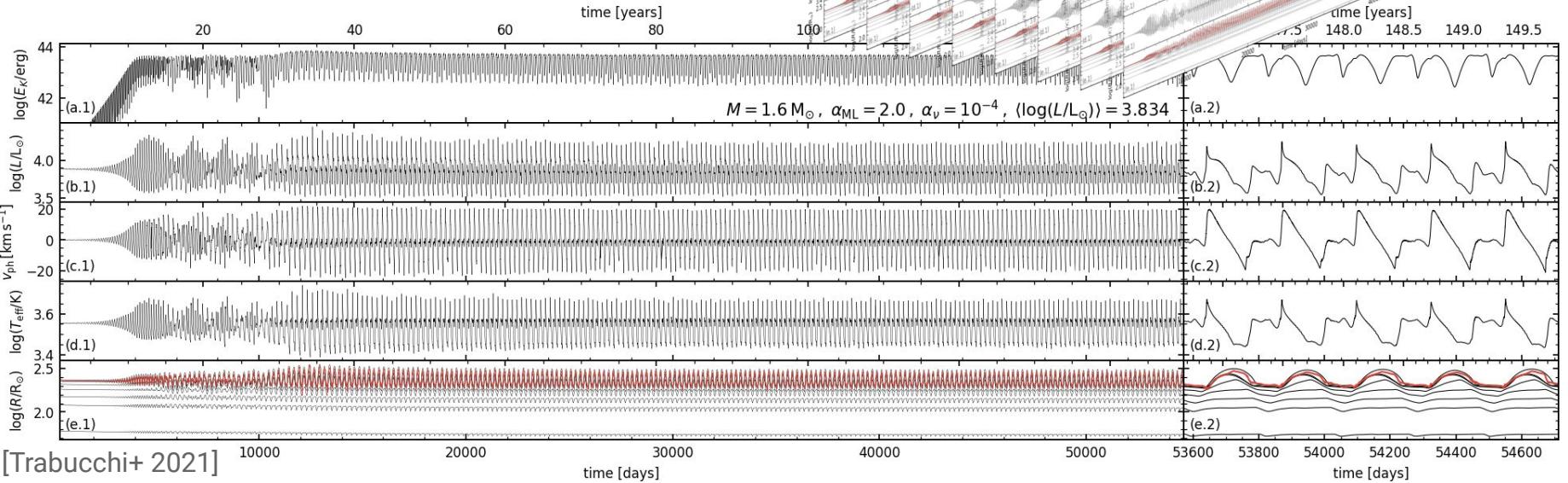


Long-Period Variables as distance and age indicators in the era of *Gaia* and LSST

Michele Trabucchi^{1,2} 

¹Dipartimento di Fisica e Astronomia Galileo Galilei, Università degli studi di Padova, Vicolo dell’Osservatorio 3, I-35122 Padova, Italy. email: michele.trabucchi@unipd.it

²Department of Astronomy, University of Geneva, Ch. Pegasi 51, 1920 Versoix, Switzerland

