Long Period Variables as seen by LSST

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LSST@Europe3 - Lyon - June 11-15, 2018

Léo Girardi

P.I. Paola Marigo

Michele Trabucchi

Giada Pastorelli

Session 14A: LSST Workshop A: Stars

Simulations of the LSST stellar content: Milky Way and Magellanic Clouds

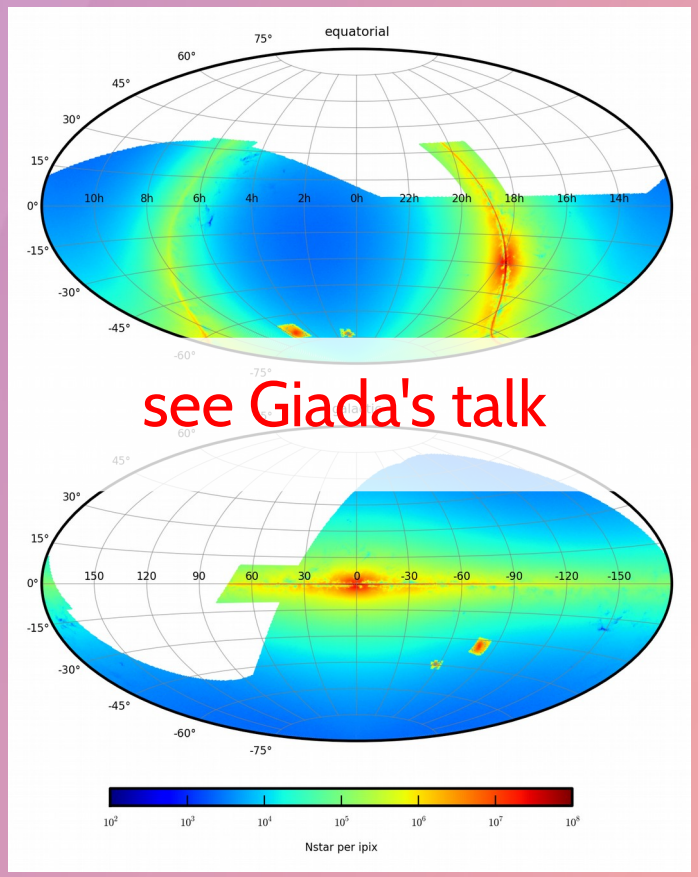
Yang Chen

Piero Dal Tio

Poster:

Binary Population Synthesis with TRILEGAL and BSE codes. Toward an information-rich simulated LSST catalog

Synthetic Stellar Populations Simulations



see Giada's talk

POPULATION SYNTHESIS

TRILEGAL

synthetic population

log(L)
log(Teff)
M
Mc
Z
X
C/O

GRID OF PULSATION MODELS

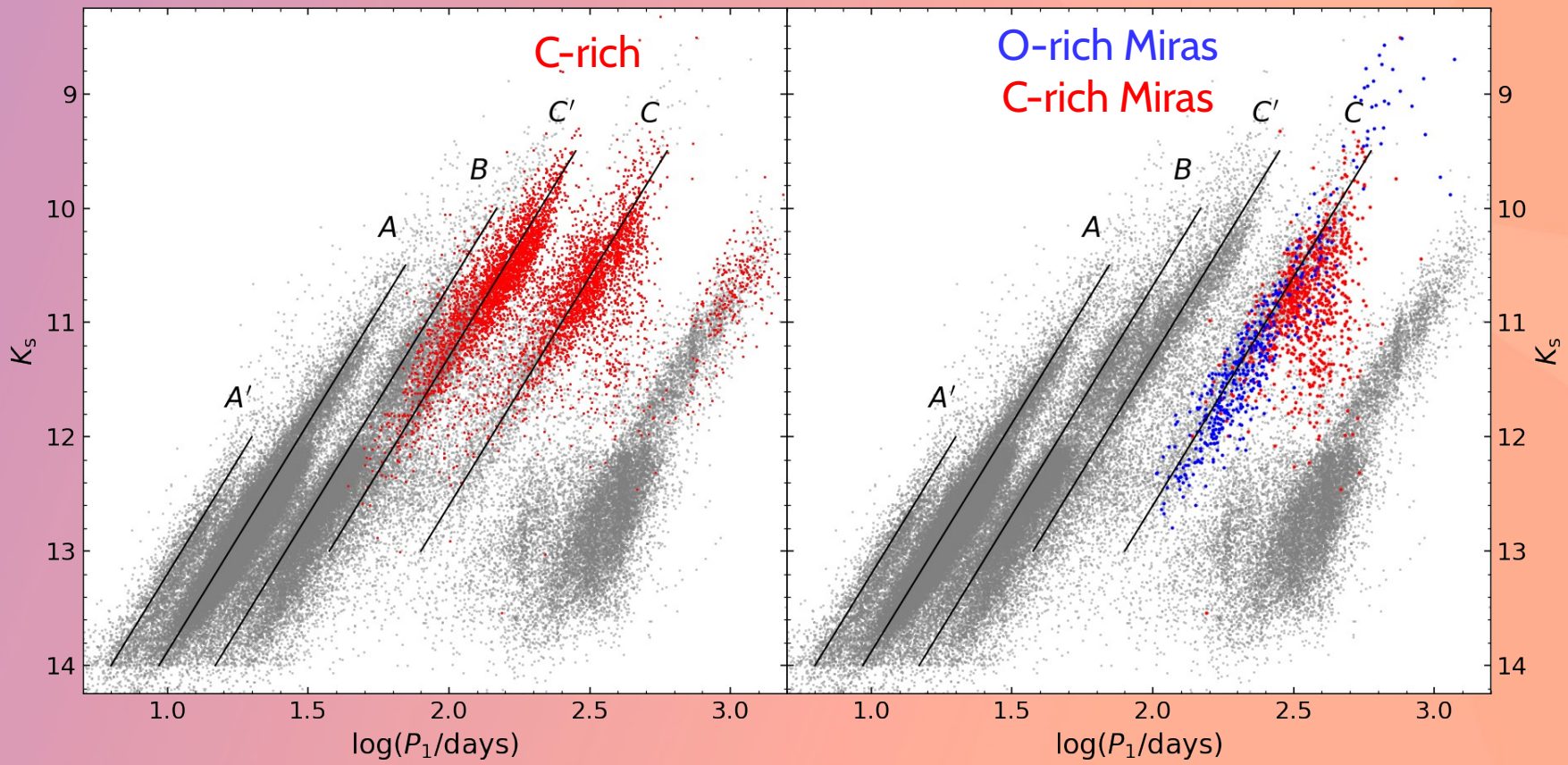
interpolation tools

synthetic population of Long Period Variables

Long Period Variables

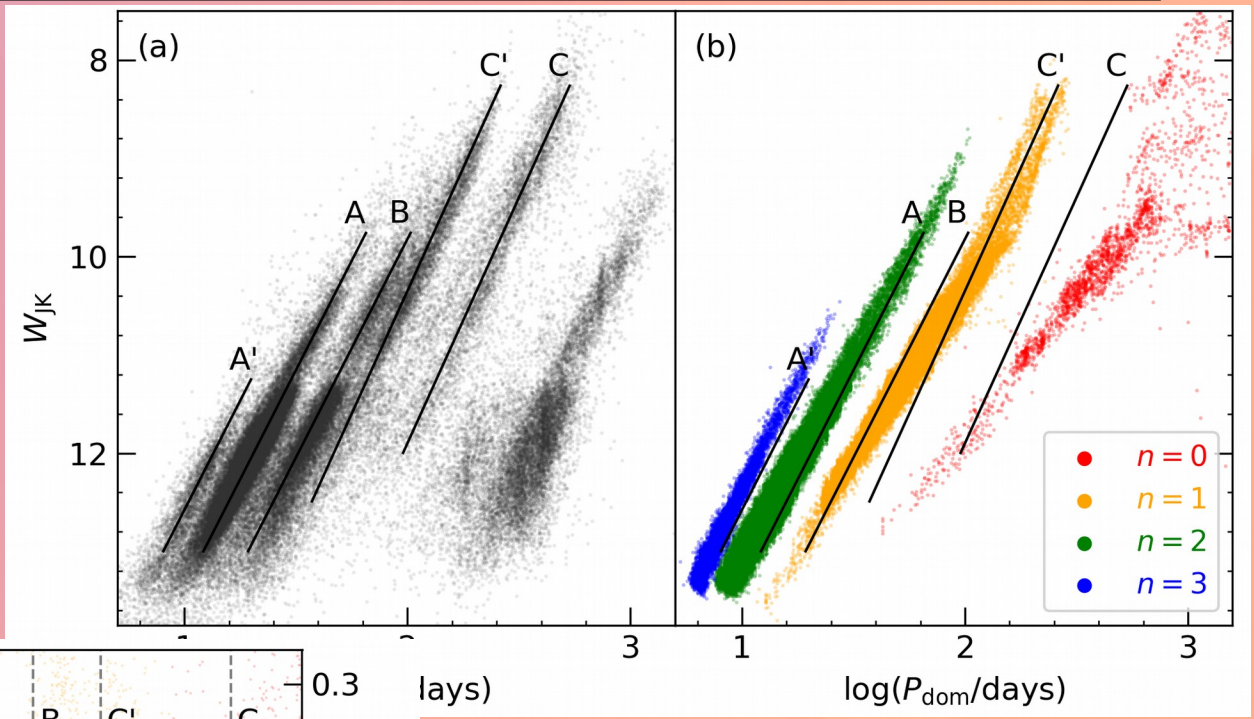
Periods: ~5 to >1000 days
Amplitudes (I-band): ~10^{-3} to >1 mag
Multi-periodic: 4(+?) radial orders, non-radial modes, LSPs
Evolutionary stages: TP-AGB, RGB, E-AGB, RSG
Variability types: Miras, SRVs, OSARGs

