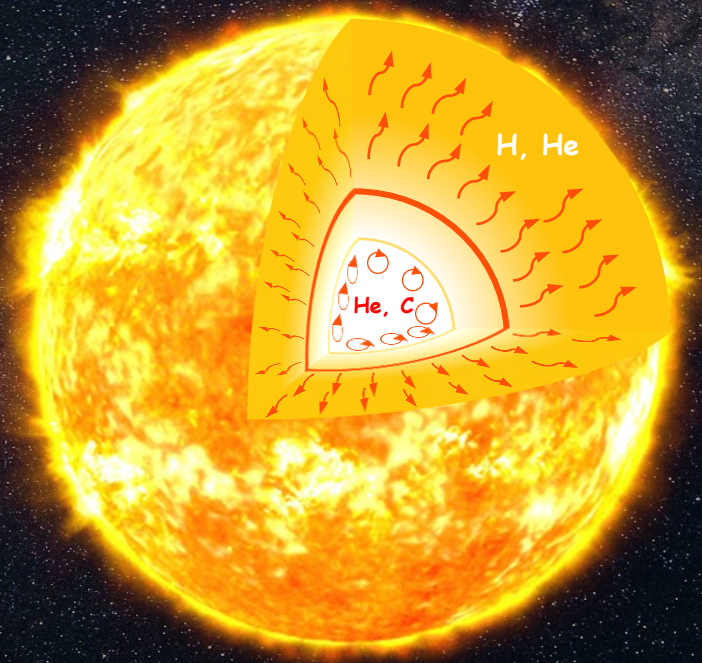
The 6th Young Astronomers Meeting at CAMK PAN

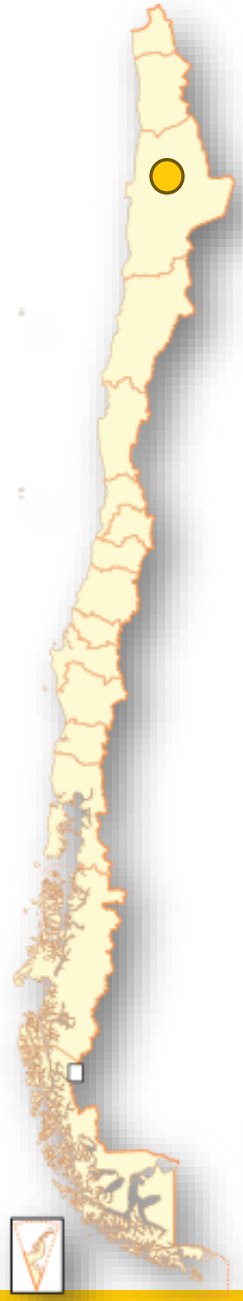
Classical Cepheids: Laboratories of Stellar Astrophysics



Felipe Espinoza Arancibia

About me

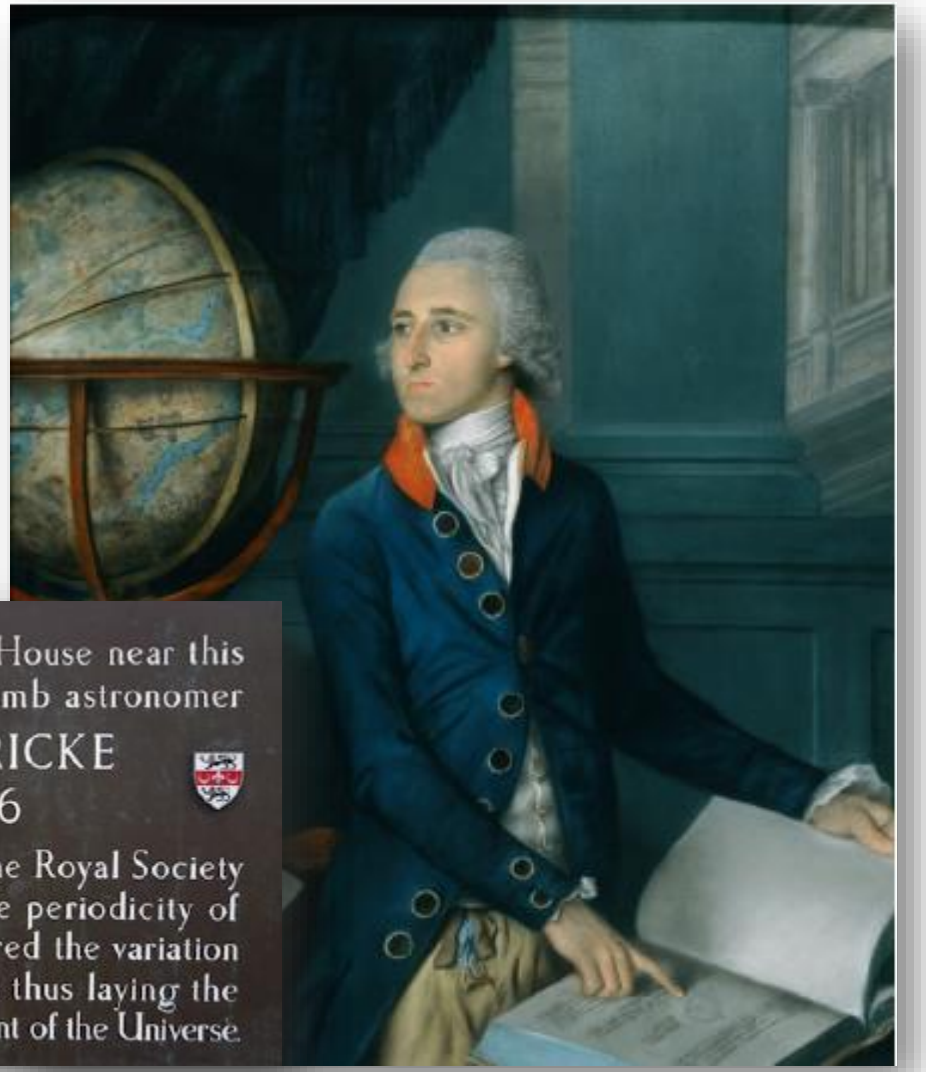
- I’m from Calama, in the north of Chile
- Undergraduate and master's degree in Astrophysics at Pontificia Universidad Católica de Chile
- 3rd year student at CAMK-PAN under the supervision of Bogumił Pilecki
- I have 4 cats 🐈 🐈 🐈 🐈
- My work focus on Classical Cepheids



@jofreconjota

Classical Cepheids

- Delta Cephei was discovered to be variable by John Goodricke during 1784.



Classical Cepheids

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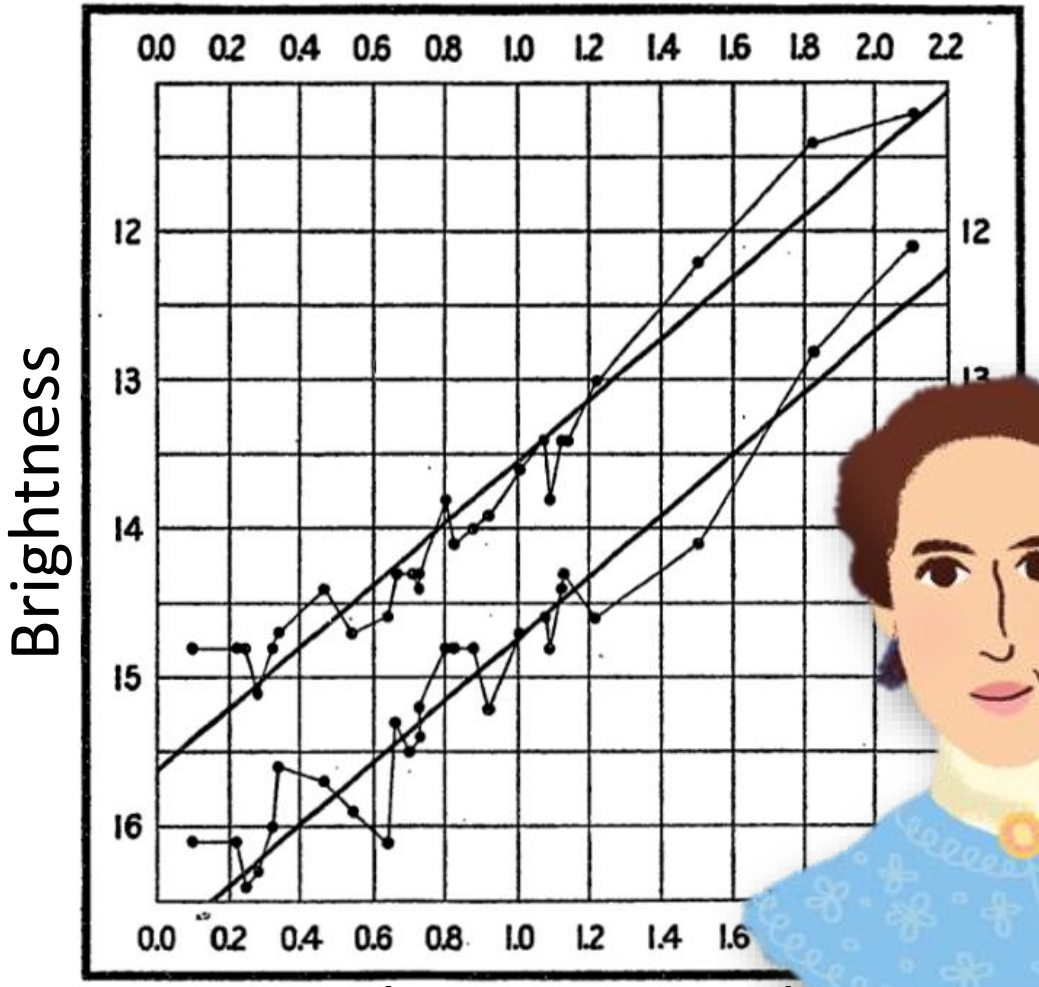
- In 1912, Henrietta Leavitt discovered that variables with longer periods had brighter magnitudes.

$$M = a + b \log P$$

M: absolute magnitude
a, b: constants
P: pulsating period

Leavitt & Pickering (1912, Harv. Obs. Circ., 173)