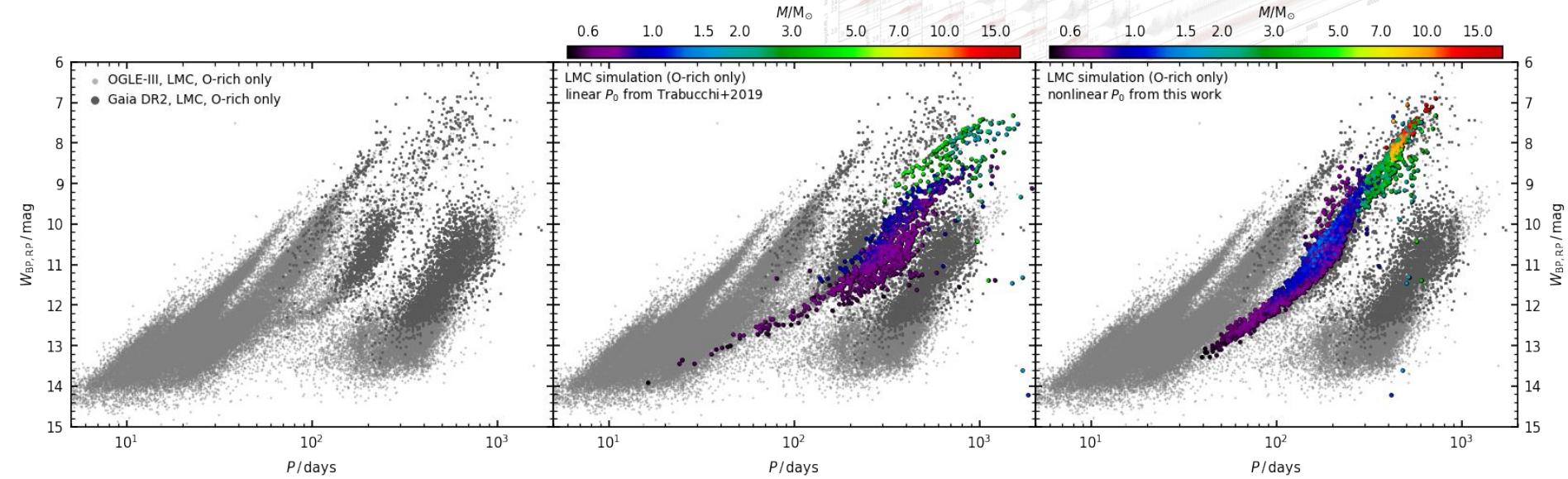
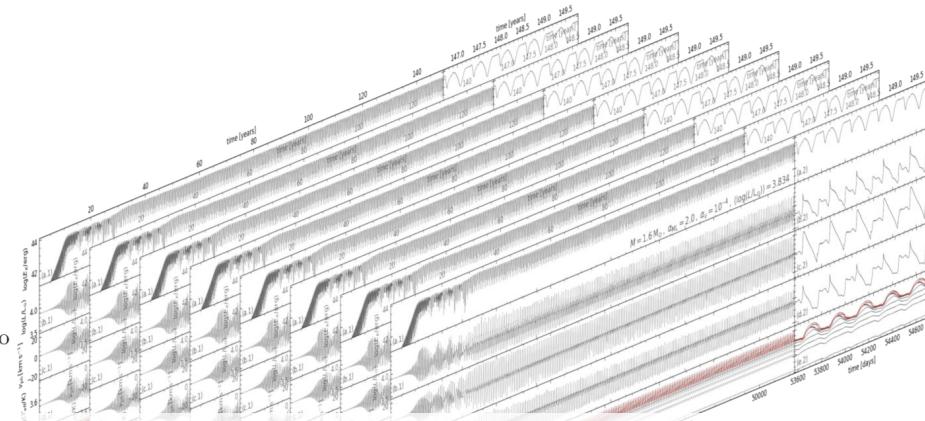


Long-Period Variables as distance and age indicators in the era of *Gaia* and LSST