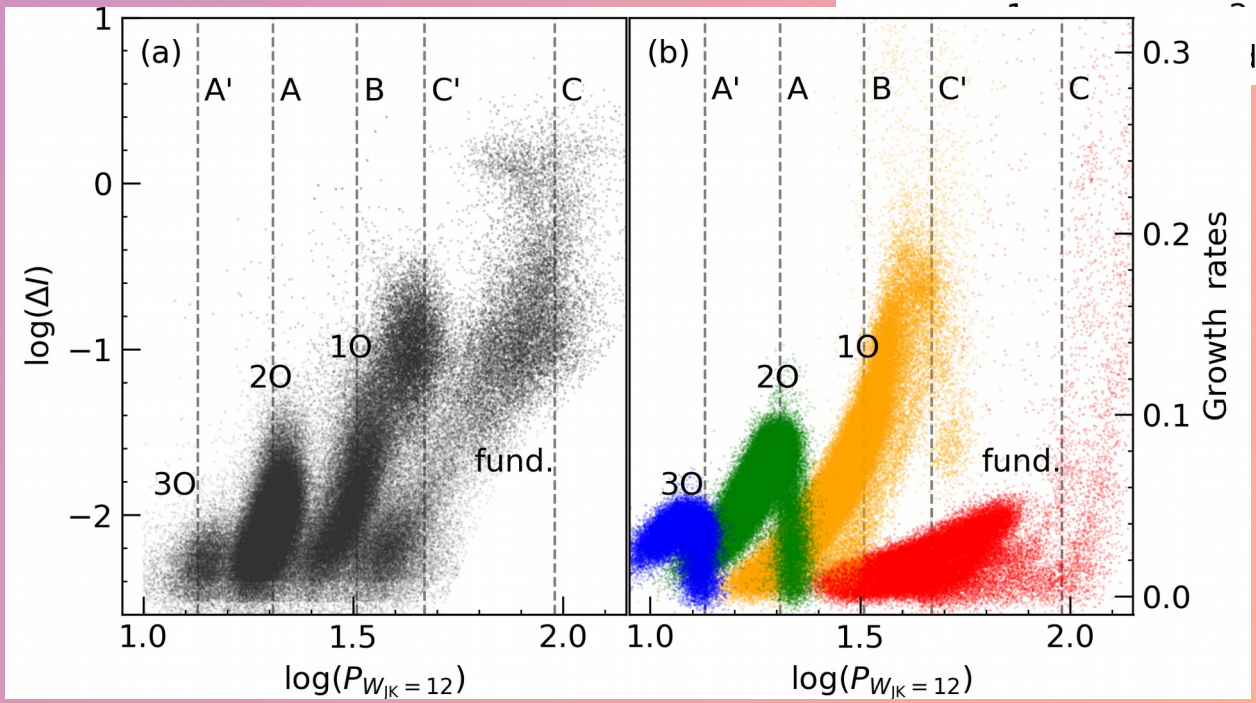
LPVs in the LMC (Soszynski+ 2009) OGLE3 + 2MASS



Simulations + LPV models

- unambiguous identification PL seq.
- growth rate - amplitude validation
- long secondary periods