Source: Abigail Malate

Classical Cepheids

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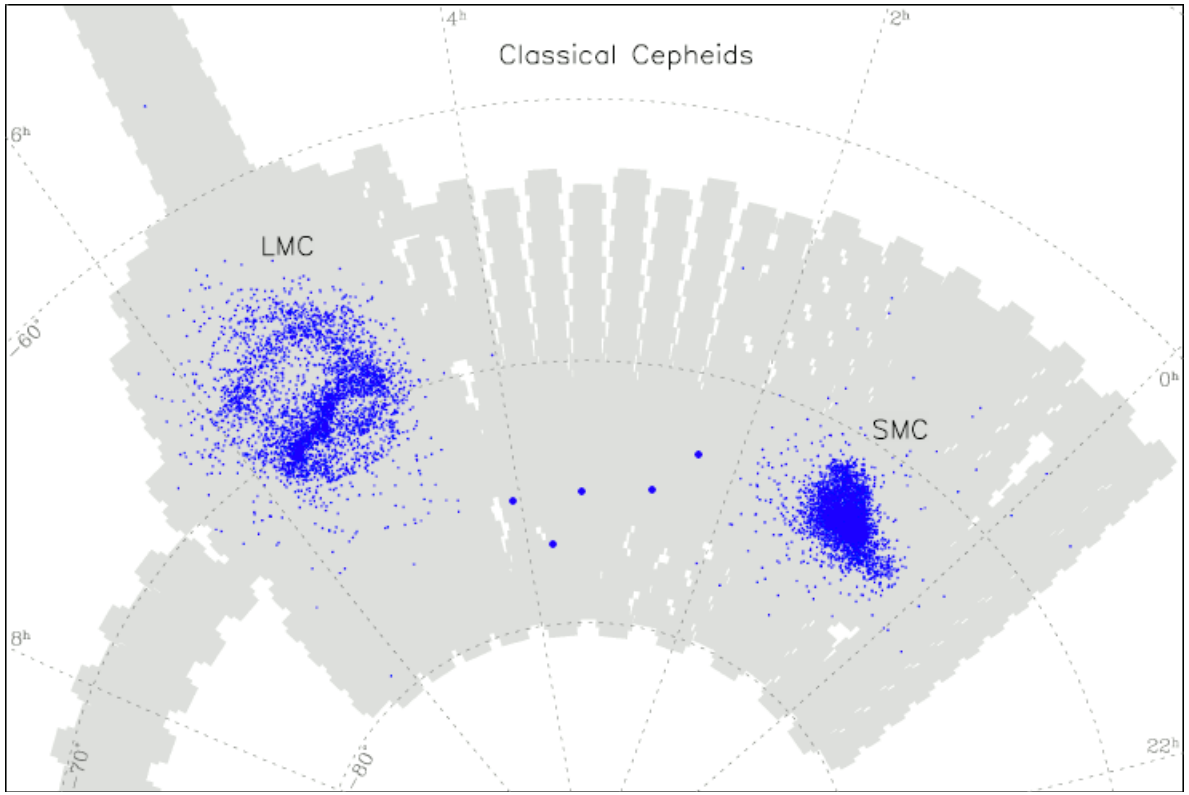
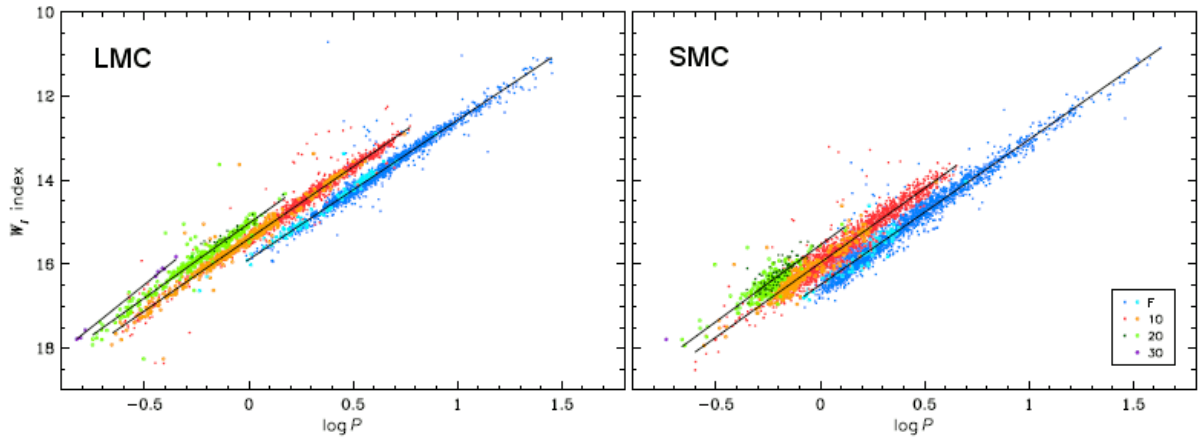
- In 1912, Henrietta Leavitt discovered that variables with longer periods had brighter magnitudes.
- Currently, there is a massive amount of data e.g. The Optical Gravitational Lensing Experiment (OGLE) presented a nearly complete census of classical Cepheids in the Magellanic System.

Soszyński et al., 2015, Acta Astronomica, 65, 297





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- Currently, there is a massive amount of data e.g. The Optical Gravitational Lensing Experiment (OGLE) presented a nearly complete census of classical Cepheids in the Magellanic System.

We need to understand all this data!

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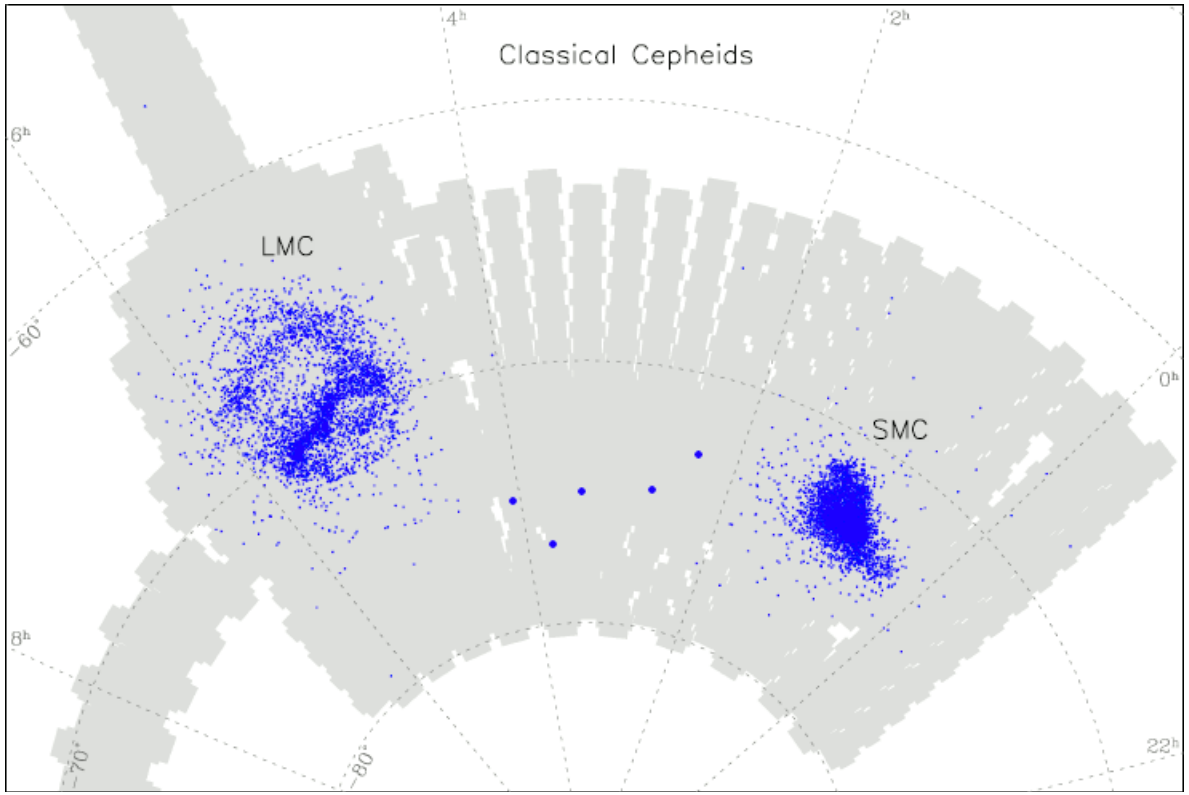
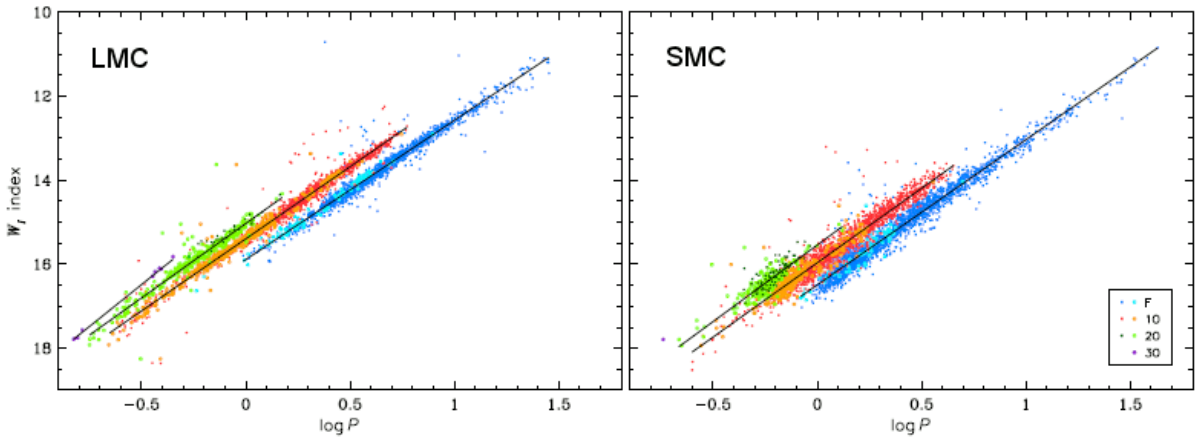
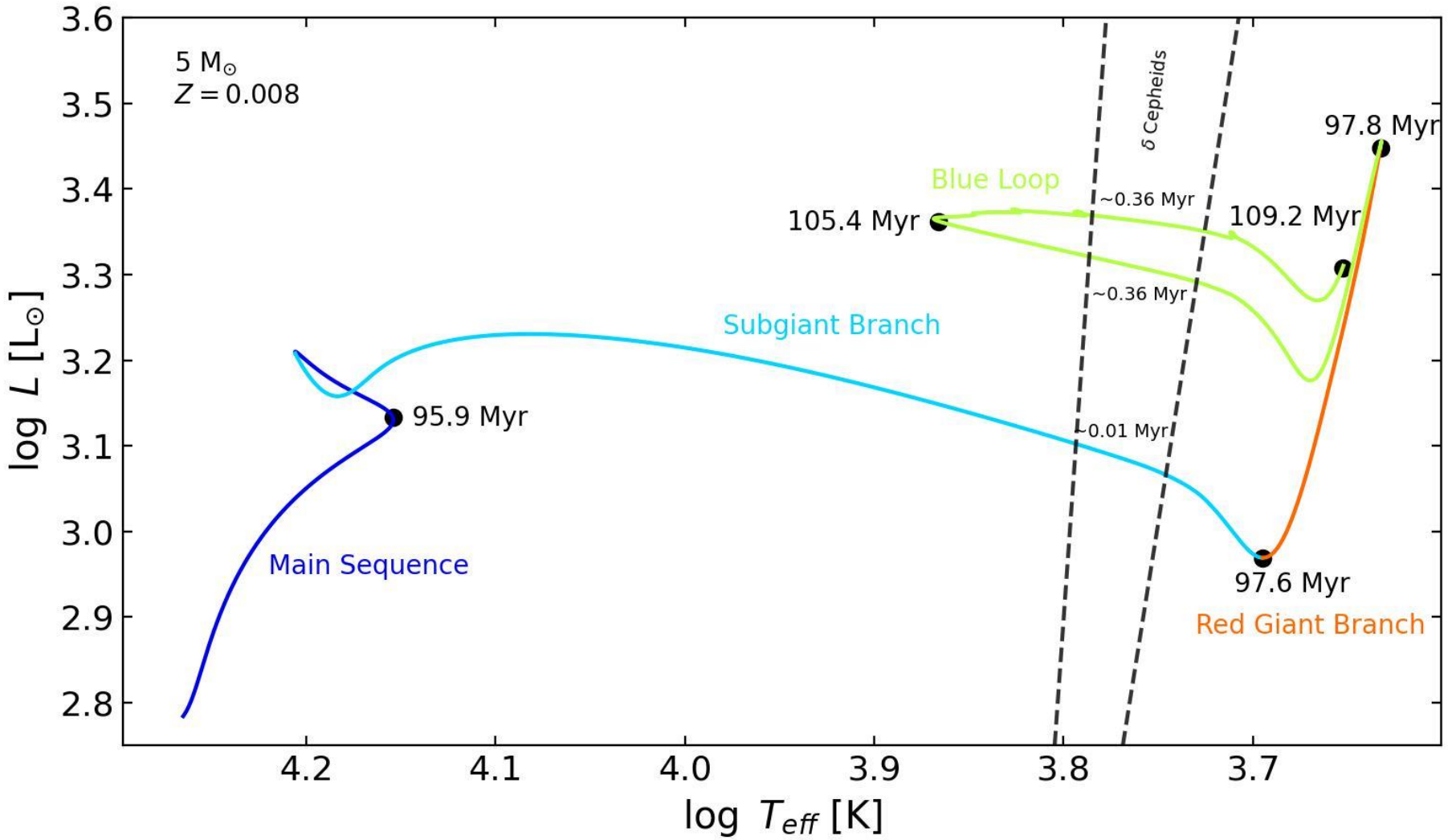




