Interior rotation and ages of A/F-type stars

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Aims

Measuring rotation, ages and (core) masses
In main-sequence A/F-type stars

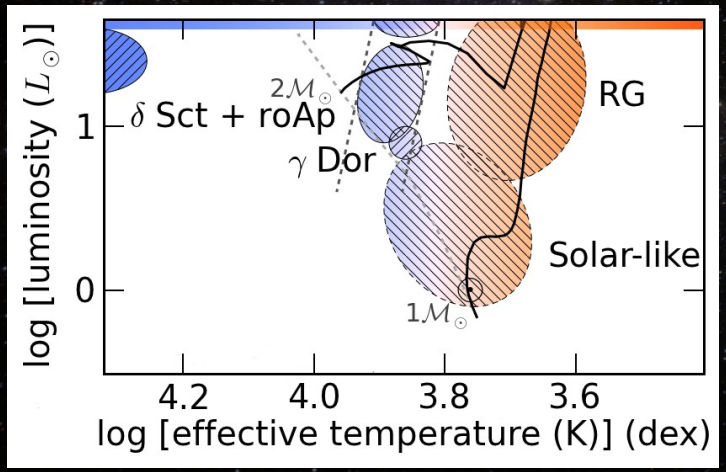
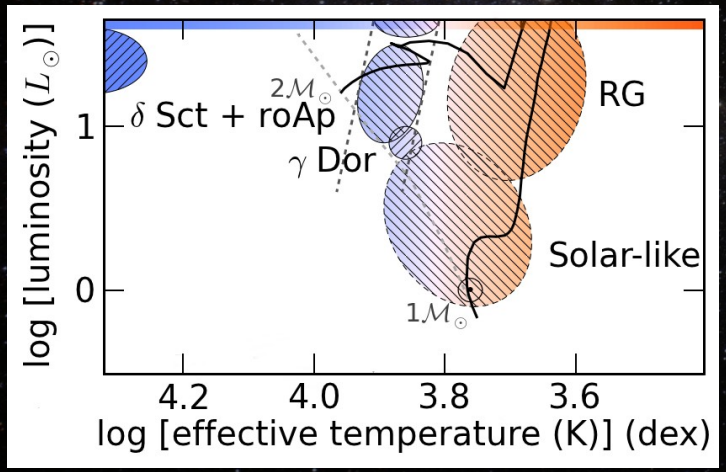


Figure courtesy of P. I. Pápics

Aims

Measuring rotation, ages and (core) masses
In main-sequence A/F-type stars

= Red Giant progenitors
(cfr. talk by C. Gehan)



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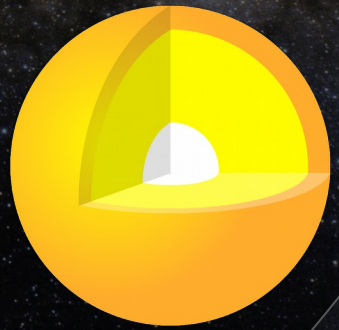