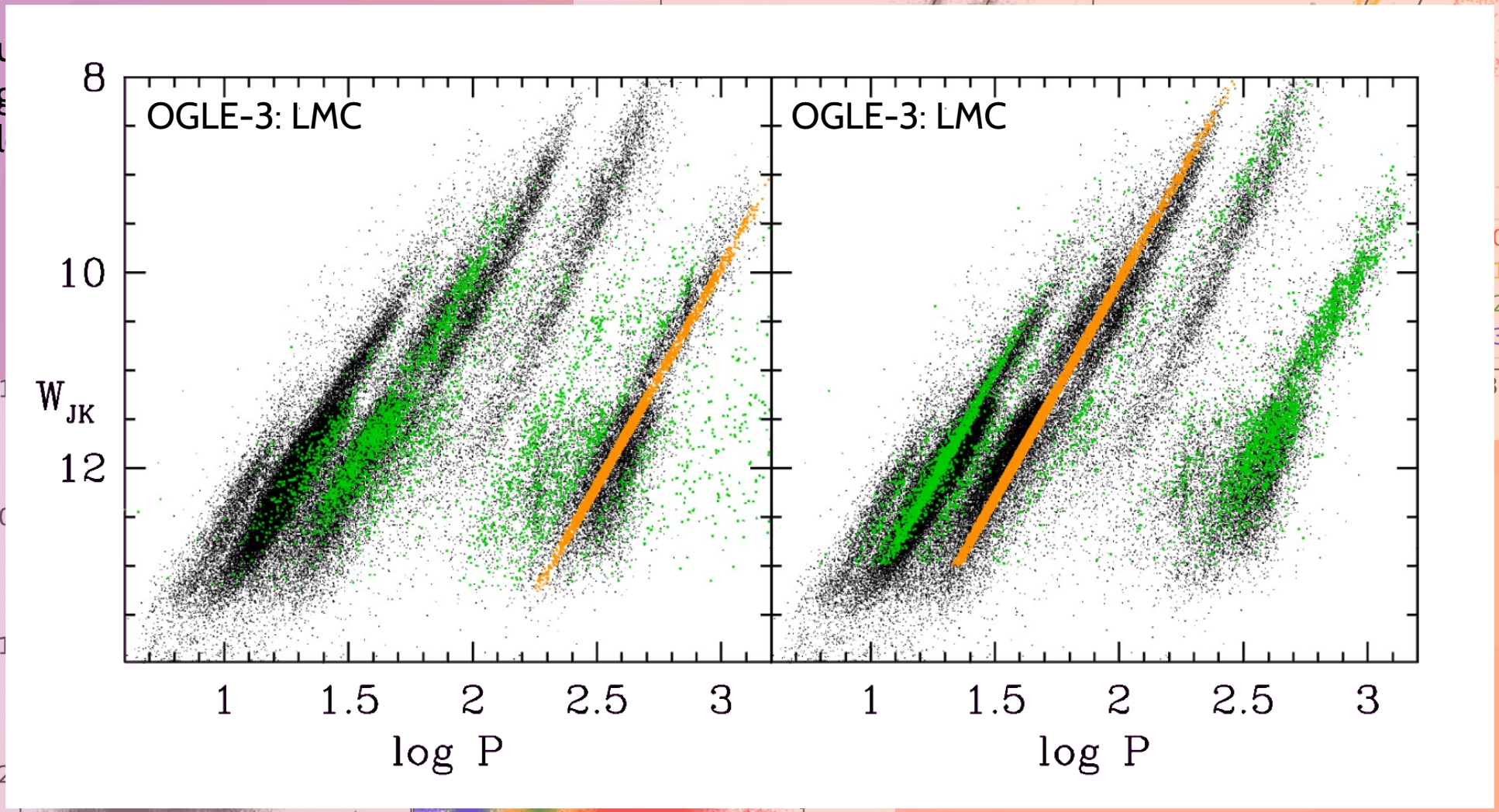




Trabucchi et al., 2017

Black: OGLE3 – LMC
Colours: simulation

Simulations + LPV models

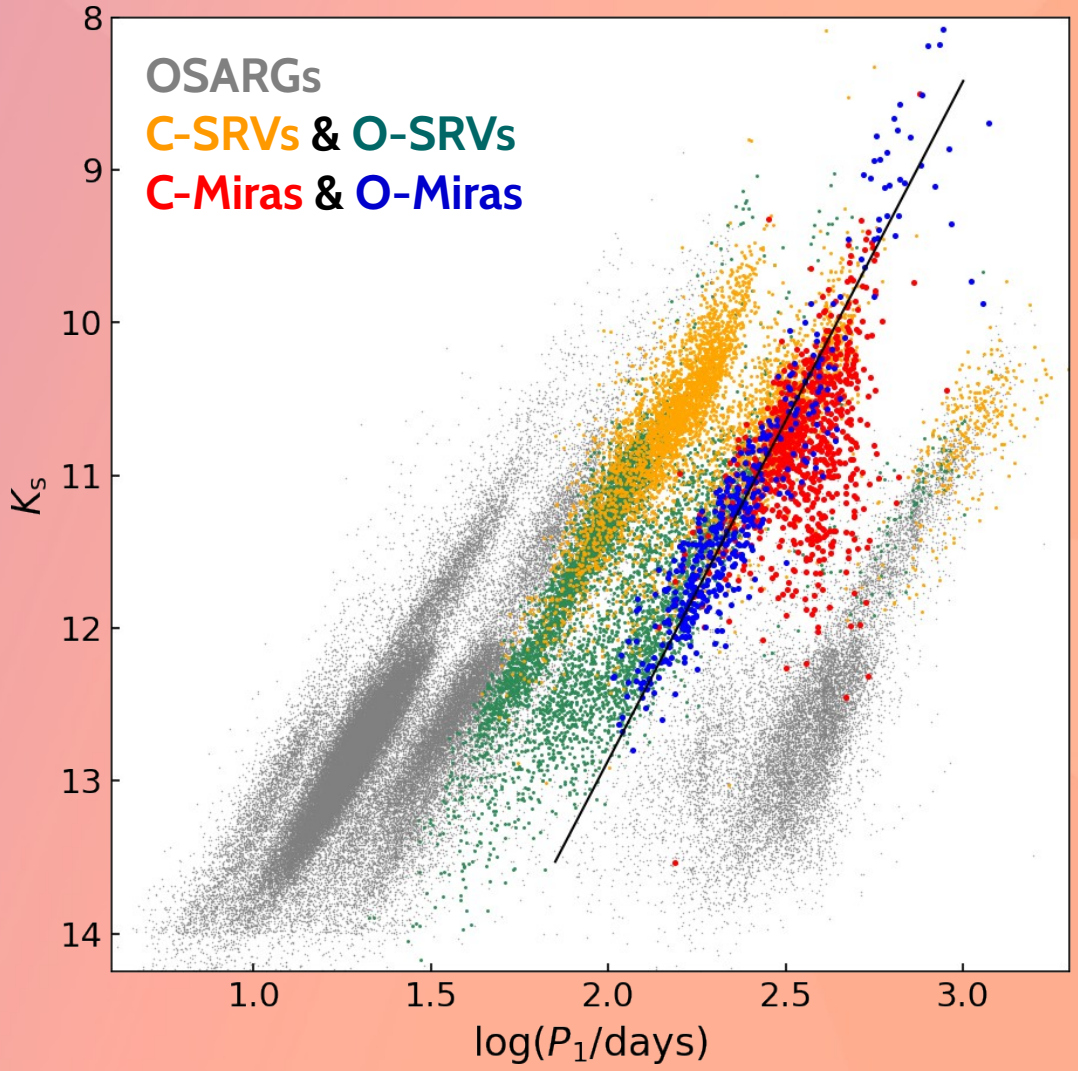


Why LPVs?

- **Distance indicators** → Huang et al., 2018 (ApJ, 857, 67); Rau et al., 2018 (arXiv:1806.0284)
- Evolution of stars and galaxies
- Stellar structure

High luminosity
(bolometric and IR)

Well defined IR PL relation



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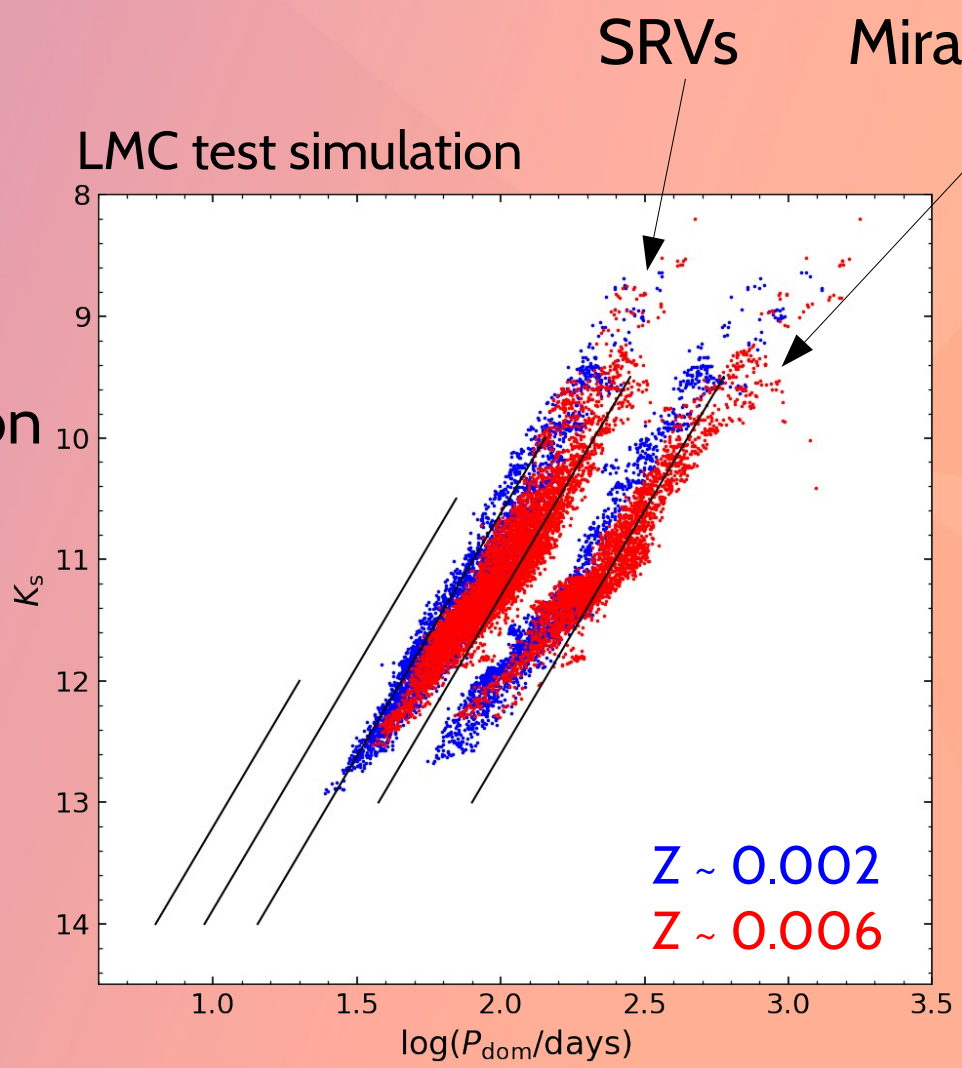
Well defined IR PL relation

metallicity
dependence?