Classical Cepheids

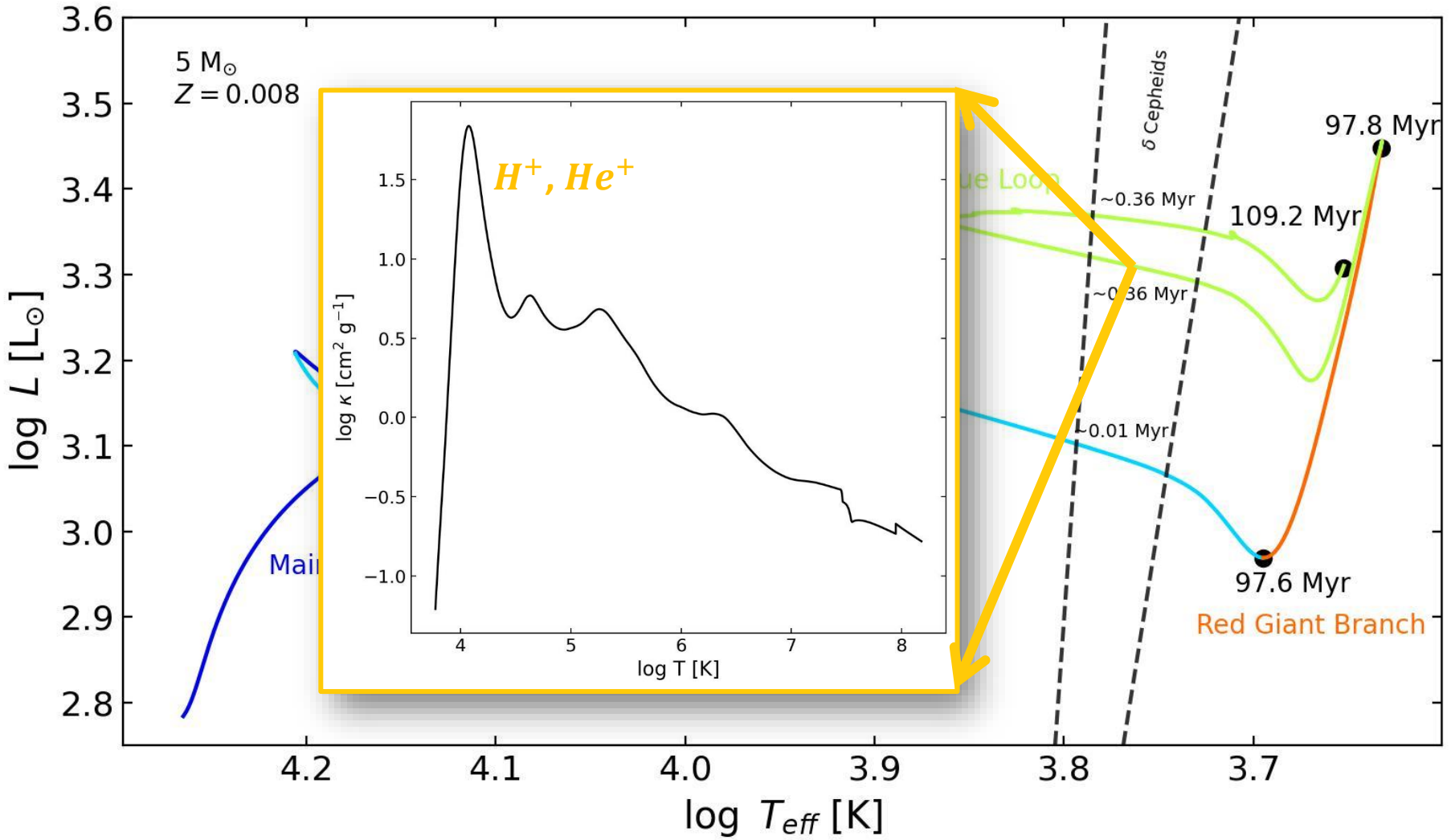
- $\sim 3 \ - 13 \ M_{\odot}$
- Located in the classical instability strip (IS)



Classical Cepheids

κ: Represents ability of stellar material to absorb radiation

- $\sim 3 \ - 13 \ M_{\odot}$
- Located in the classical instability strip (IS)
- Pulsations are excited by the κ - γ mechanism



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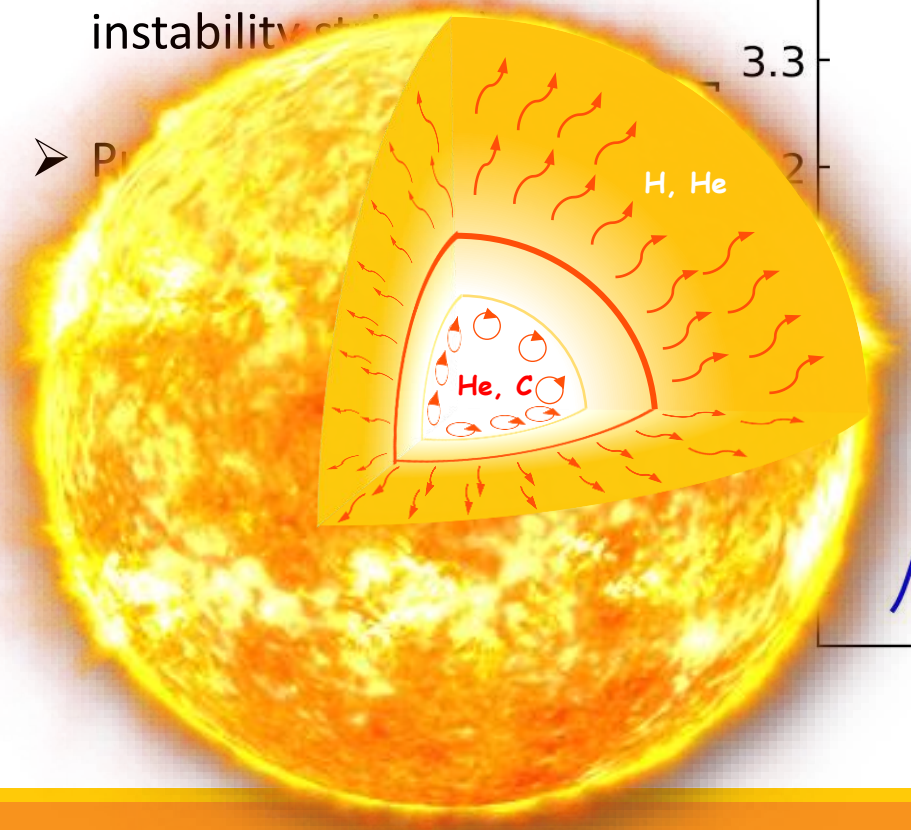
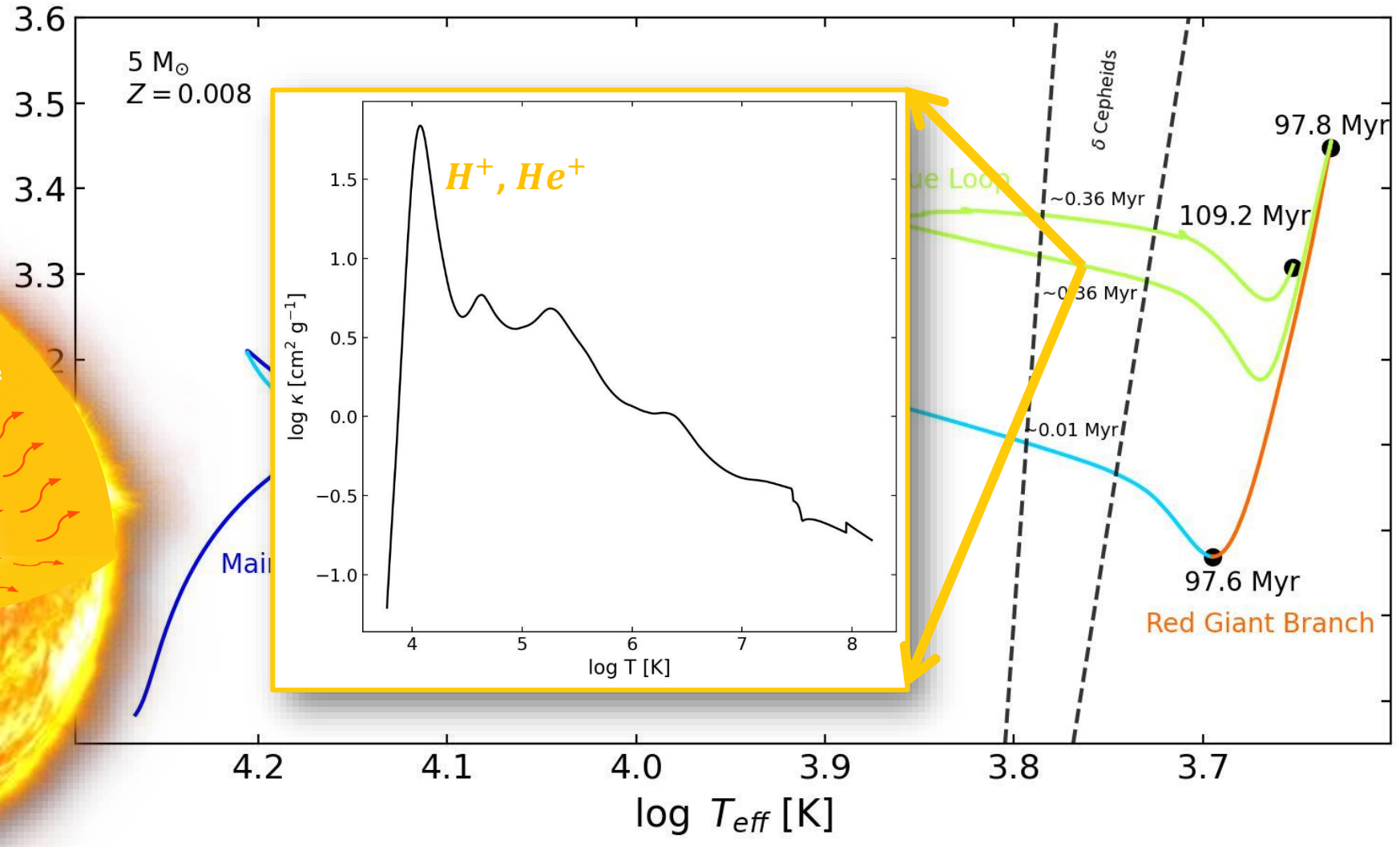