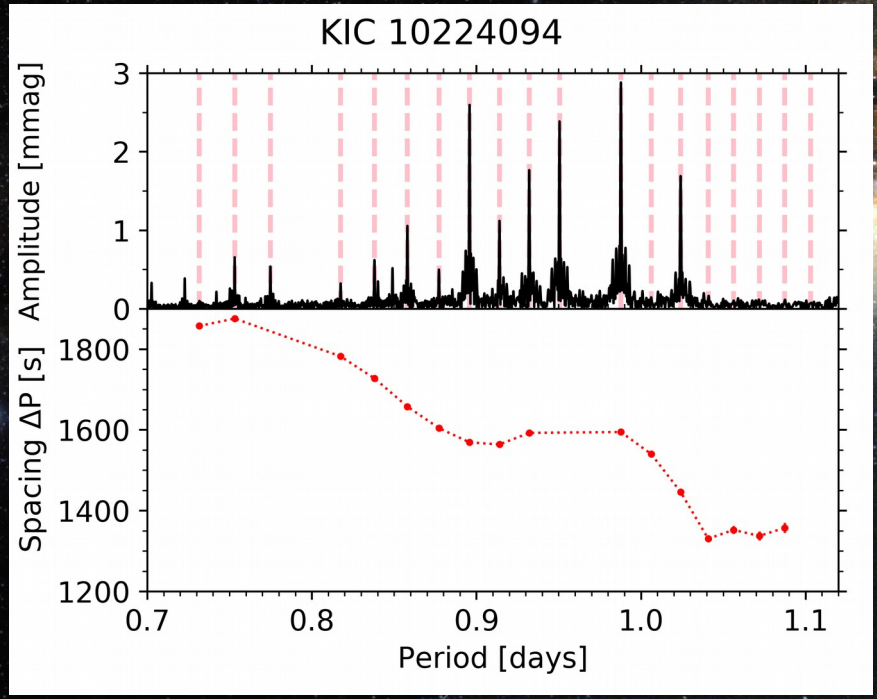
Gravity-mode asteroseismology

probing near-core physics:

rotation, mixing processes,
magnetic fields, …

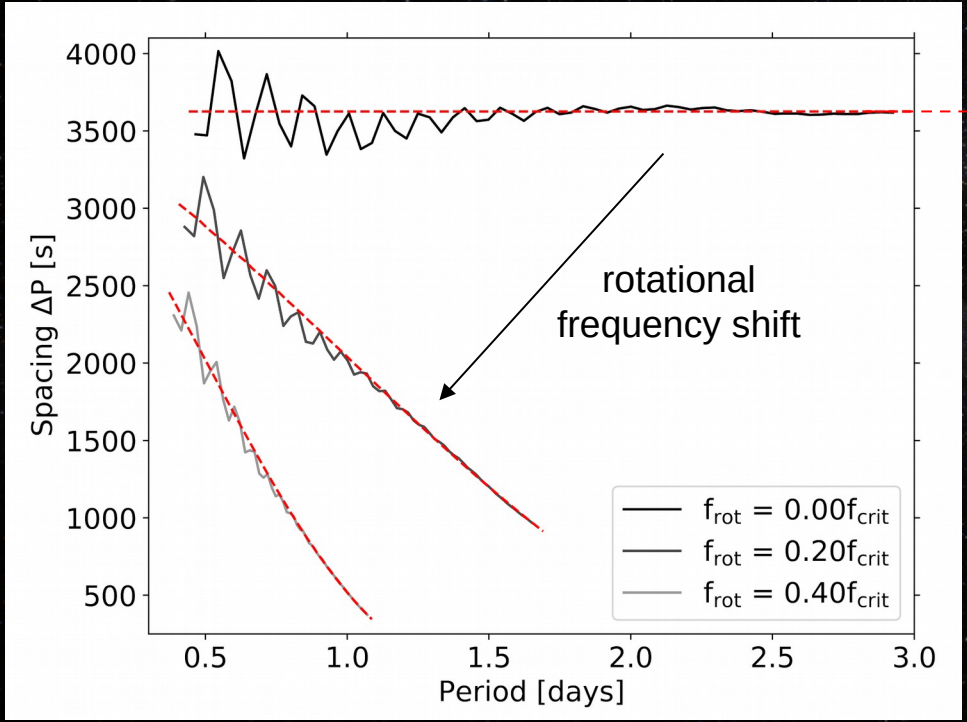
≳ 1 year of observations required:

- *Kepler*
- TESS - CVZ (+ extended mission)
- PLATO - long pointing



Van Reeth et al. 2015

Constraining rotation with gravity-modes



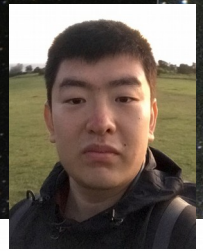
$$\Delta\Pi_l = \frac{\Pi_0}{l(l+1)}$$

Π_0 = “buoyancy radius”

= *info on the interior stellar structure*

(e.g.,Van Reeth et al. 2016, Ouazzani et al. 2017, Christophe et al. 2018, Li et al. 2019)

Differential rotation



Required for detection:

- ≥ 2 period spacing patterns, or
- info on the outer stellar layers from
  - pressure modes
  - rotational modulation

Moderate to fast rotating M-S A/F-type stars rotate (quasi-)rigidly.

Van Reeth et al. 2018, A&A, 618, A24
Li et al. MNRAS, submitted.