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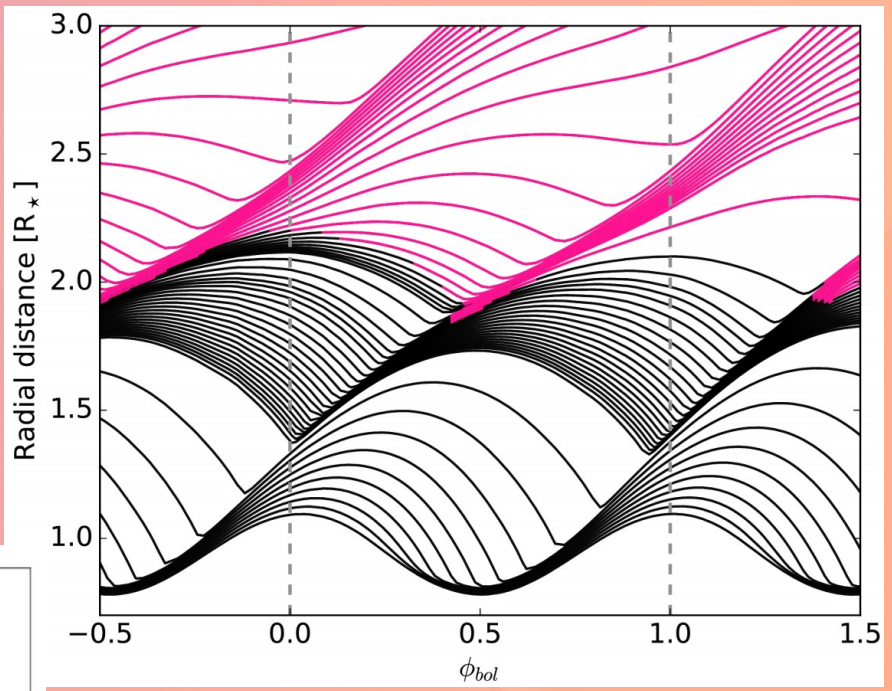
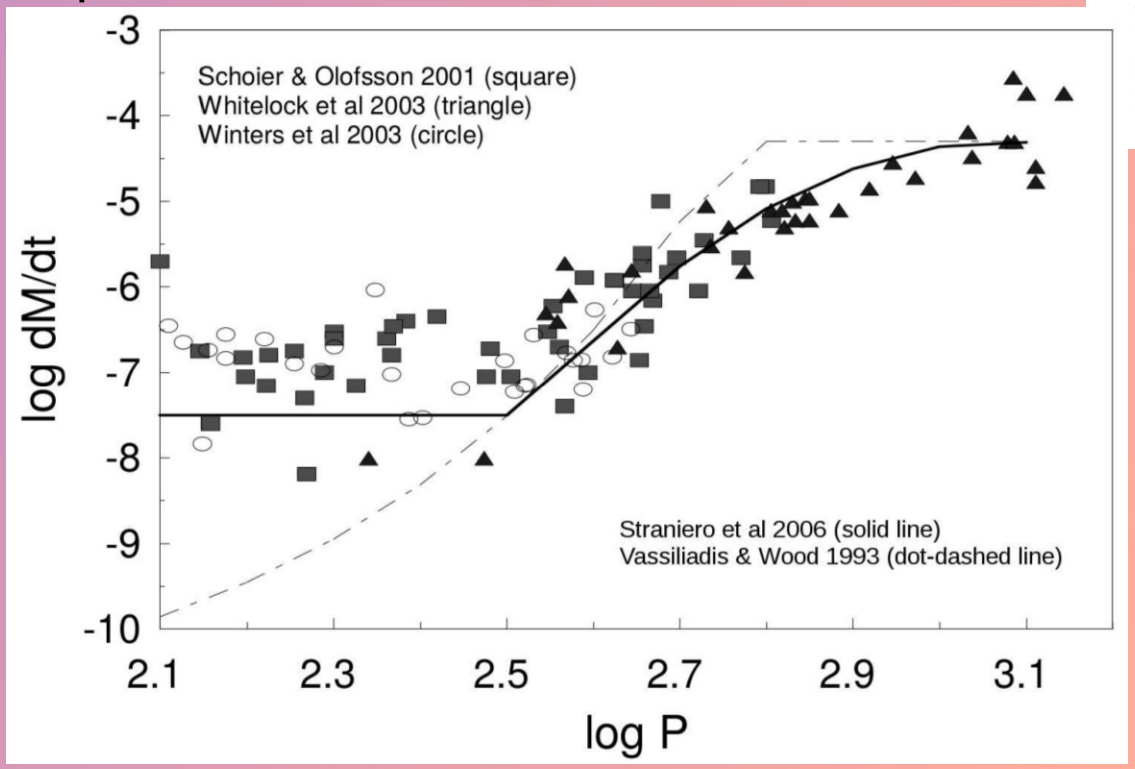


Liljegren et al., 2017

adapted from Straniero et al., 2006



large-amplitude pulsation
dust formation
mass-loss
ISM enrichment

Why LPVs?

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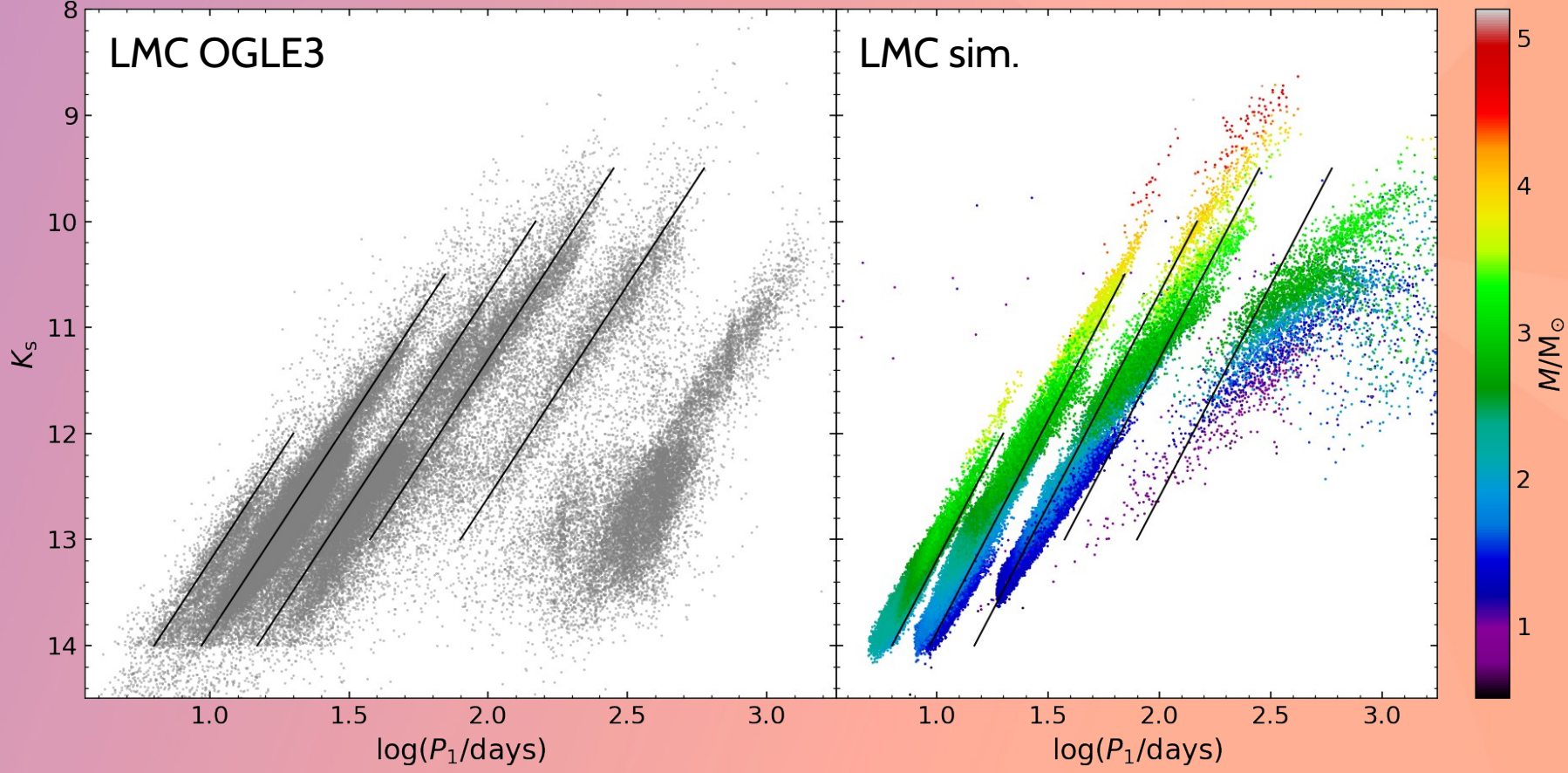
- **Stellar structure**
- Estimates of stellar masses and radii



Why LPVs?

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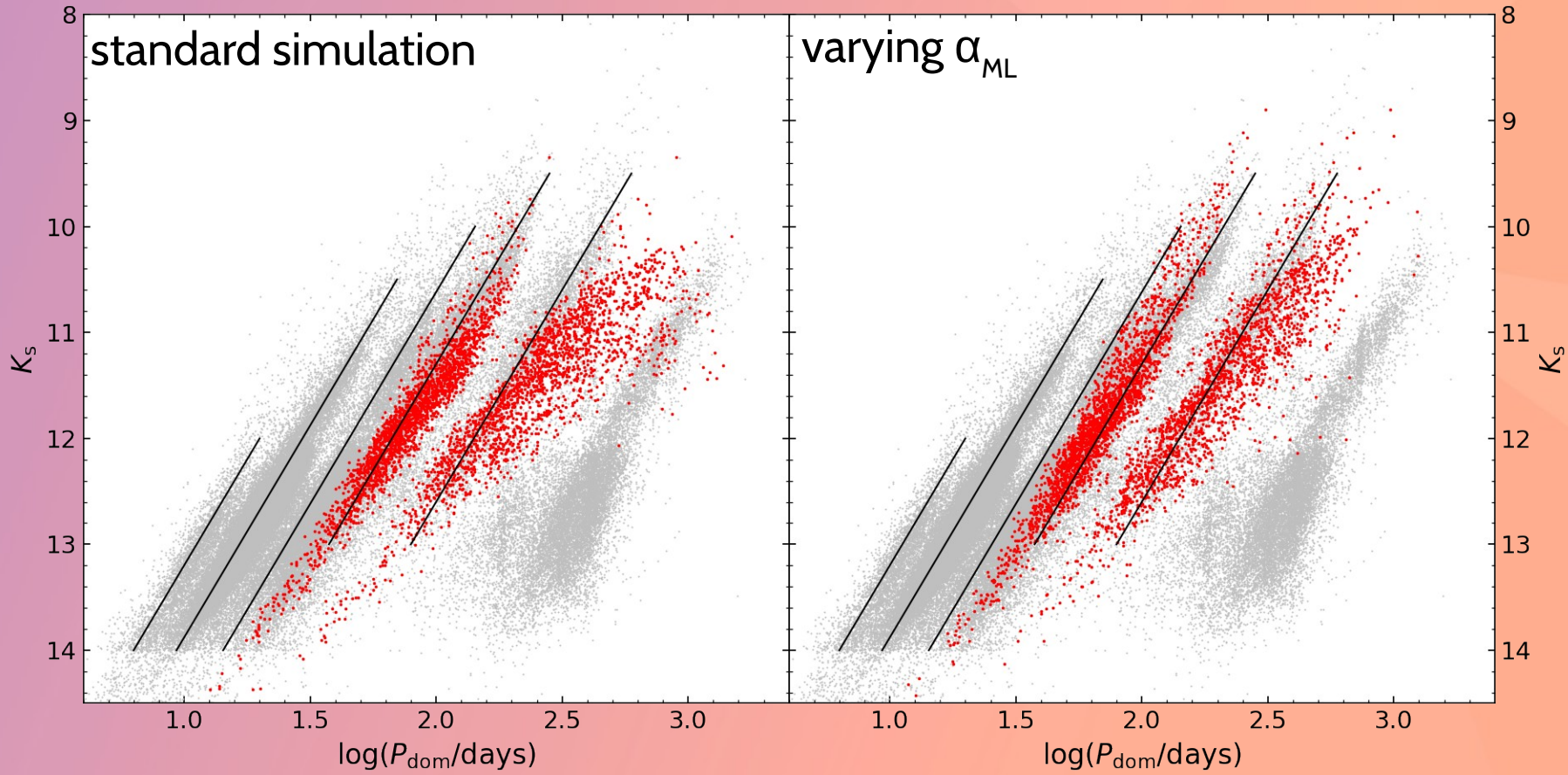
- Estimates of stellar masses and radii
- Temperature scale calibration