Classical Cepheids: Laboratories of Stellar Astrophysics

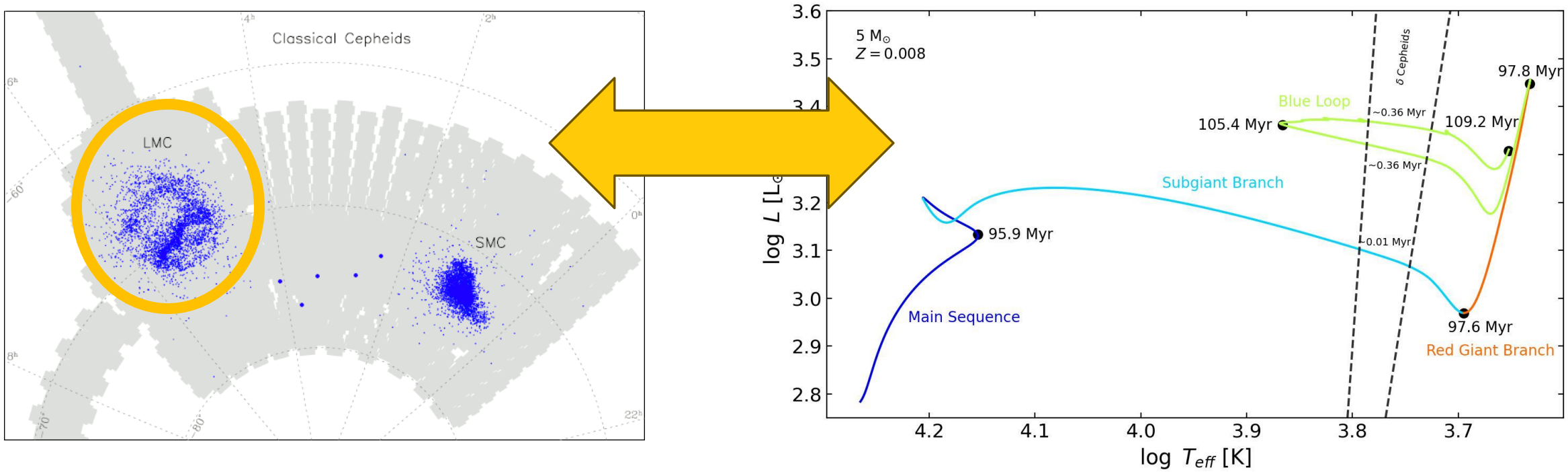
Instability strip

Double-lined binary systems

MESA

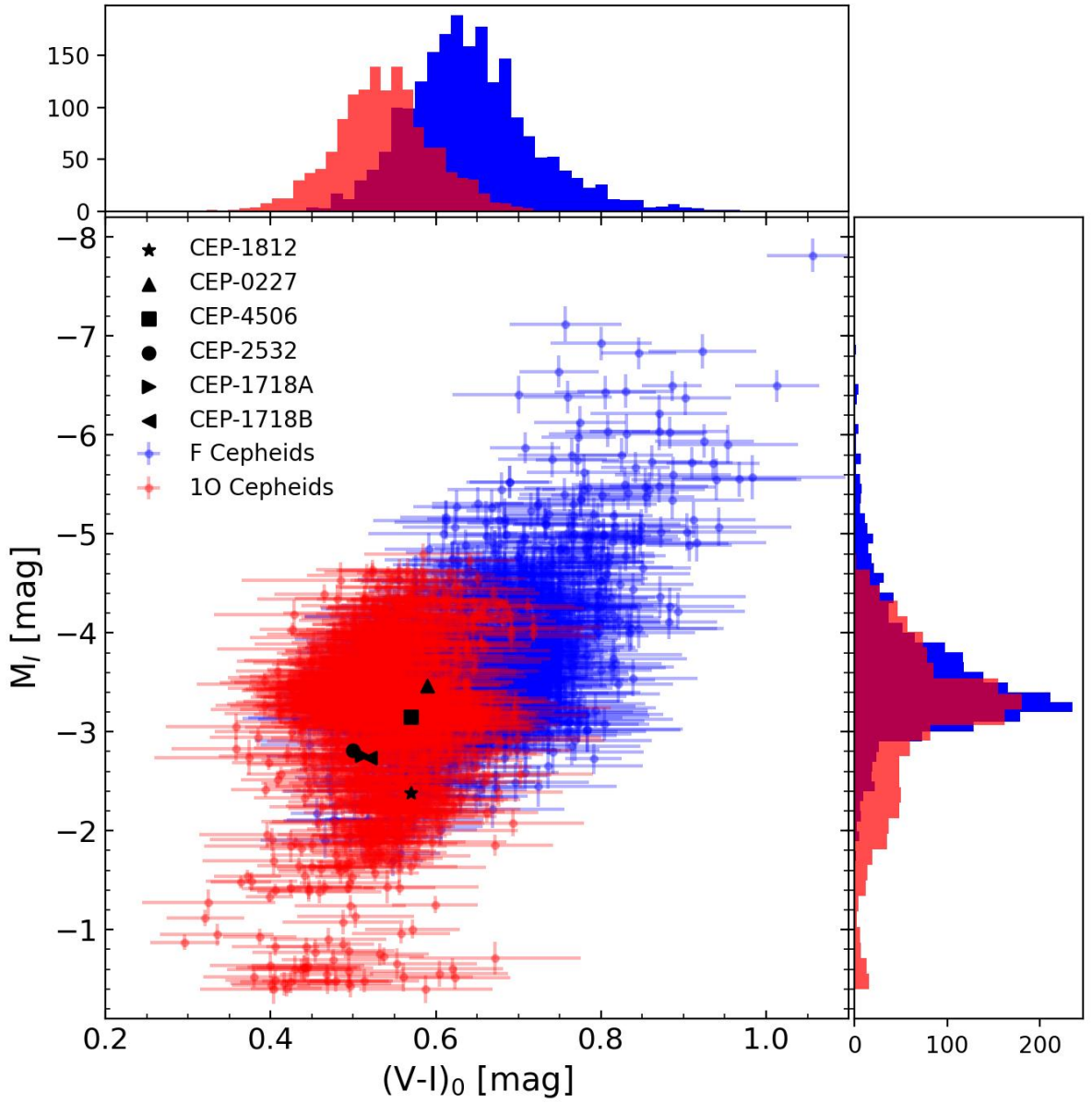
https://docs.mesastar.org/en/release-r24.03.1/

Empirical instability strip for classical Cepheids I. The LMC Galaxy



Espinoza-Arancibia et al. 2024, A&A, 682, A185

2058 fundamental and 1387 1st overtone Cepheids



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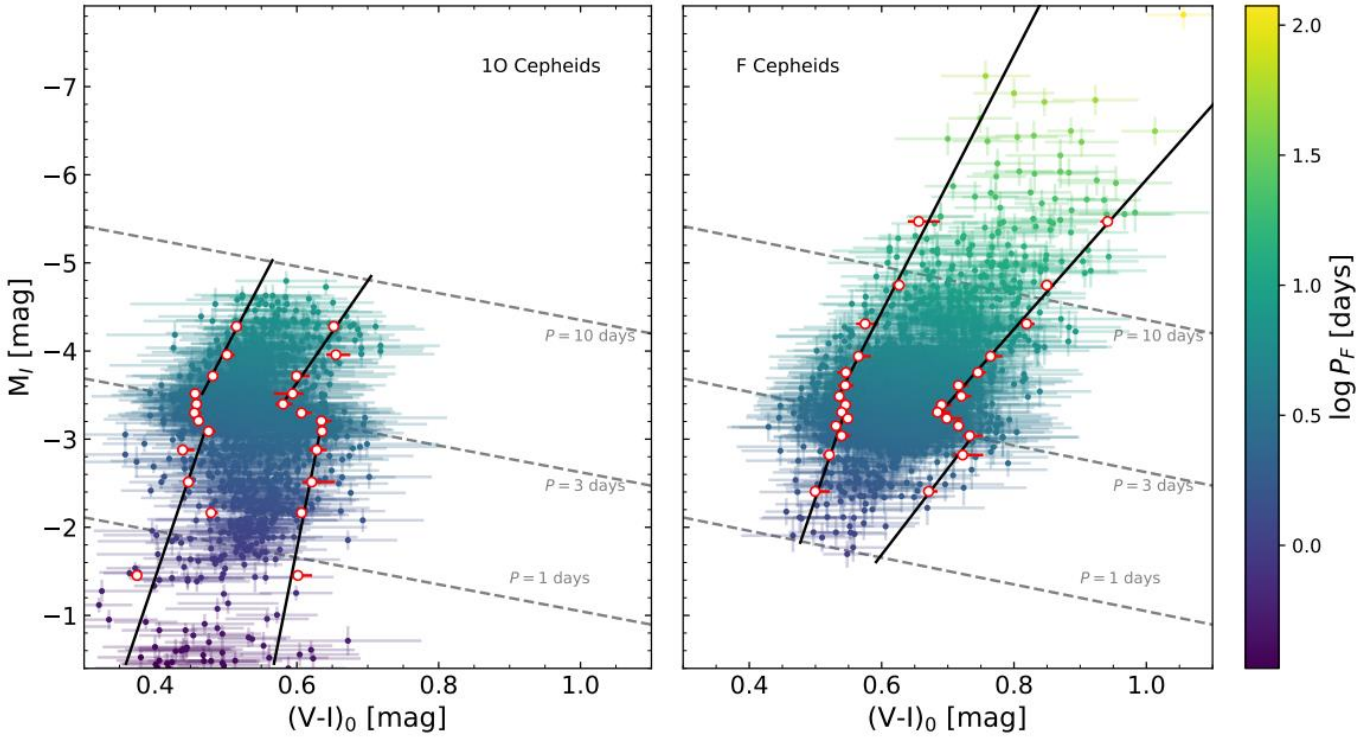
Empirical ISs of both samples show a break