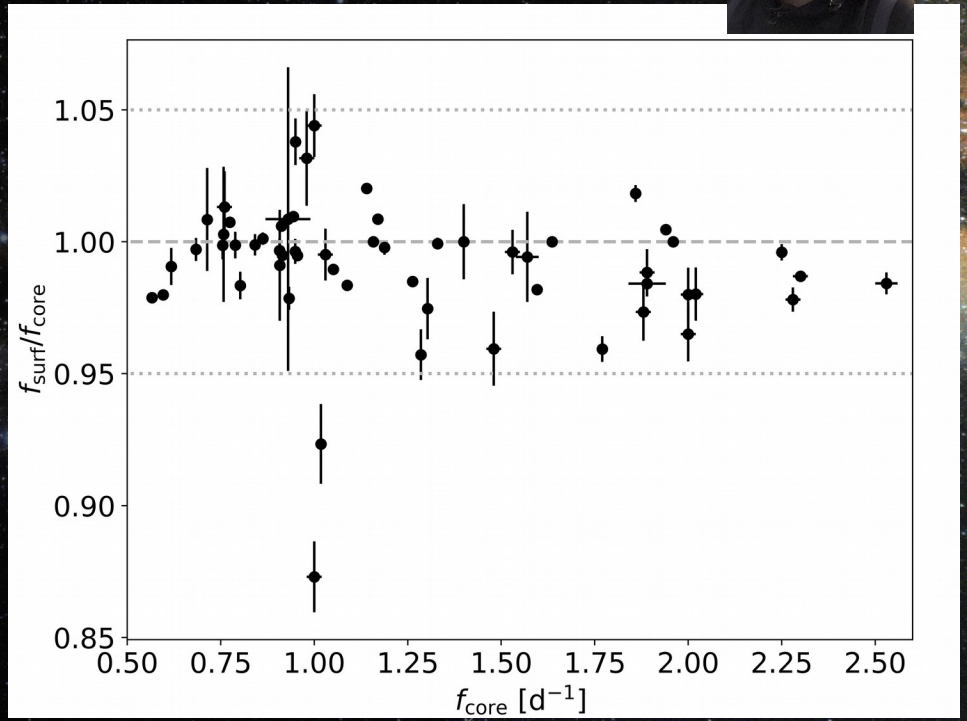
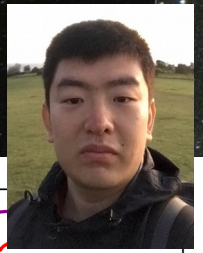


Figure courtesy of Gang Li (Li et al., MNRAS, submitted)