Why LPVs?

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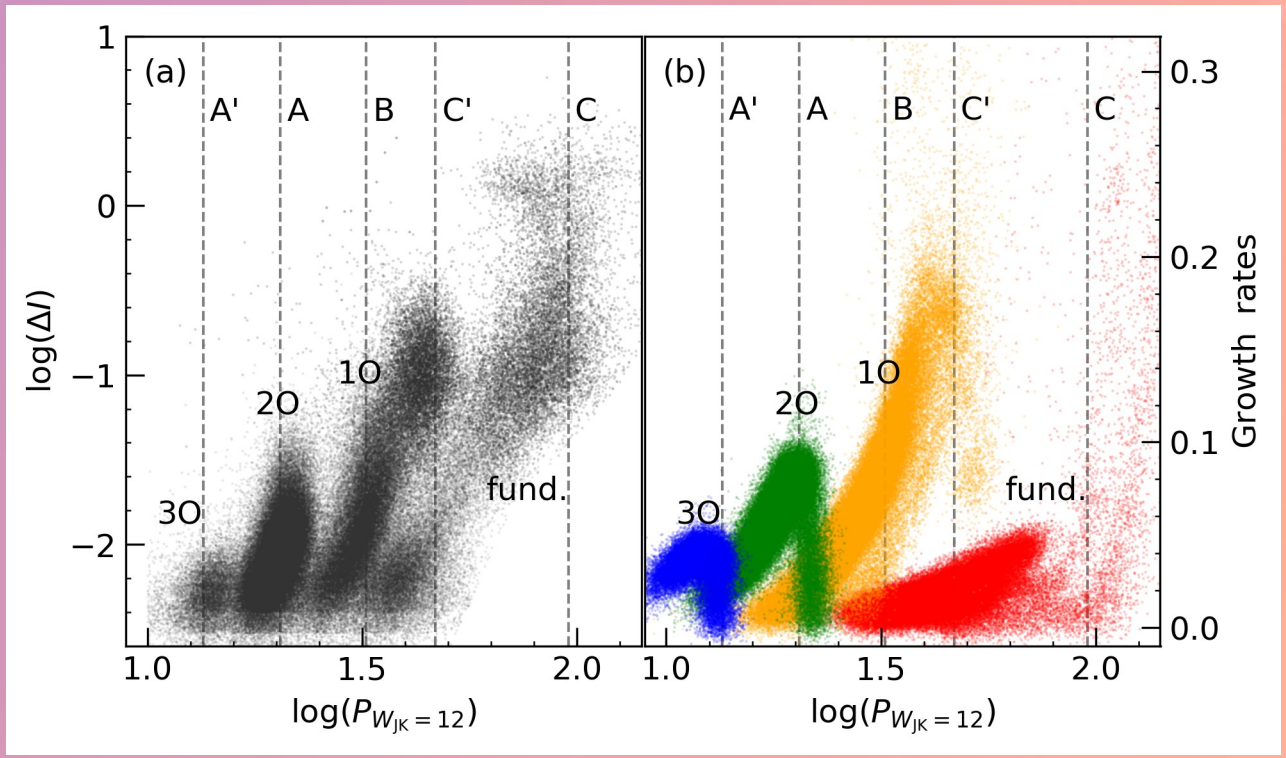
- **Stellar structure**

- Estimates of stellar masses and radii
- Temperature scale calibration
- Solar-like – Mira-like transition?

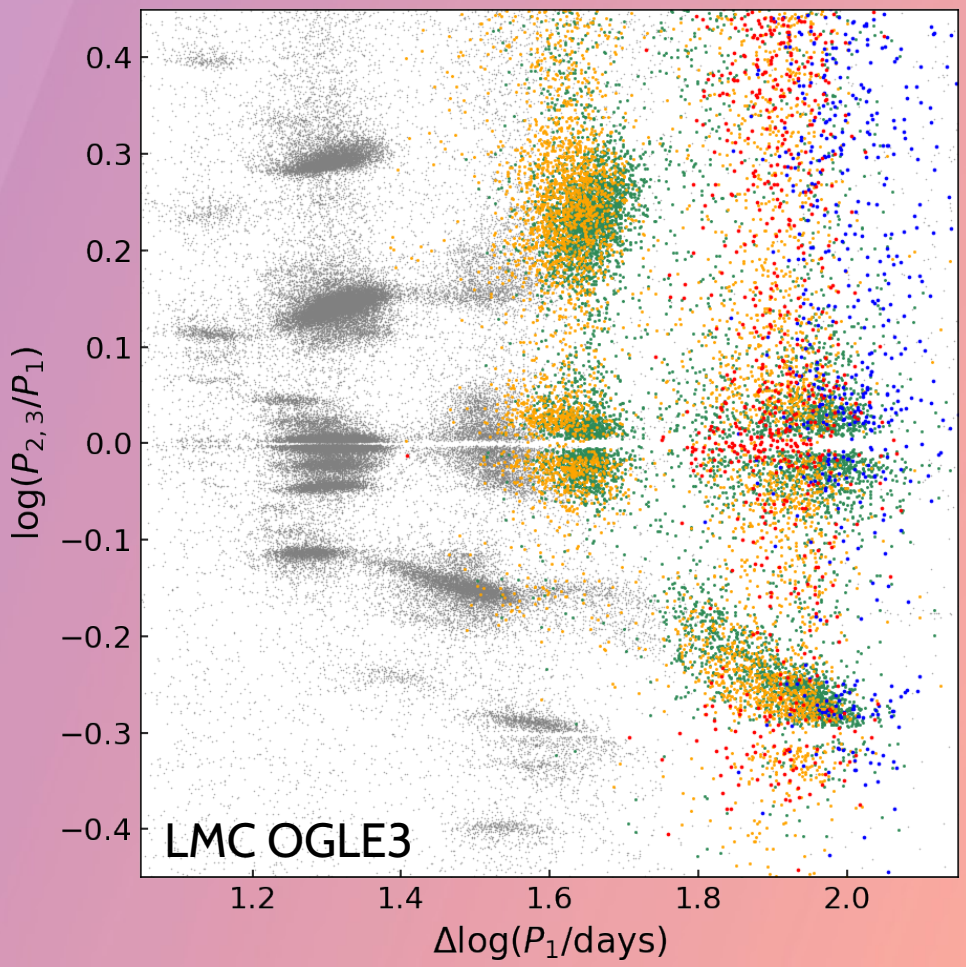
Dziembowski & Soszyinski., 2010
Mosser et al., 2013
Xiong & Deng, 2013



Trabucchi et al., 2017

Why LPVs?