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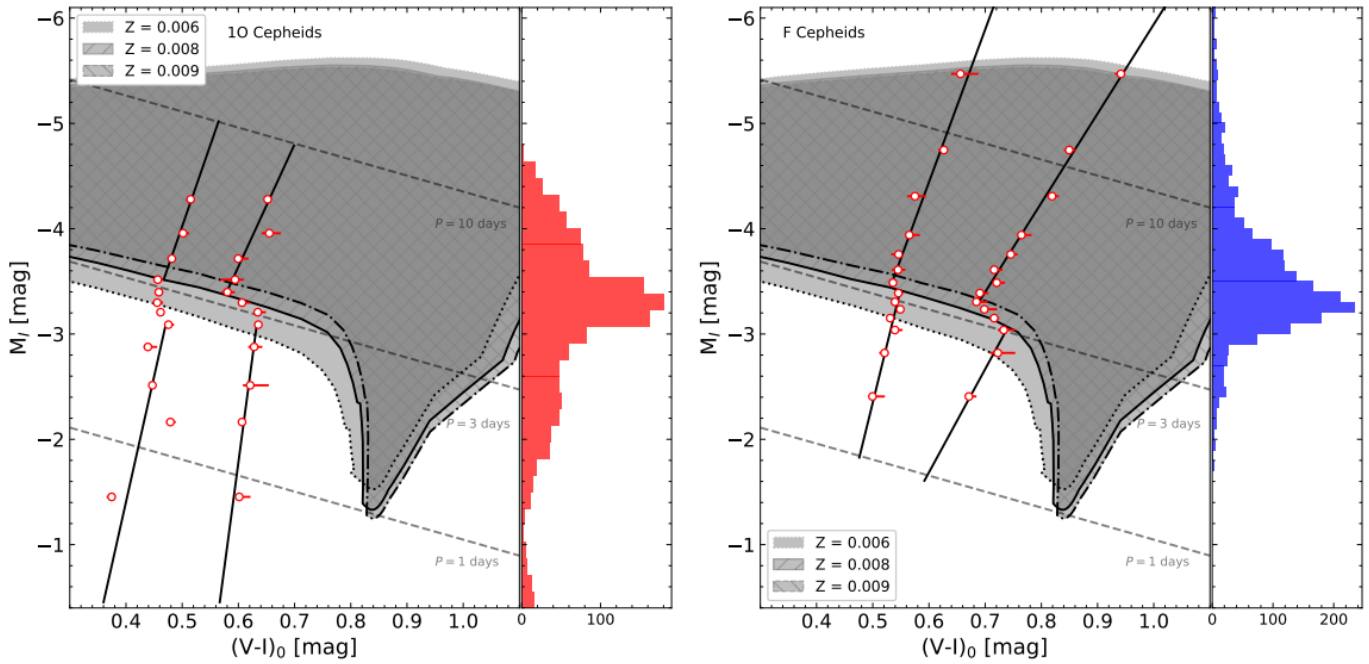

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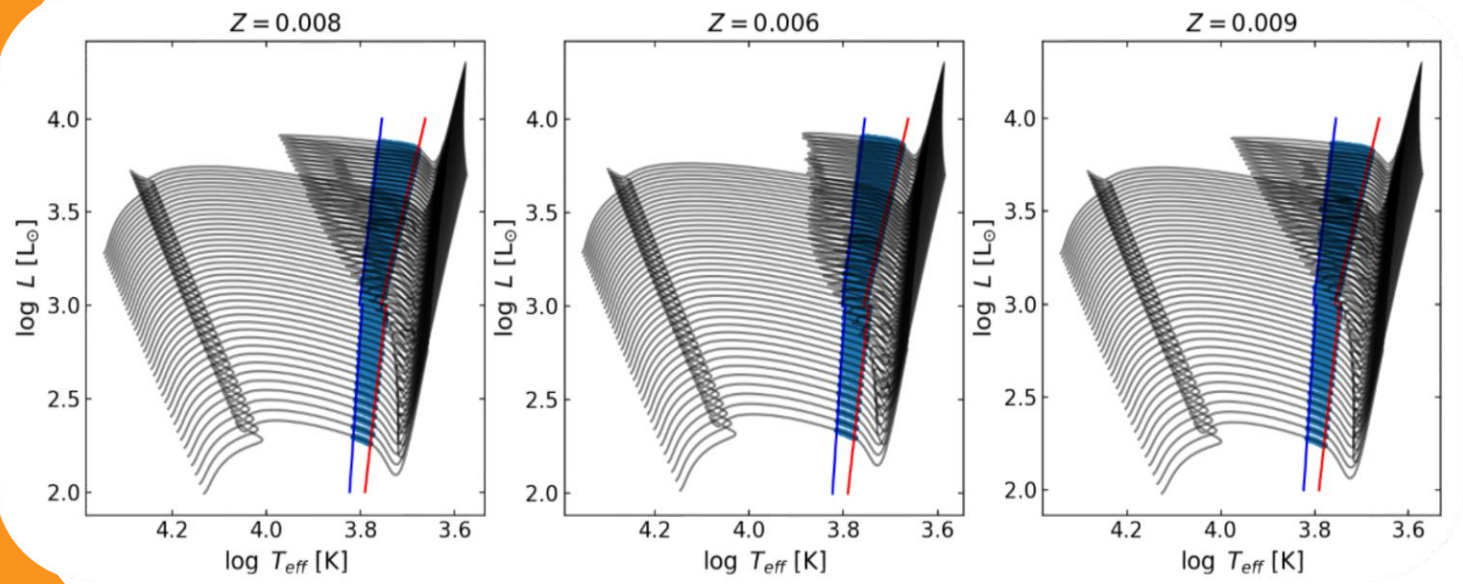
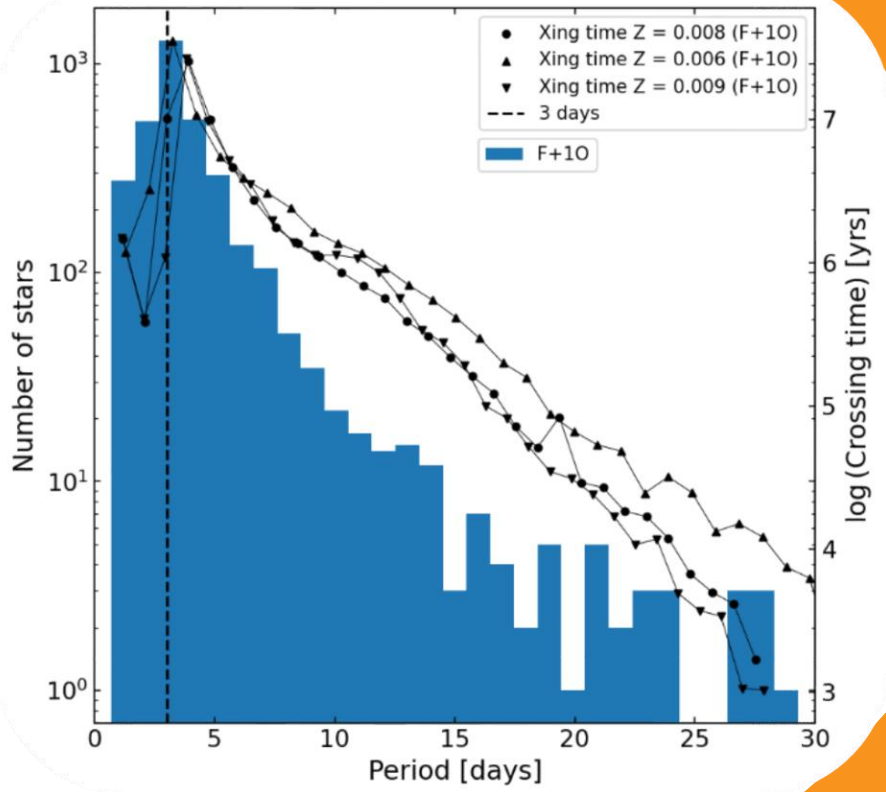
Summer Student Program 2023





Student: Matylda Łukaszewicz (UW)