Ensemble analysis of stellar rotation



Angular momentum transport

= missing in the models

But: buoyancy radius Π_0

≠ sufficient to constrain the stellar age

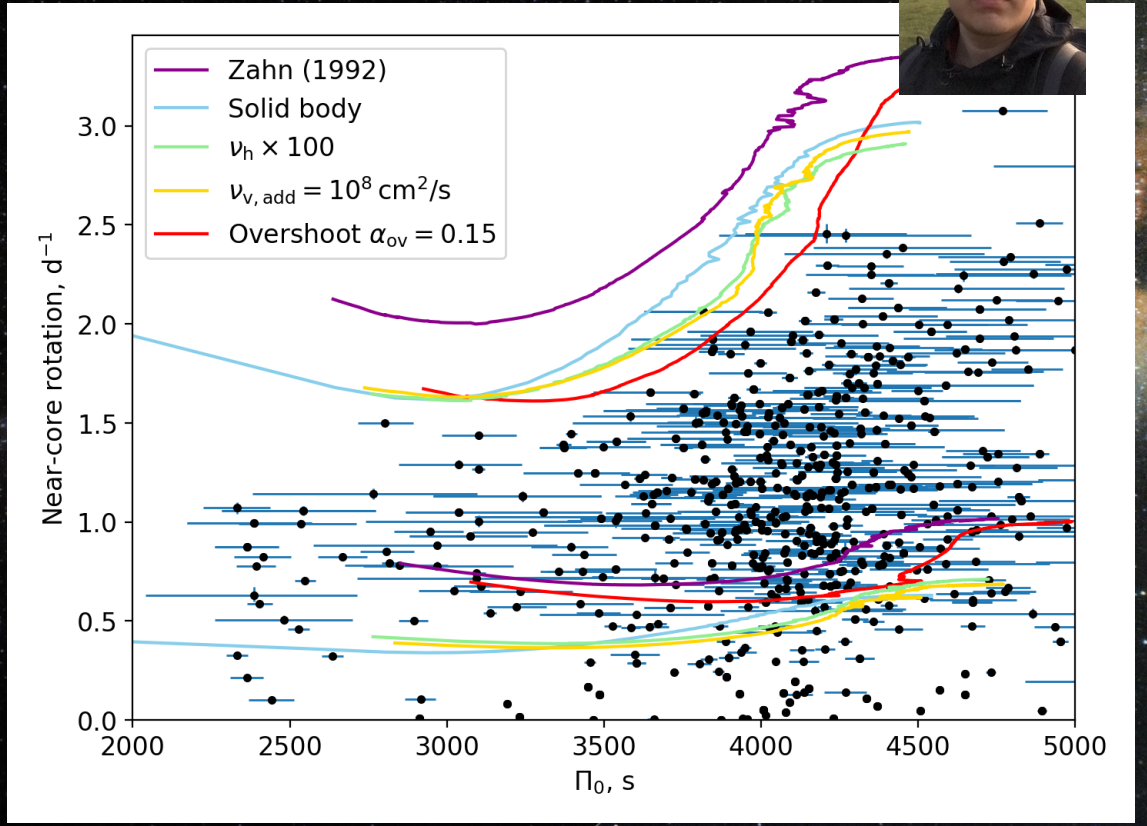


Figure courtesy of Gang Li
(Li et al., MNRAS, submitted)
Theoretical models by Ouazzani et al. (2019)

The buoyancy radius Π_0

Mombarg et al. 2019, MNRAS, 485 (3), 3248-3263.

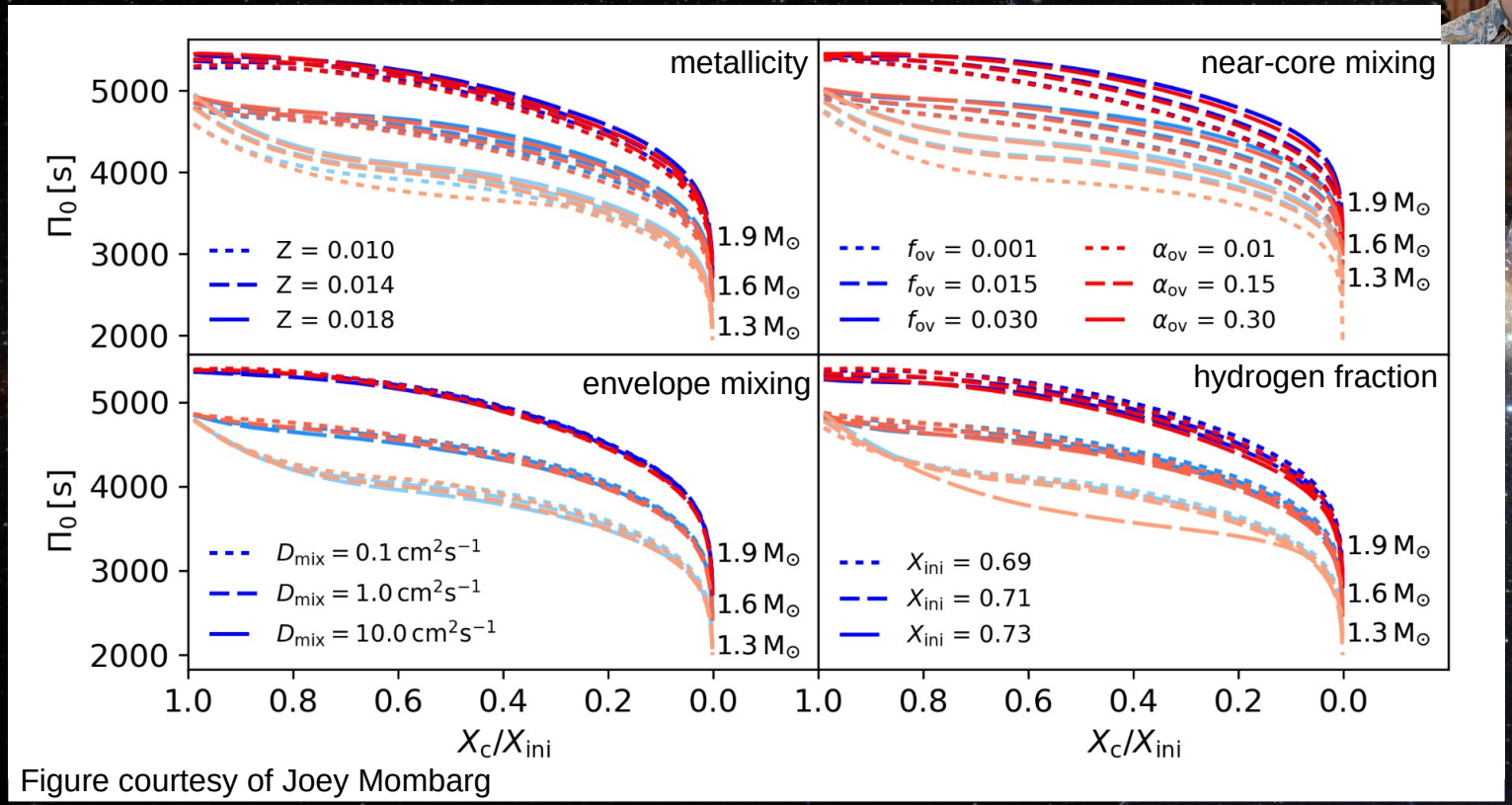
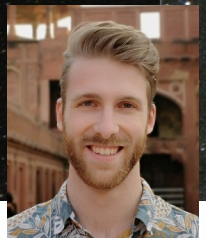