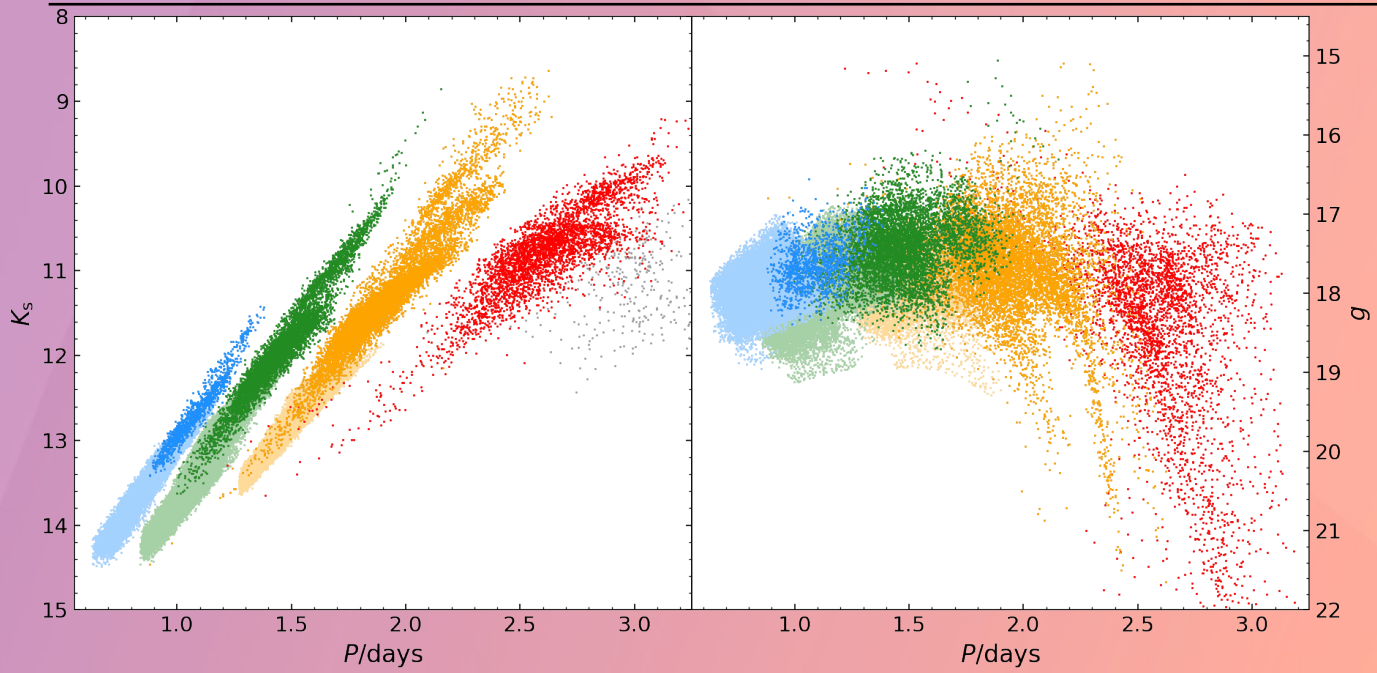
- Distance indicators
- Evolution of stars and galaxies
- **Stellar structure**



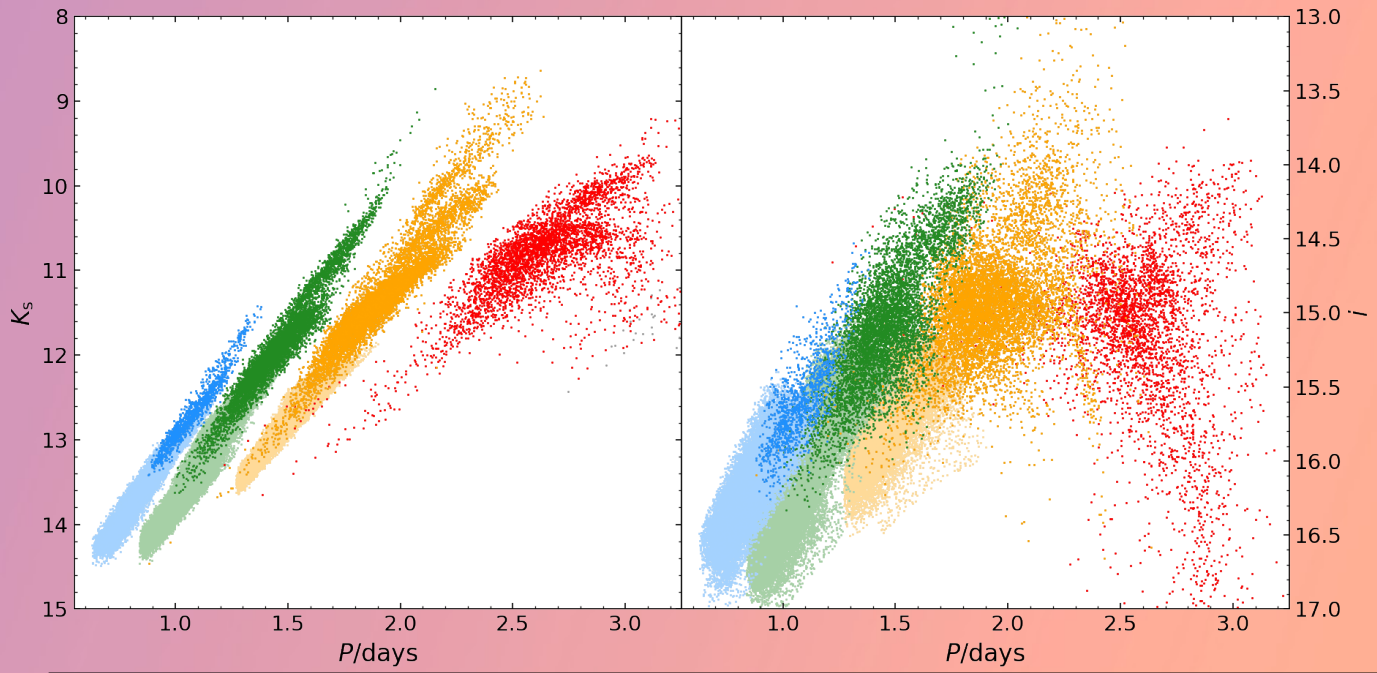
- Estimates of stellar masses and radii
- Temperature scale calibration
- Solar-like – Mira-like transition?
- Envelope structure (period ratios)
- Convection
- Pulsation-convection interaction
- Much more! ...