Michele Trabucchi^{1,2} 

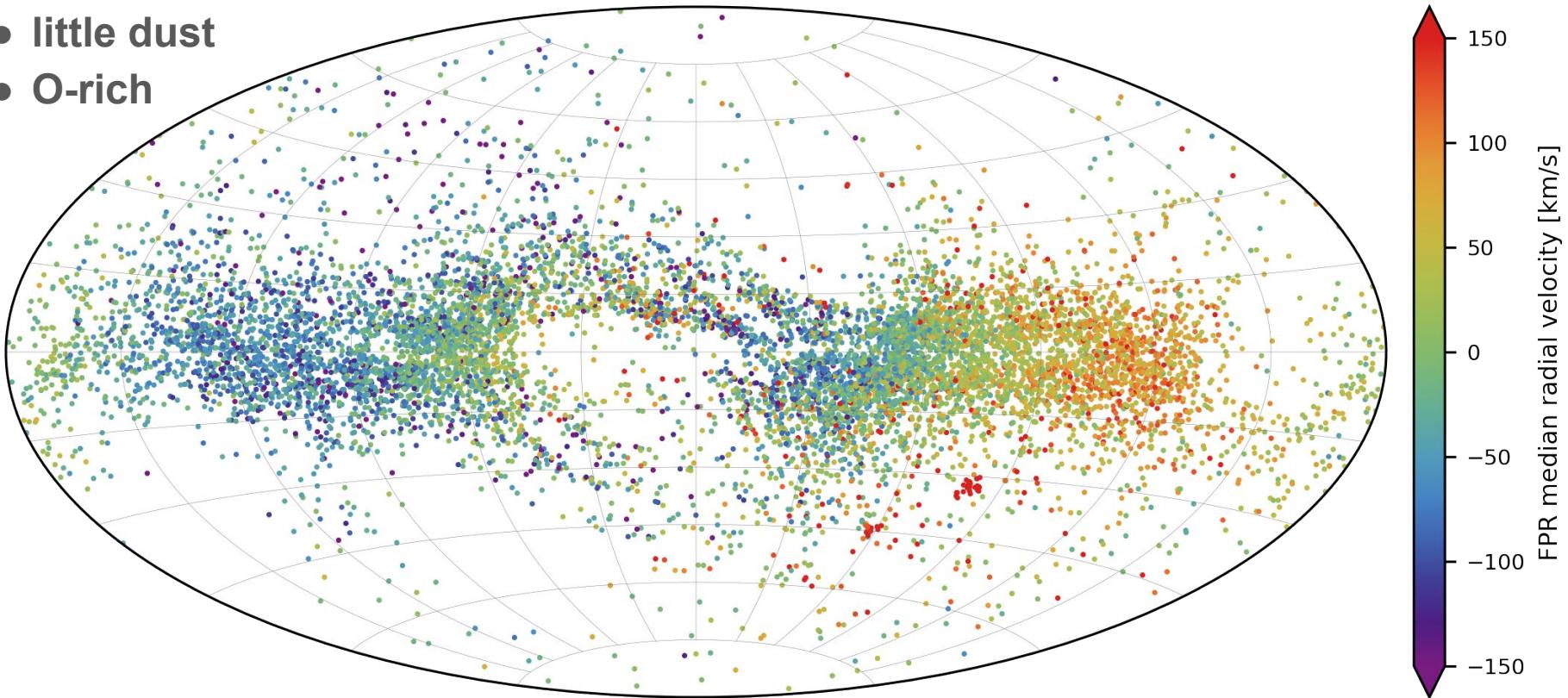
¹Dipartimento di Fisica e Astronomia Galileo Galilei, Università degli studi di Padova, Vicolo dell’Osservatorio 3, I-35122 Padova, Italy. email: michele.trabucchi@unipd.it

²Department of Astronomy, University of Geneva, Ch. Pegasi 51, 1920 Versoix, Switzerland



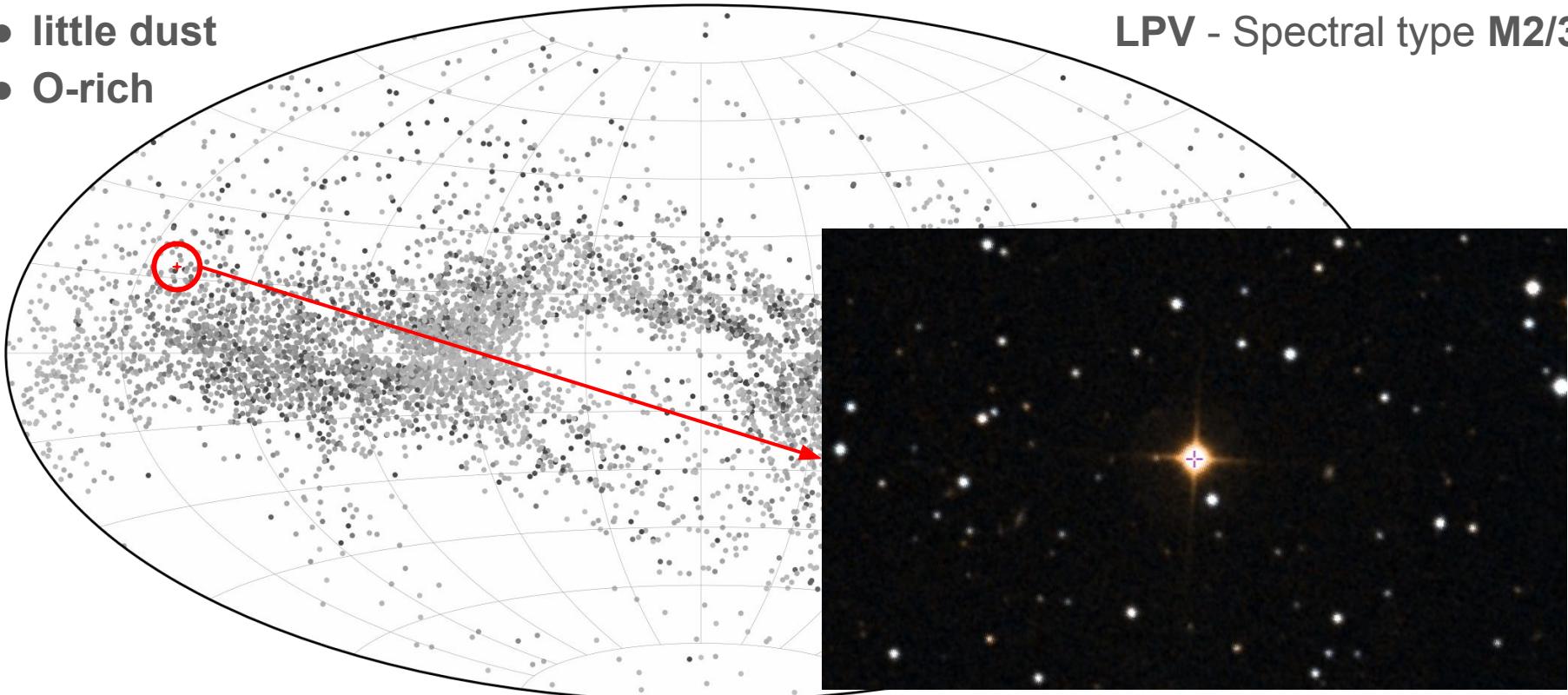
Selection on *Gaia* + 2MASS data:

- Parallax error < $\sim 15\%$
- **little dust**
- O-rich



Selection on *Gaia* + 2MASS data:

- Parallax error < $\sim 15\%$
- **little dust**
- O-rich



Gaia DR3 496501865848362496

IRAS F04574+7030

LPV - Spectral type M2/3

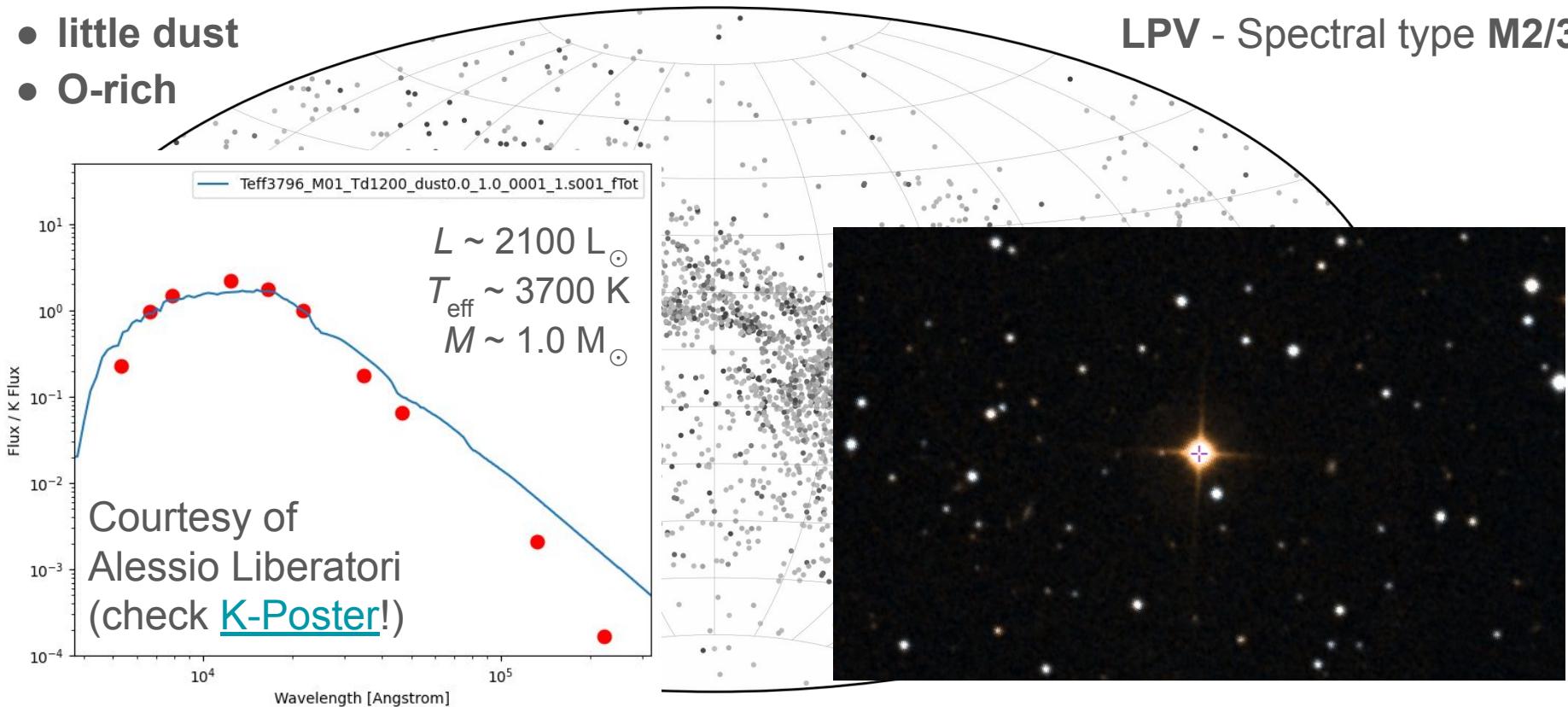
Selection on *Gaia* + 2MASS data:

- Parallax error < $\sim 15\%$
- little dust
- O-rich

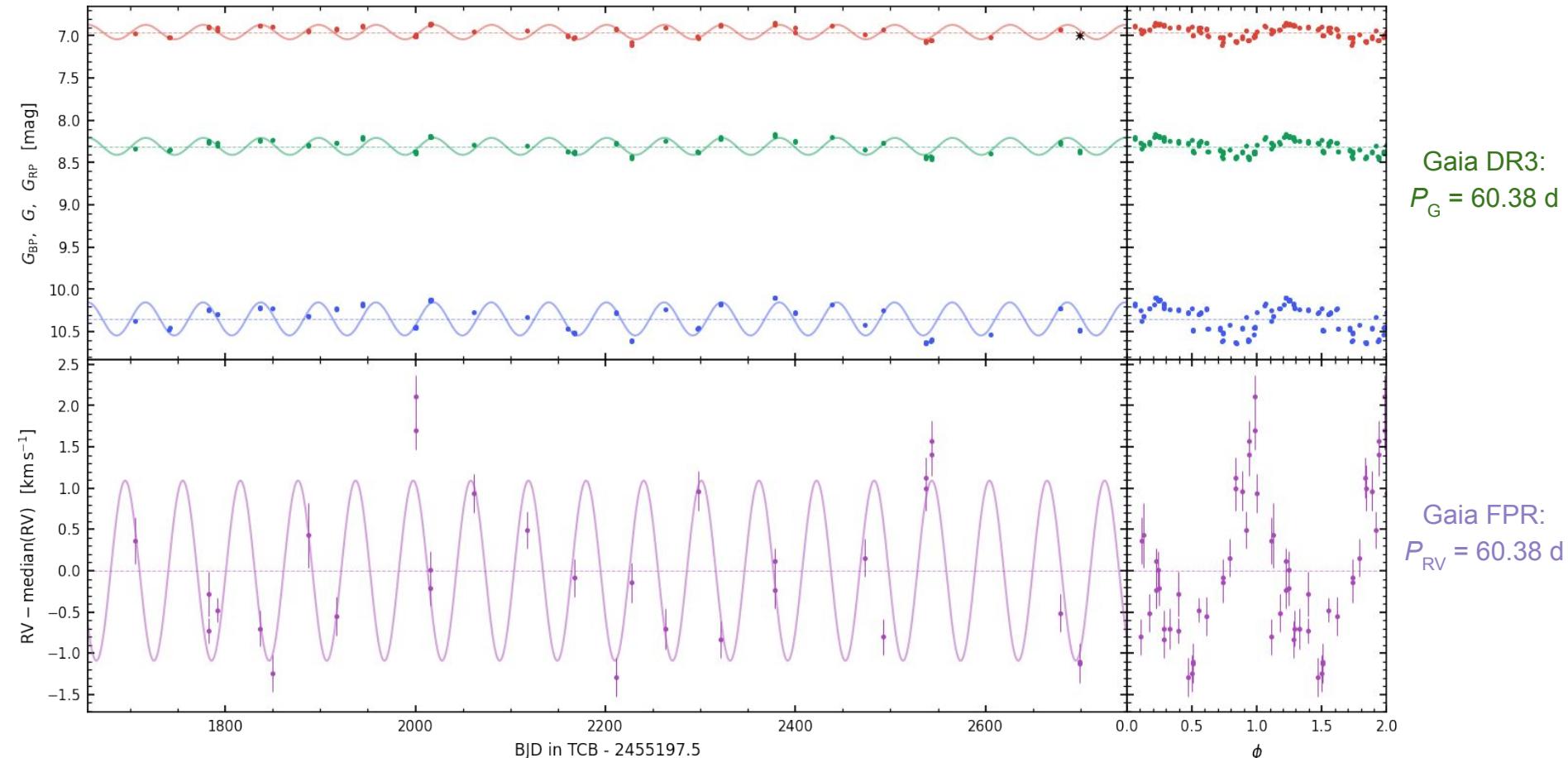
Gaia DR3 496501865848362496

IRAS F04574+7030

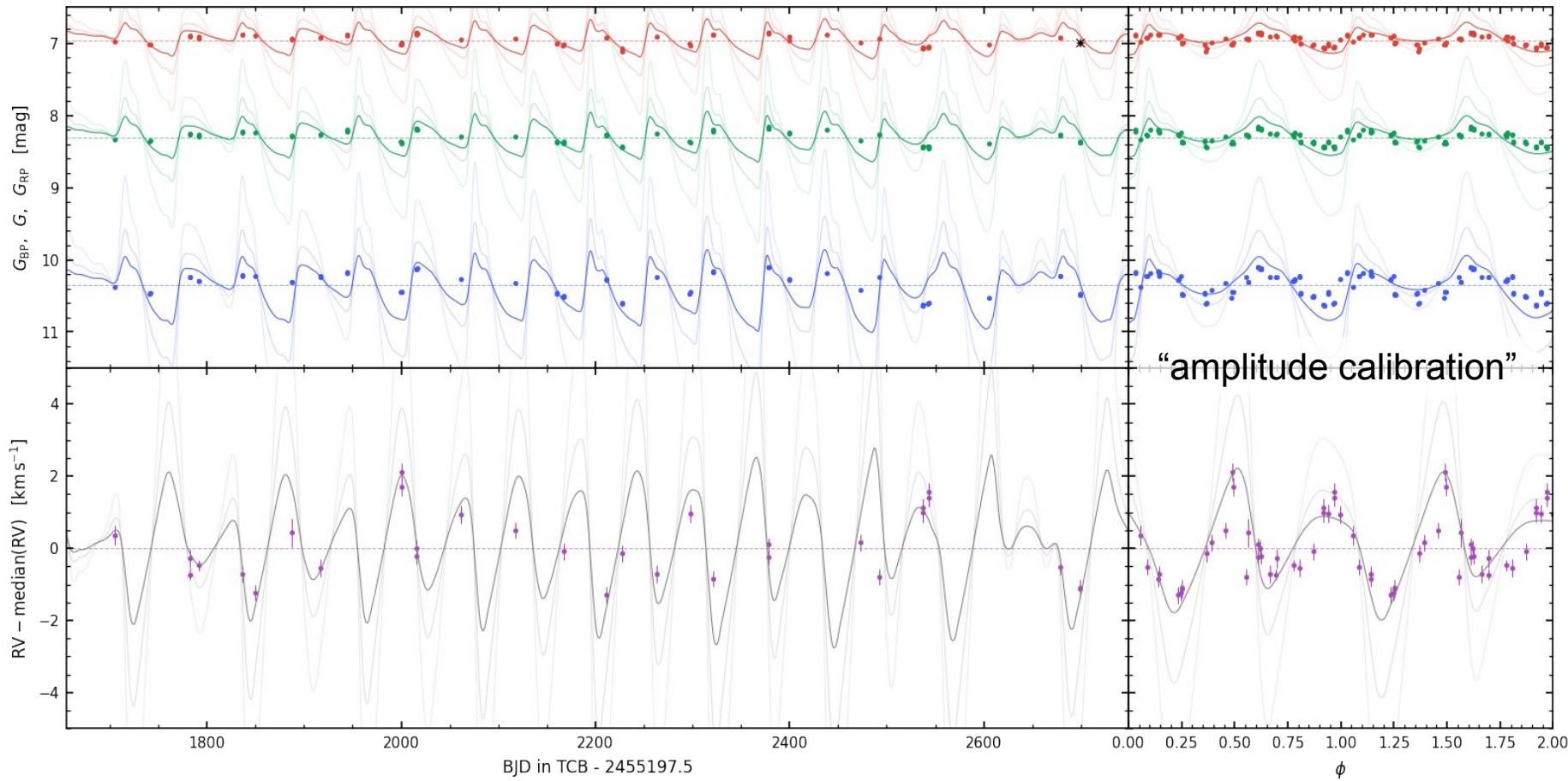
LPV - Spectral type M2/3



Multi-band (G, RP, BP, RV) Lomb-Scargle periodogram ([VanderPlas & Ivezić, 2015](#)): $P_{G,RP,BP,RV} = 60.64$ days



1D hydrodynamic model ([Trabucchi+2021](#)): $P_{\text{model}} = 60.2$ days | $L \sim 2500 L_{\odot}$ | $T_{\text{eff}} \sim 3550$ K | $M = 1.0 M_{\odot}$



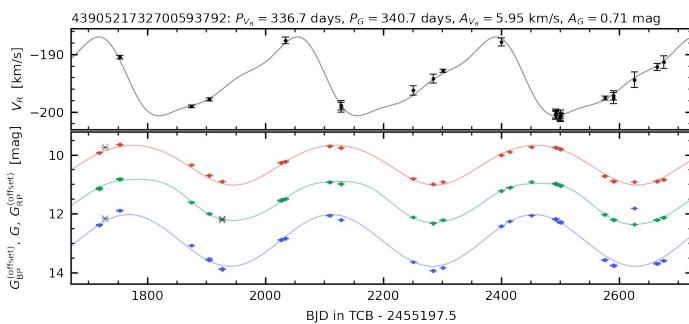
CONVERGENCE



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DI PADOVA