Maybe it will be repited this year

2058 fundamental and 1387 1st overtone Cepheids

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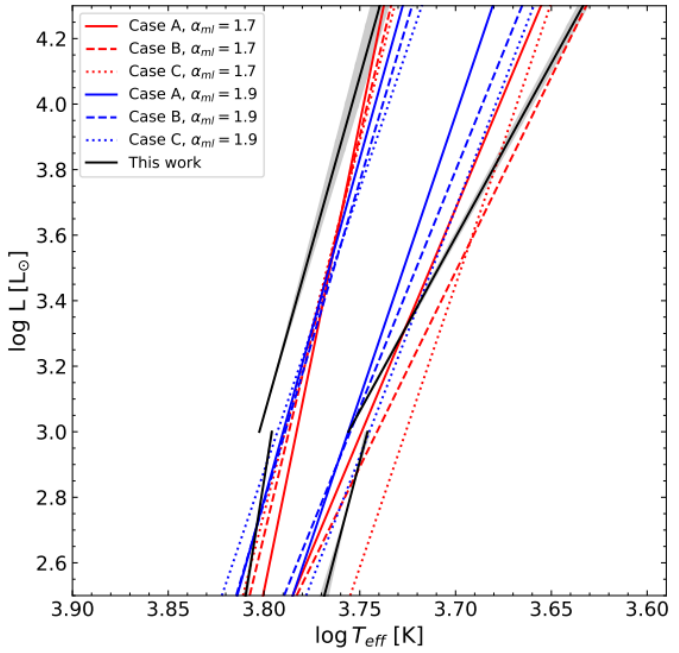
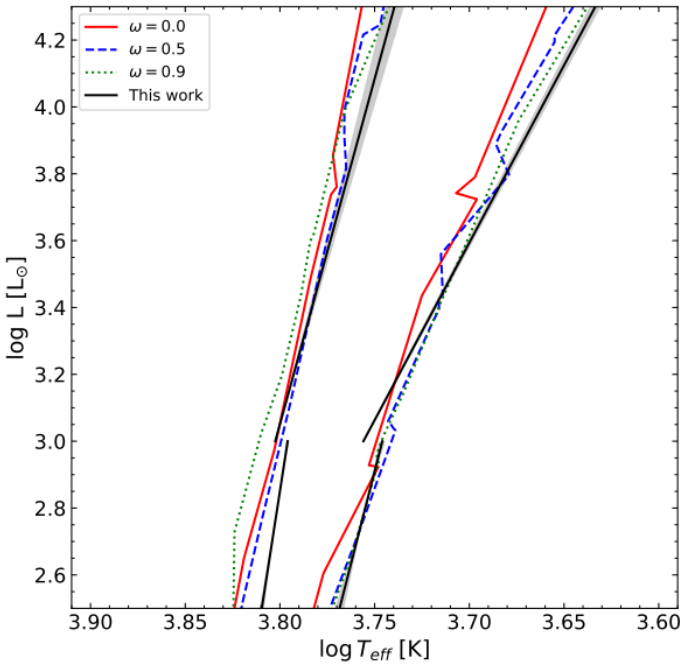
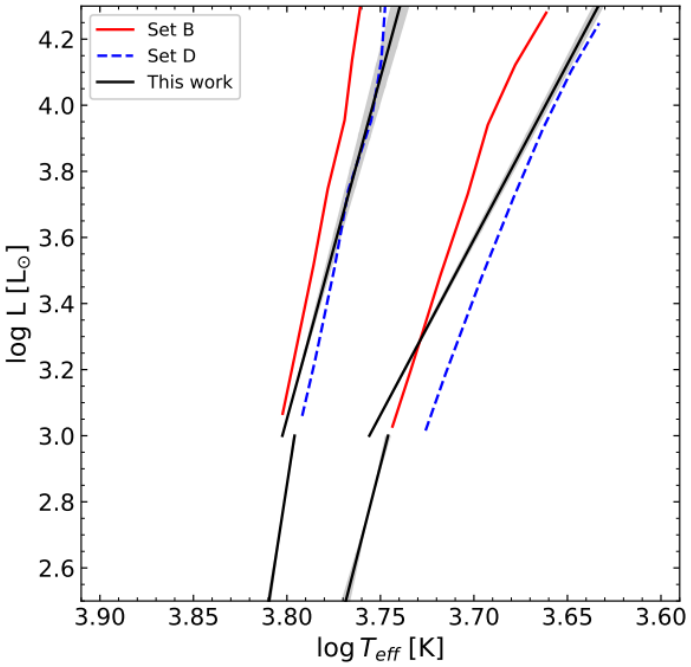
Good agreement with other theoretical results

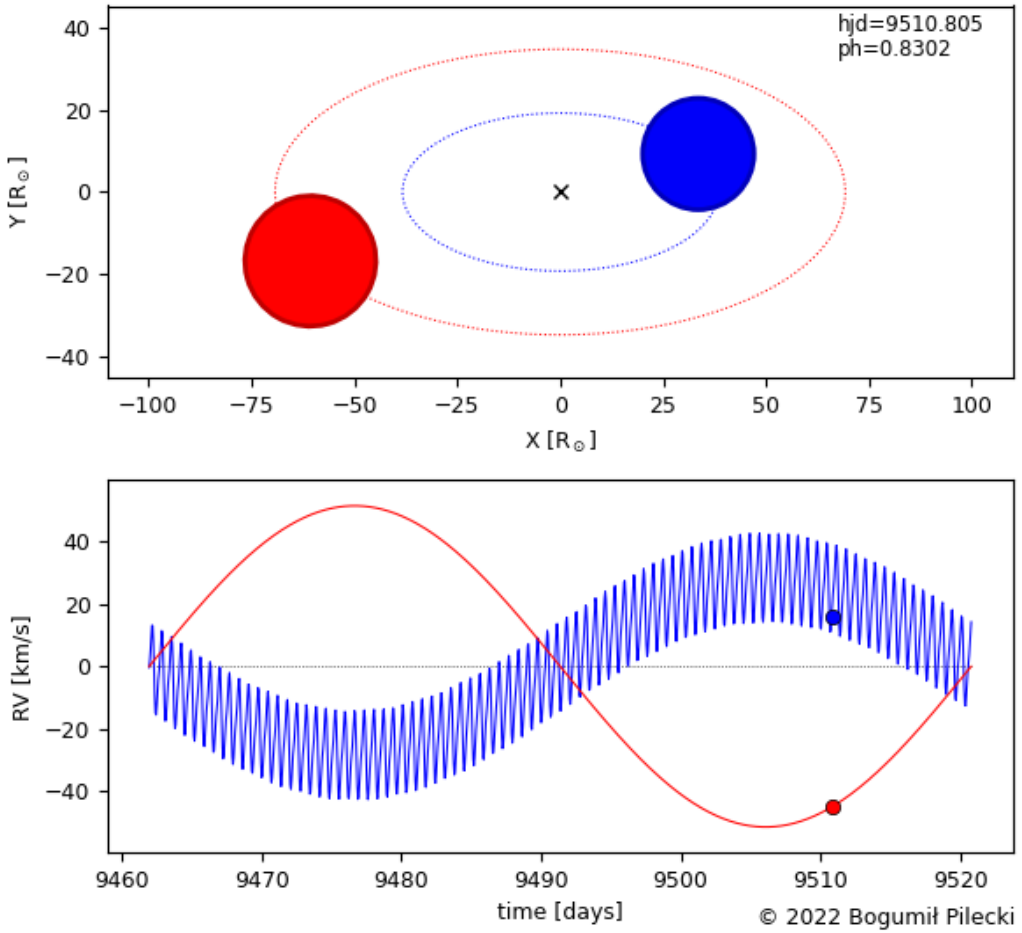


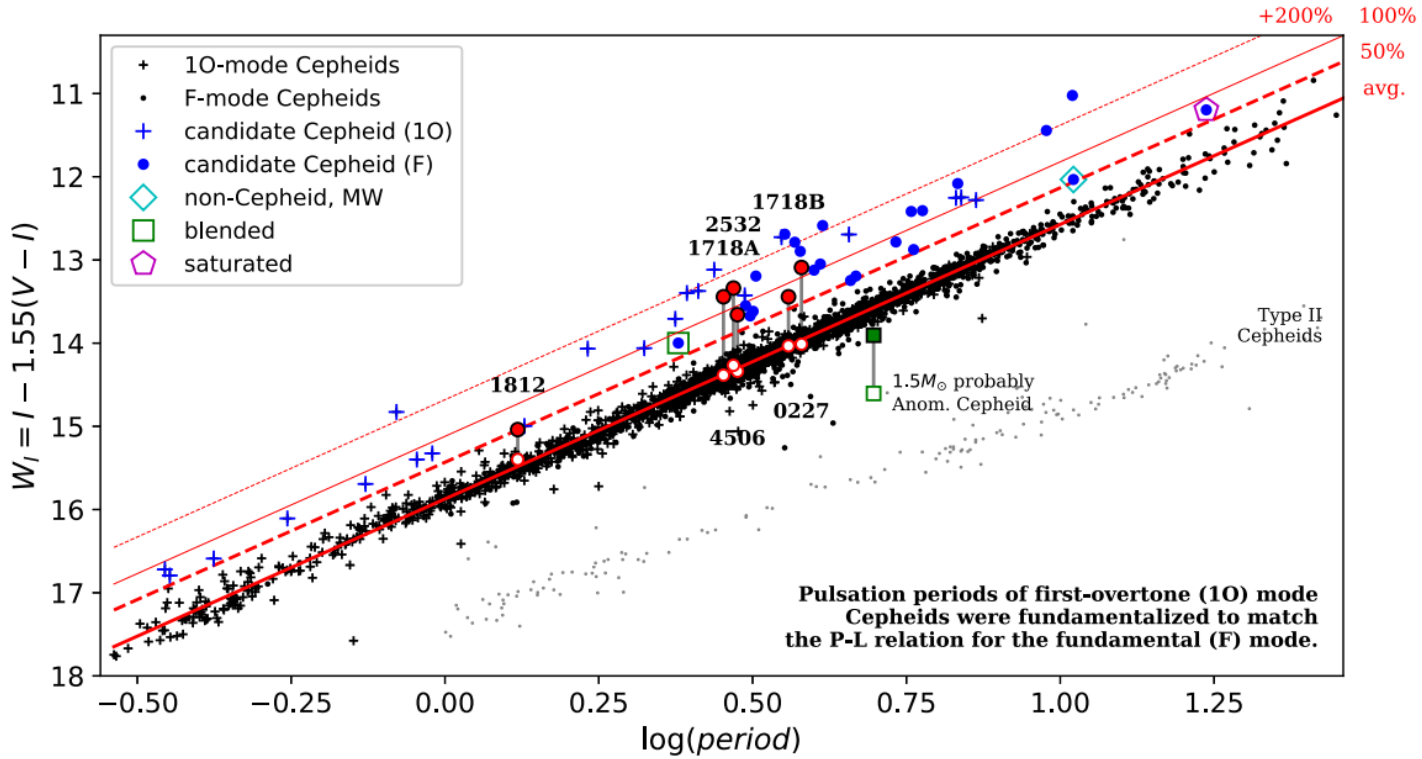




Espinoza-Arancibia et al. 2024, A&A, 682, A185

Double-lined binary systems (SB2)