LPVs & LSST

LPVs & LSST

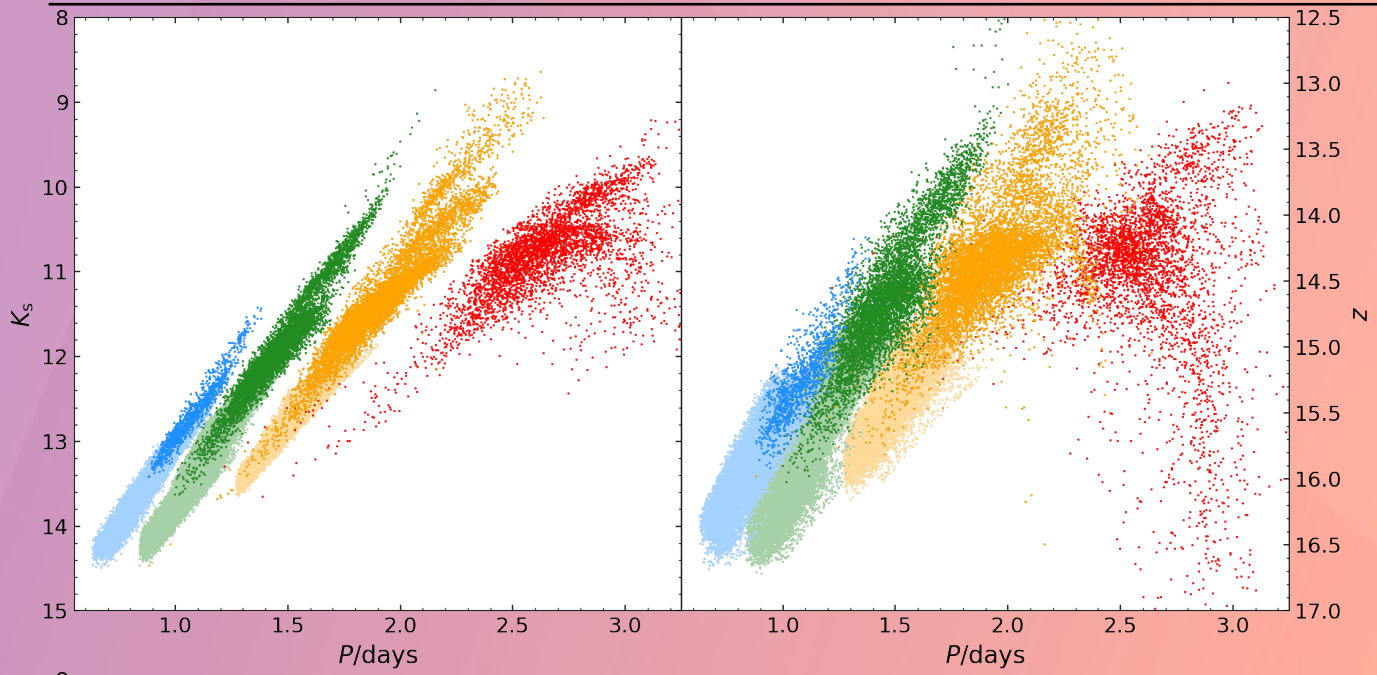


simulation:
LSST g band
Compared with
2MASS Ks band

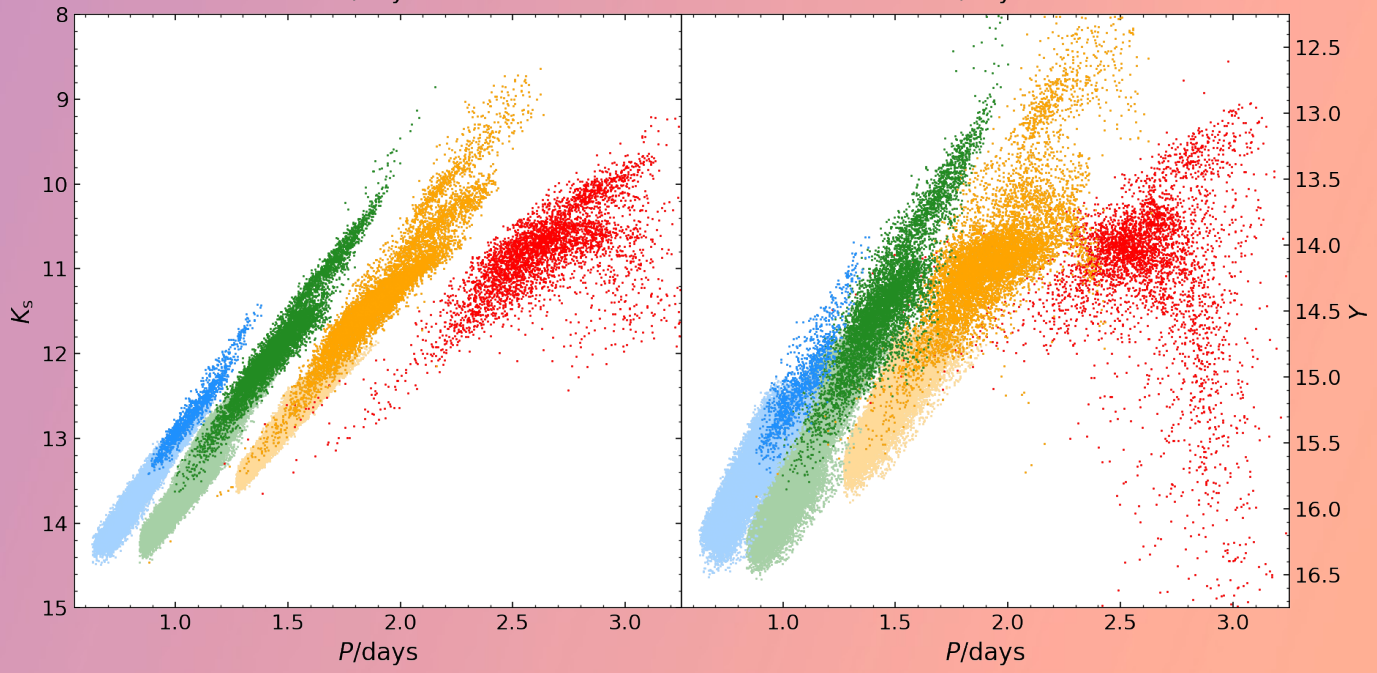


simulation:
LSST i band
Compared with
2MASS Ks band

LPVs & LSST

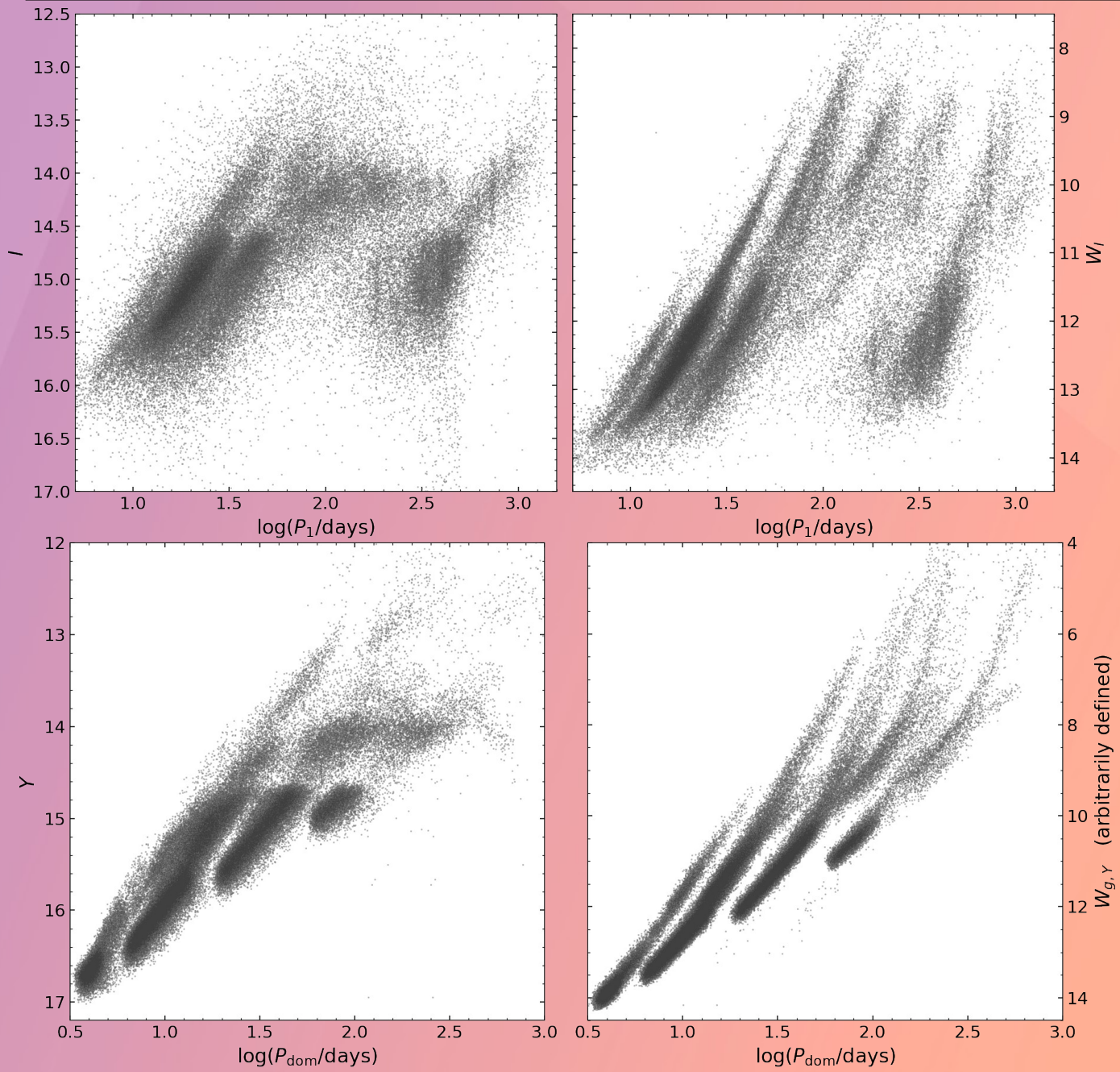


simulation:
LSST z band
Compared with
2MASS Ks band



simulation:
LSST Y band
Compared with
2MASS Ks band

LPVs & LSST



OGLE data:
I band
Compared with
$W_{I,V-I}$ index

simulation:
Y band
Compared with
arbitrary LSST
Weisenheit index

LPVs & LSST

multi-band colour characterisation

multi-band amplitudes & light-curve characterisation

short cadence + multi-year project = wide period coverage

LSST

amplitudes at millimag precision

multiple periods per star (radial + non-radial + LSP)