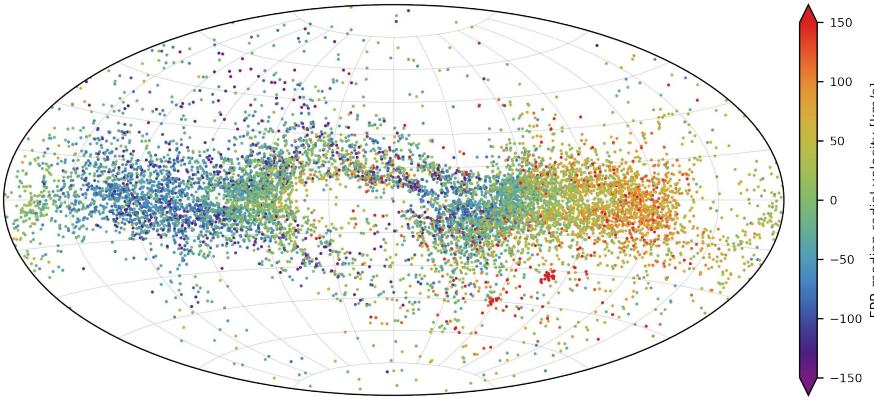
STARS
@UNIPD

SUPPORTING TALENT IN RESEARCH
©UNIVERSITY OF PADUA



Gaia Focused Product Release

Radial velocity time series of long-period variables



- epoch RVs of $\sim 10^4$ LPVs... and more!
- $\sim 10\text{-}100$ times larger than literature
- *top quality sample*
- simultaneous $G, G_{\text{BP}}, G_{\text{RP}}, \text{RV}$ time series
- 34 months (> 1000 d) observations
- ~ 20 RV epochs per time series
- pulsation, LSP, and ellipsoidal RGs
- classification consistent with PLD
- high-quality data: preparation for DR4

2023 | Astronomy & Astrophysics,
Volume 680, id.A36, 38 pp.