Figure courtesy of Joey Mombarg

Forward ensemble modelling

Mombarg et al. 2019, MNRAS, 485 (3), 3248-3263.

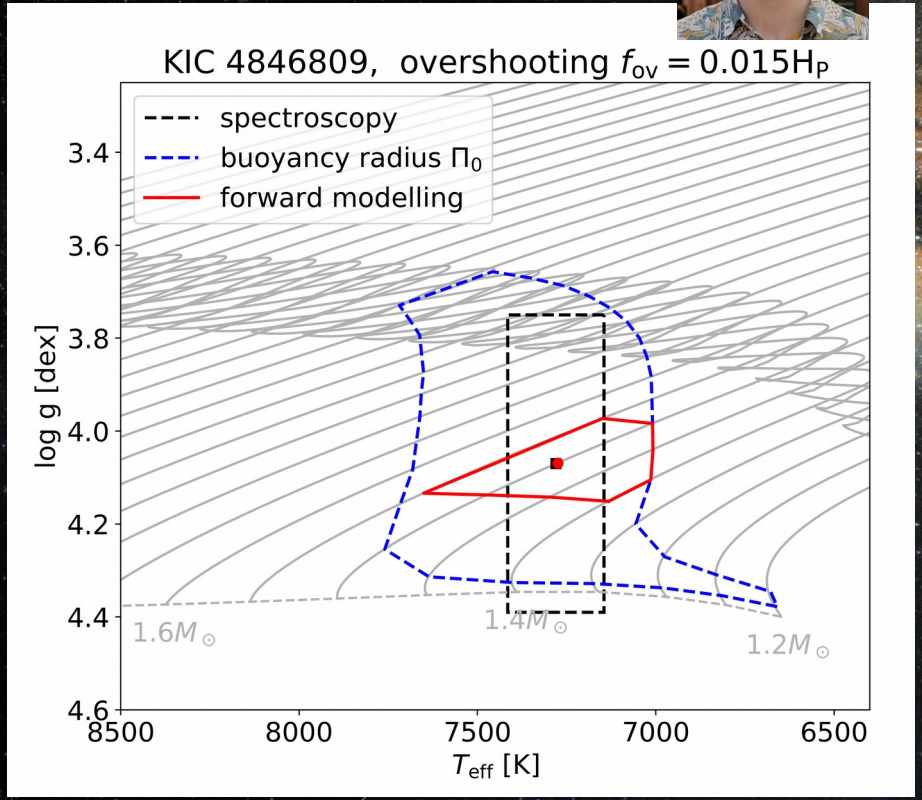


T_{eff} & log g
(spectroscopy)

Π_0
(asteroseismology)

MESA
stellar evolution models

constrain stellar ages & masses
(down to *~10% precision)*



Ensemble modelling of gravity-mode pulsators

Mombarg et al. 2019, MNRAS, 485 (3), 3248-3263.