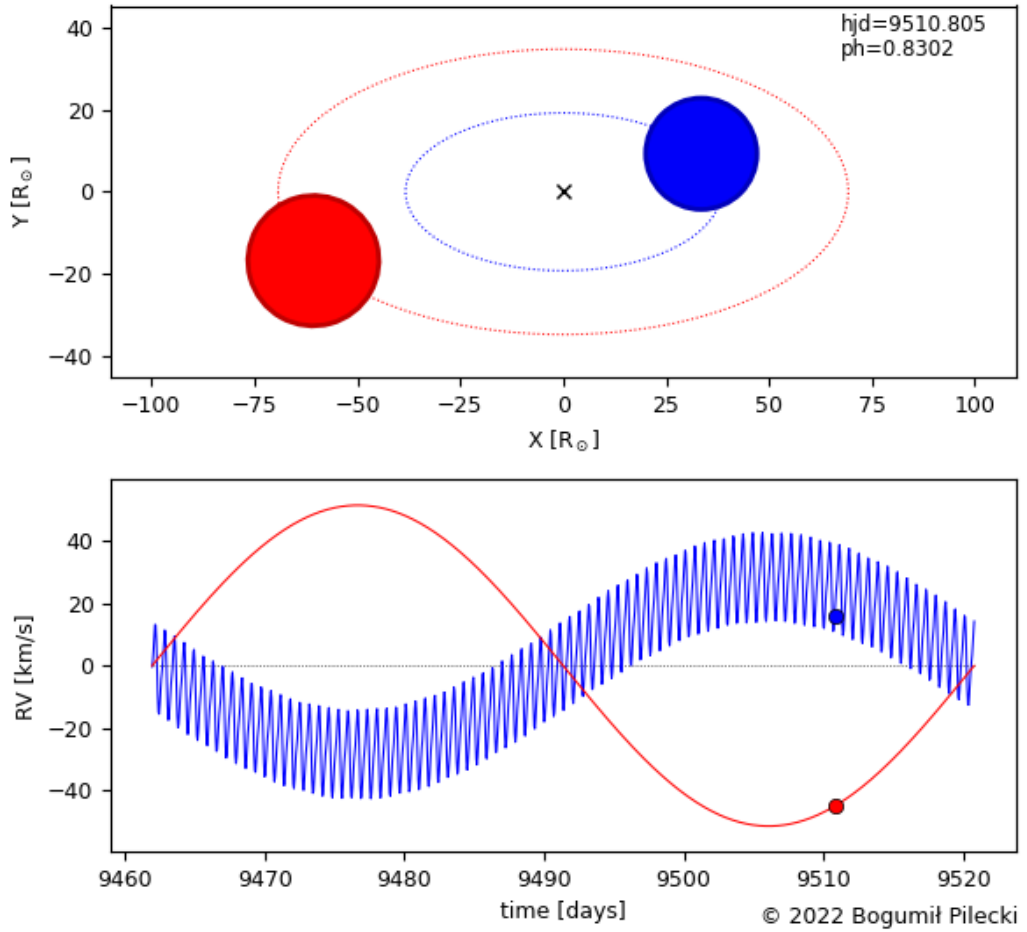
Pilecki B., Thompson, I. B., Espinoza-Arancibia, F. et al. 2022, ApJL, 940, L48

Pilecki B. et al. 2021, ApJ, 910, 118

Double-lined binary systems (SB2)

OGLE-LMC-CEP-1347
Pulsating in the first ($P_{1o} = 0.69\ d$) and second overtone ($P_{2O} = 0.556\ d$) modes

The orbital period ($P_{orb} = 59\ d$) of the system is five times shorter than the shortest known to date for a binary Cepheid



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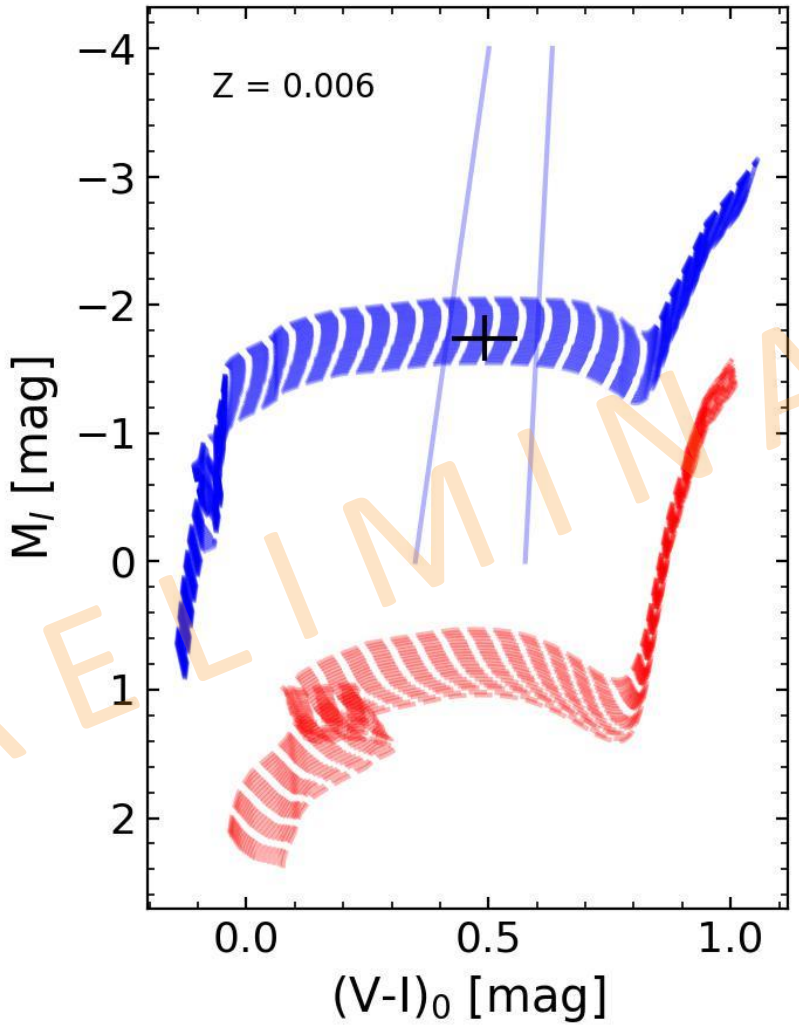

Espinoza-Arancibia et al. in prep.

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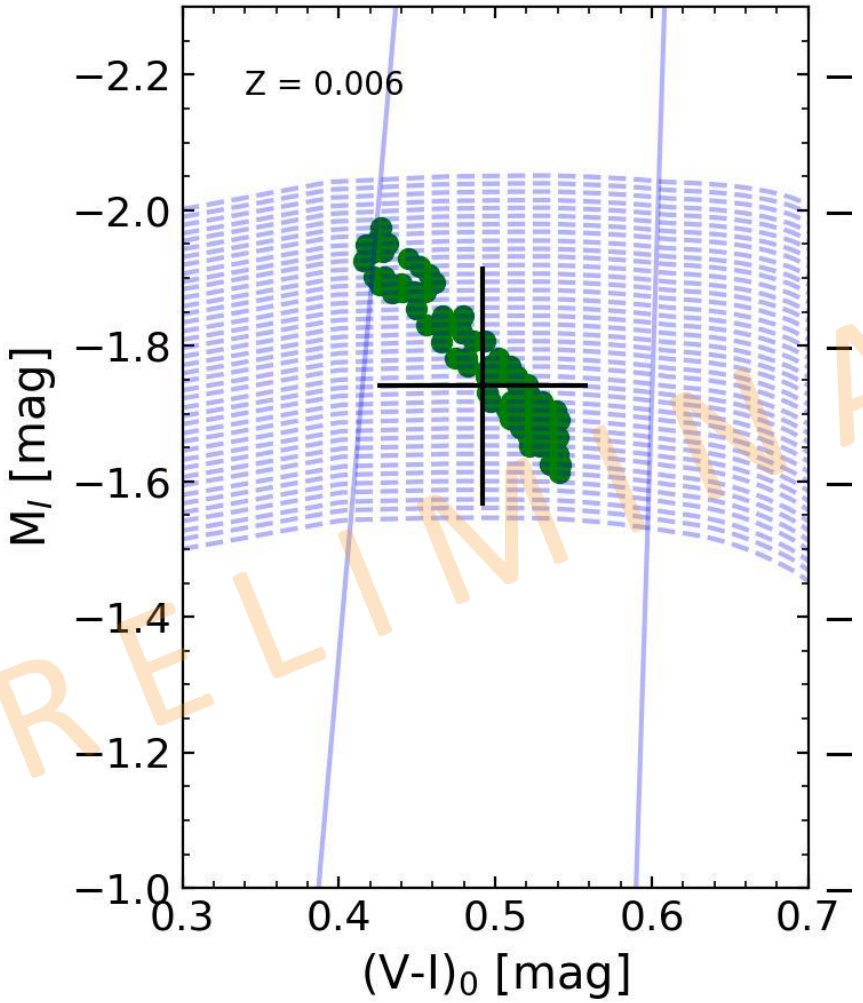
MESA-RSP