multiple environments

Conclusions

- LSST: multi-band, long-term, several periods, low-amplitudes

Simulations

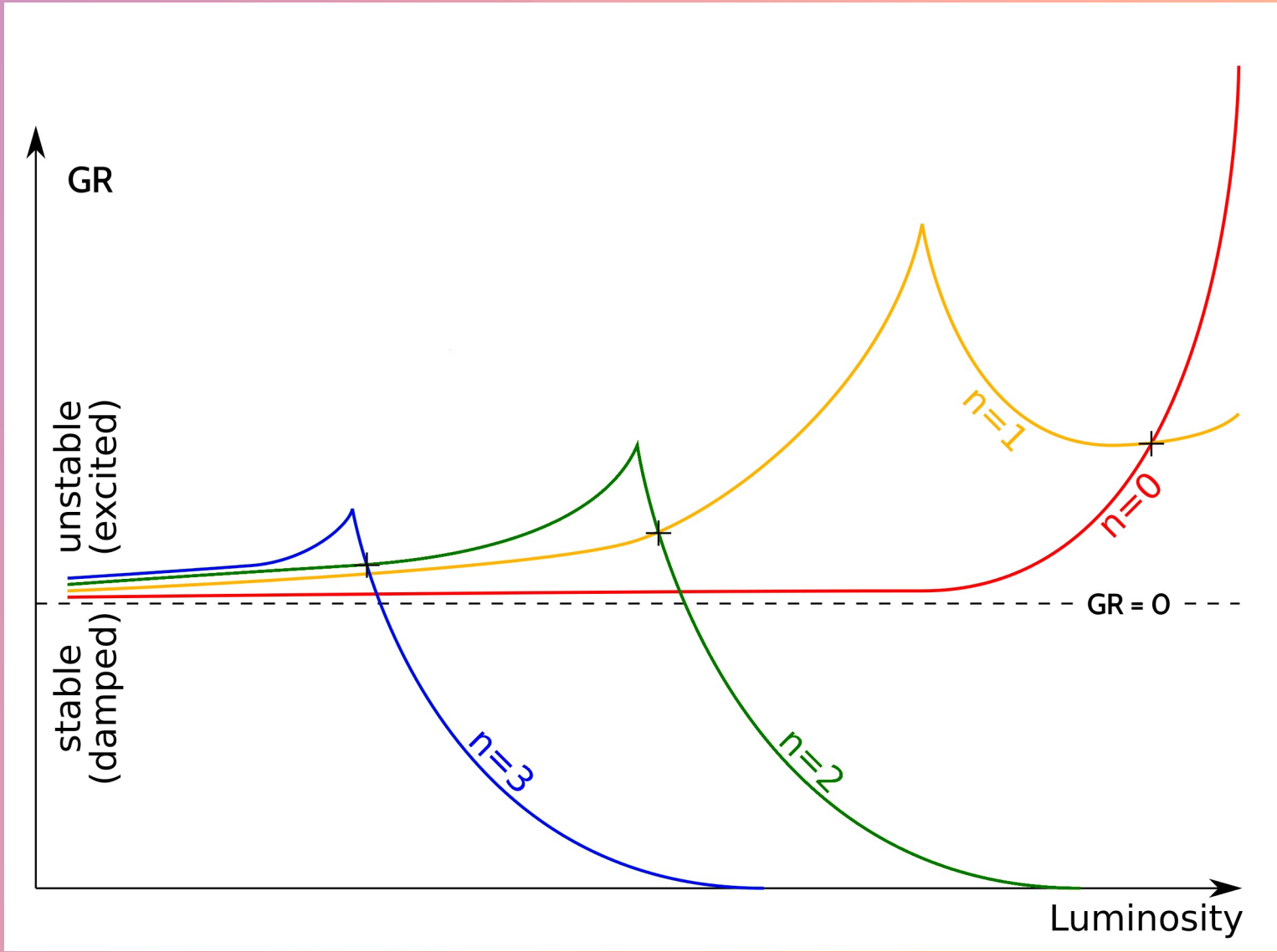
- Long-Period Variables: periods + growth rates, 5 radial modes
- Models validation with OGLE3+2MASS, GAIA DR2

Work in progress:

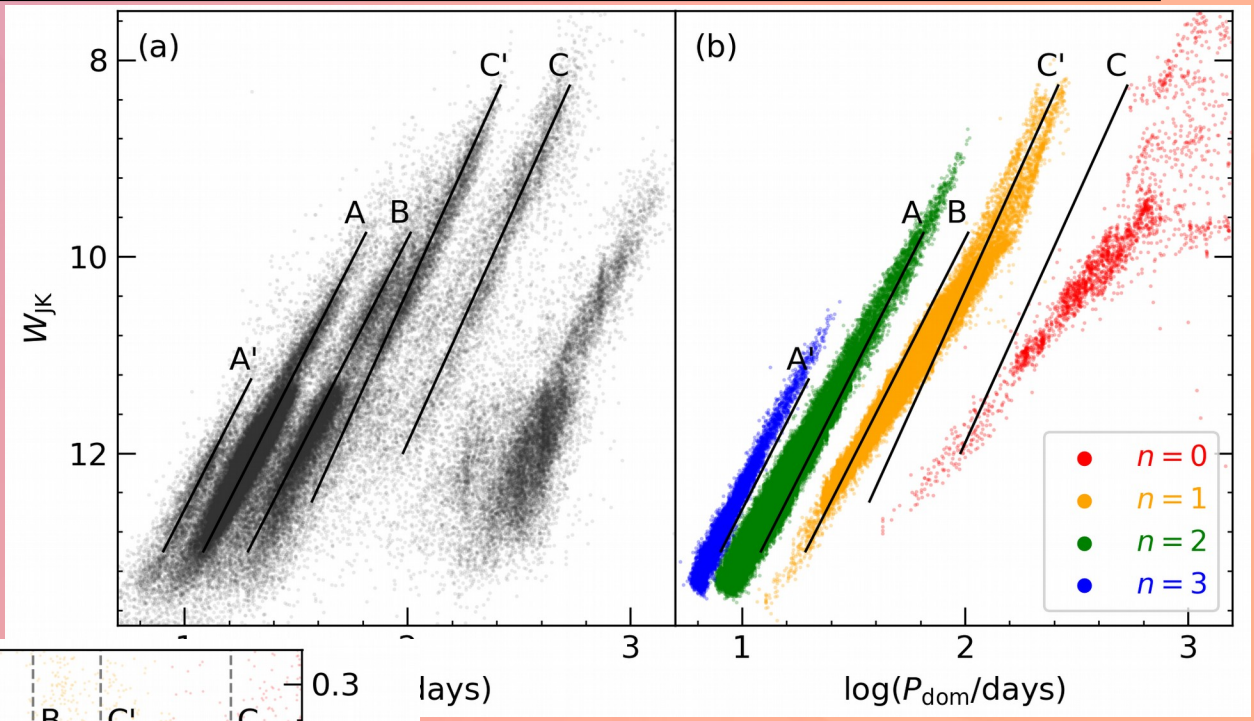
- Amplitudes, prescriptions for non-radial modes
- Additional variability: Cepheids, RR Lyrae, ...
- Full LSST sky: Milky Way, Magellanic Clouds, ...

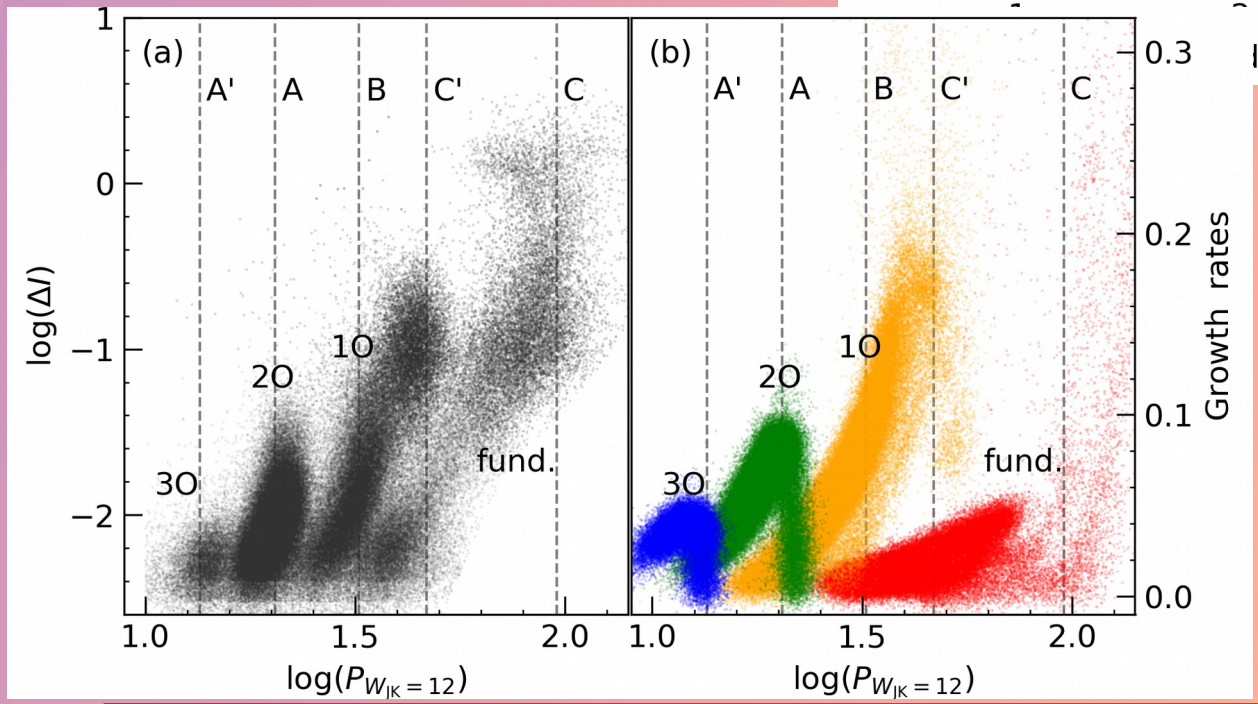
We acknowledge the support from
the ERC Consolidator Grant funding scheme
(project STARKEY, G.A. n. 615604)

Supplementary: Growth Rates



Supplementary: Fundamental Mode





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