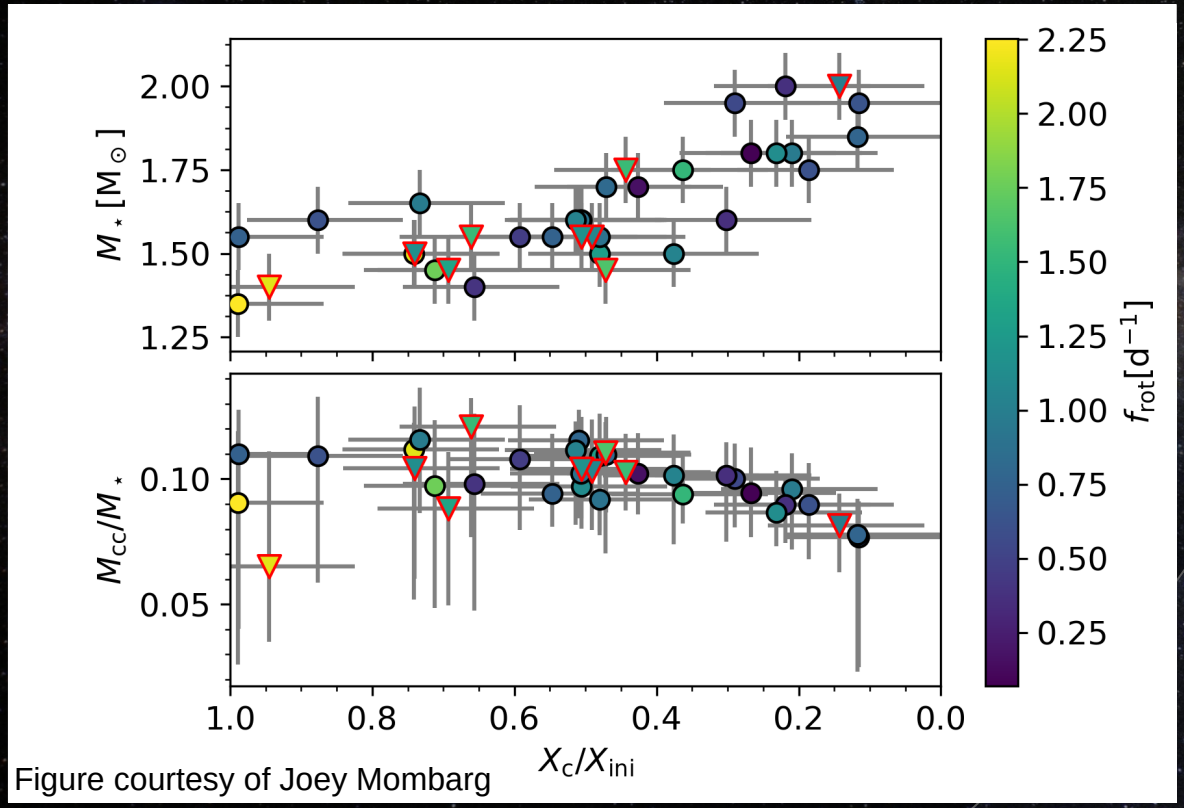


Figure courtesy of Joey Mombarg

Conclusions & future prospects

- Gravity-mode pulsations provide information on the near-core physics in main-sequence A/F-type stars:
  - (quasi-)uniform rotation
  - (core) masses
  - stellar ages

    down to *~10% precision*

  matching the PLATO science goals

- Future modelling: mixing processes, magnetism, etc.
- More stars needed: PLATO long pointing observations


Extra slides

Ensemble modelling - effect of the overshooting

Mombarg et al. 2019, MNRAS, 485 (3), 3248-3263.