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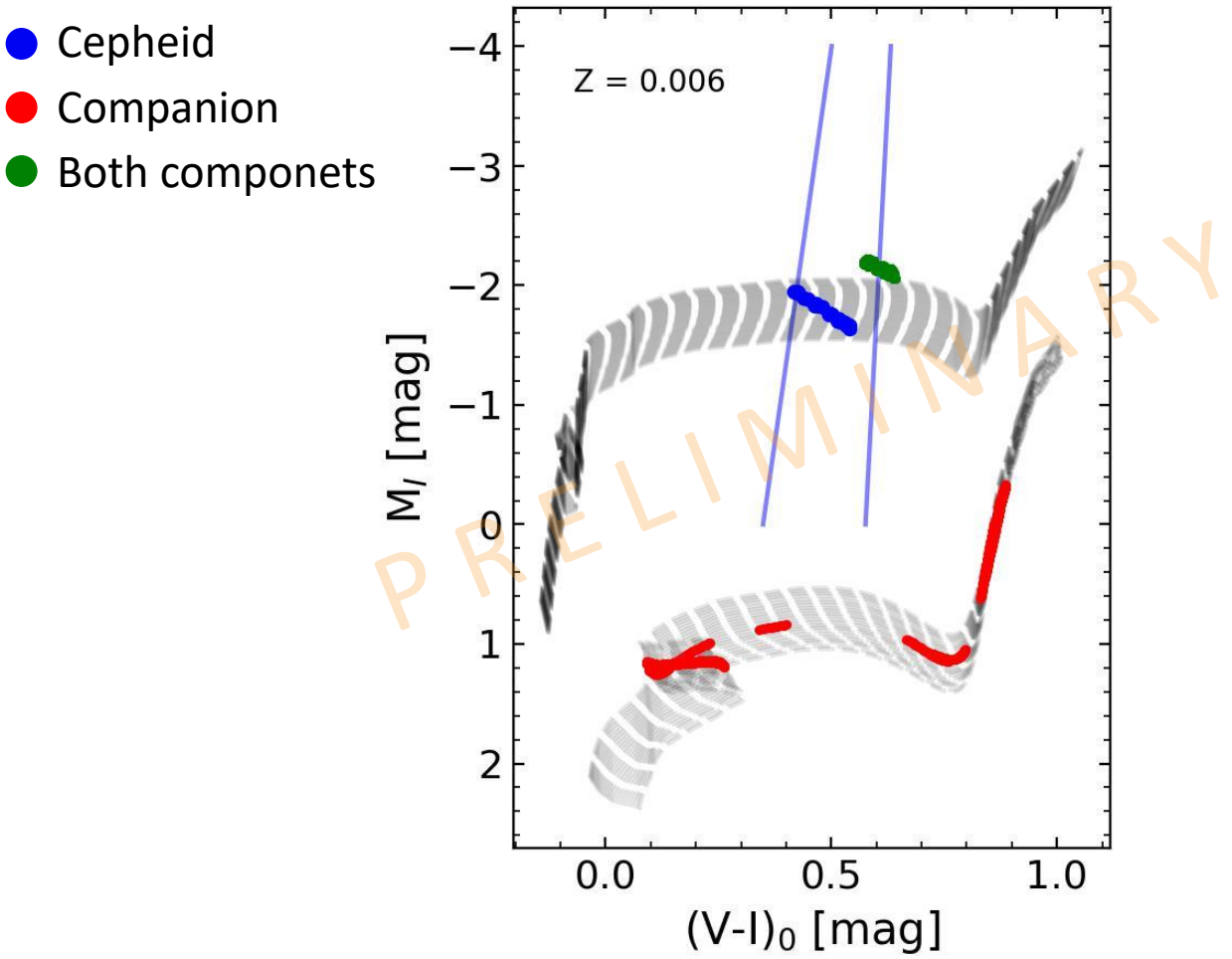
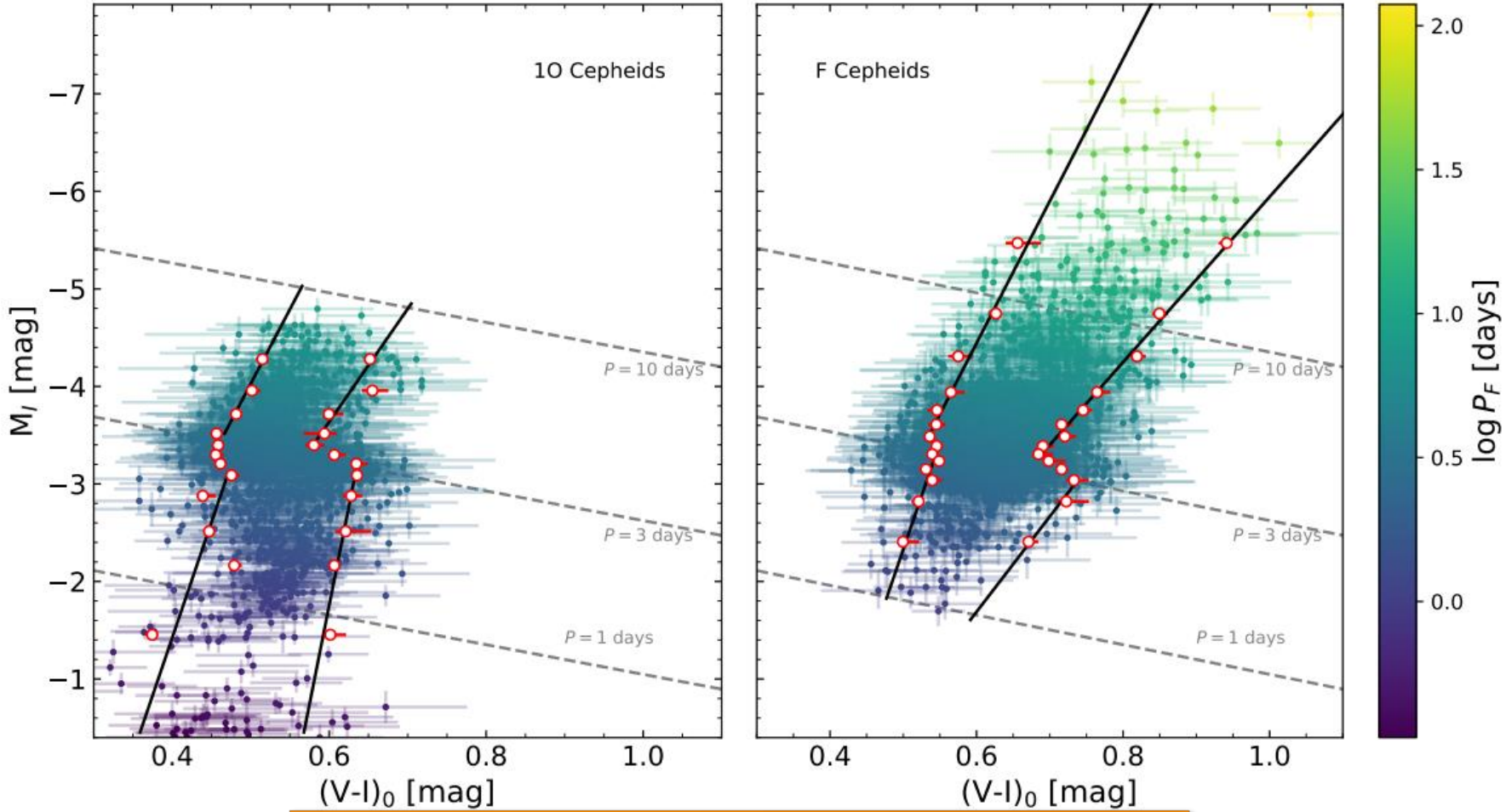
MESA-RSP

= Model the complete system + distance + reddening



Espinoza-Arancibia et al. in prep.

Conclusions

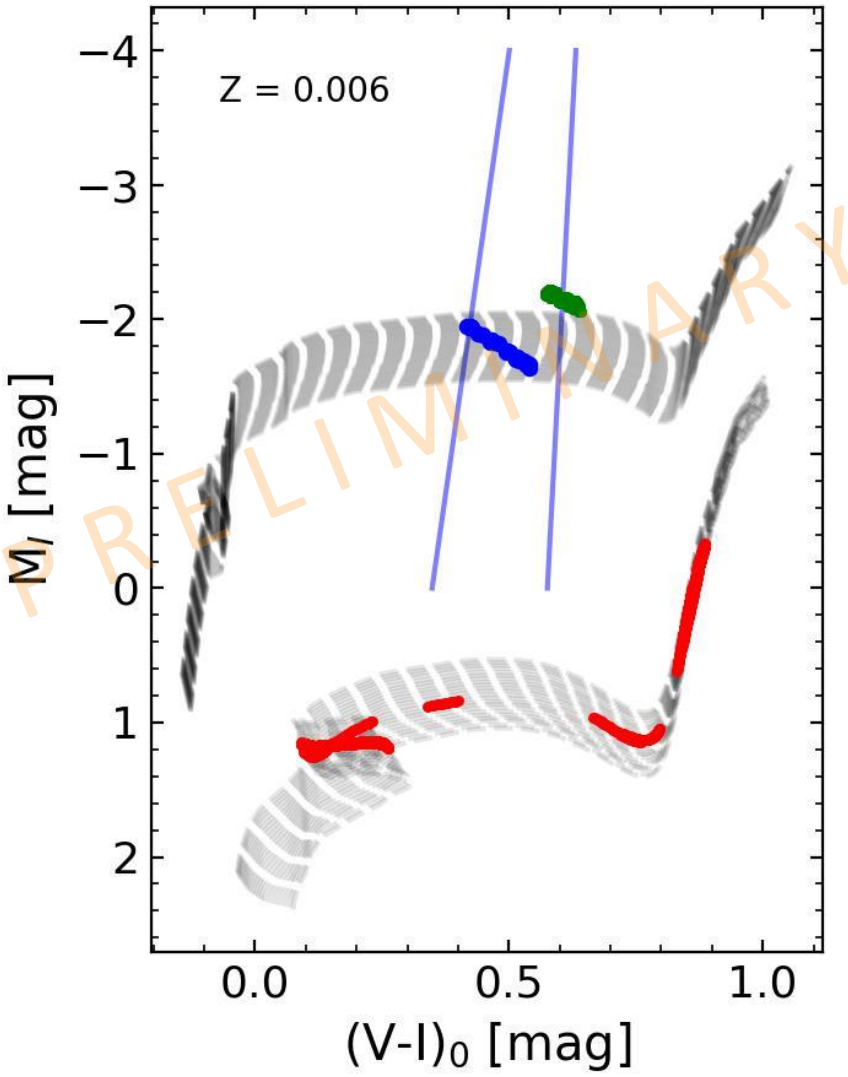


Useful tool to constrain theoretical models

Espinoza-Arancibia et al. 2024, A&A, 682, A185

Conclusions

Useful tool to constrain theoretical models and physical parameters



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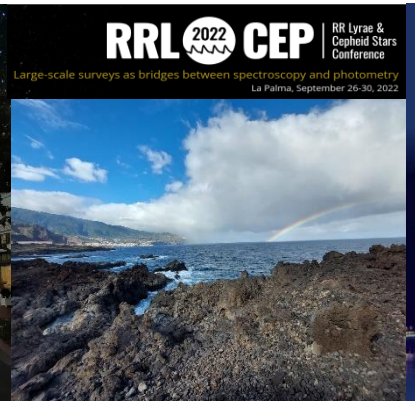
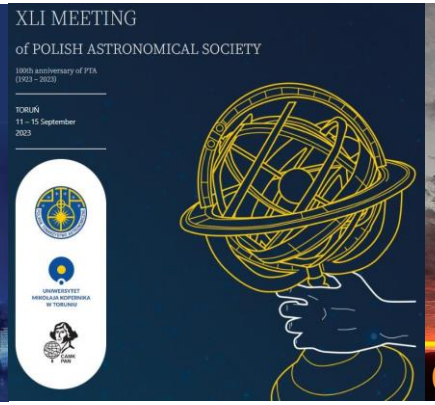
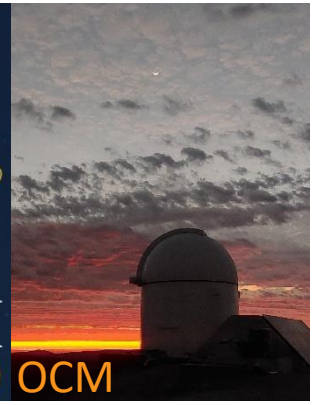
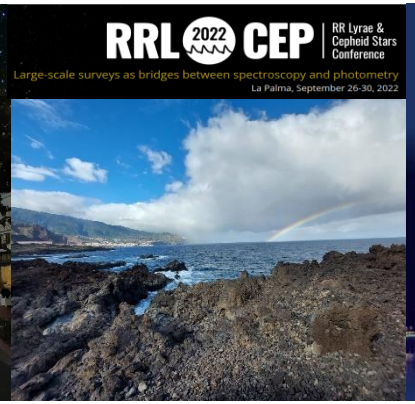
Conclusions

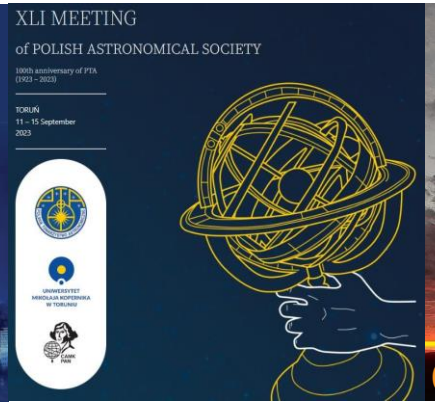


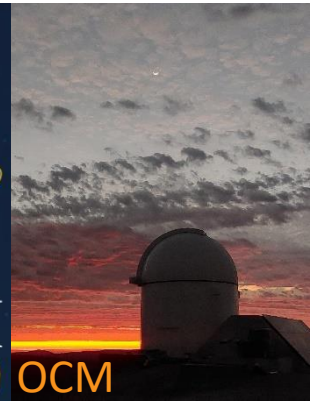




Thanks!







https://users.camk.edu.pl/fespinoza/