Core Overshooting and Extra Mixing in Two Kepler SPBs

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What?

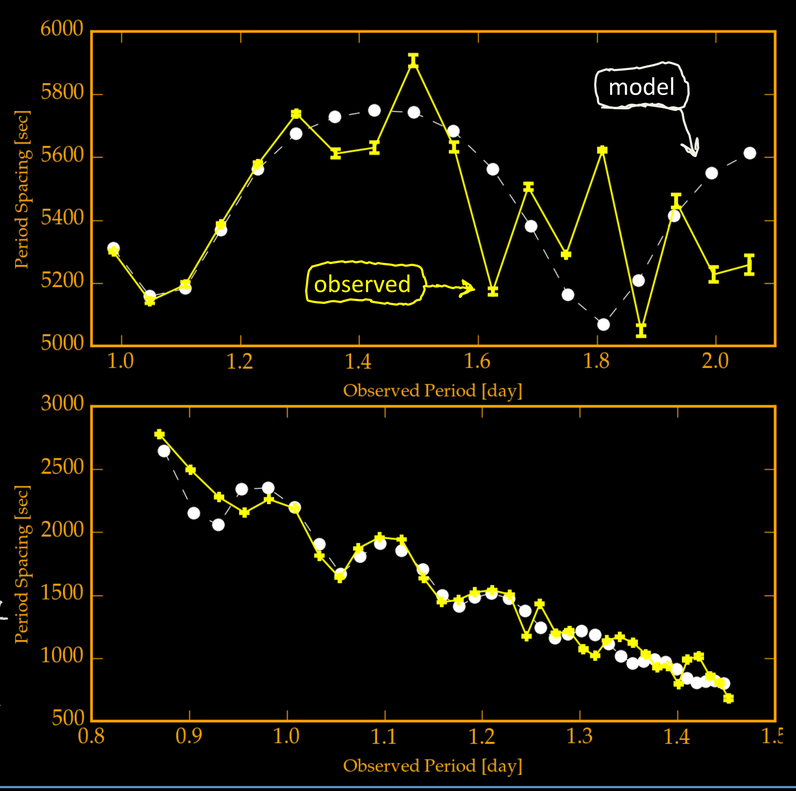
How?

(1) Observations

KIC 10526294
(3.25 $M_\odot$)
$v \sin i = 7$ km sec^{-1},
19 g-modes: l=1, m=0

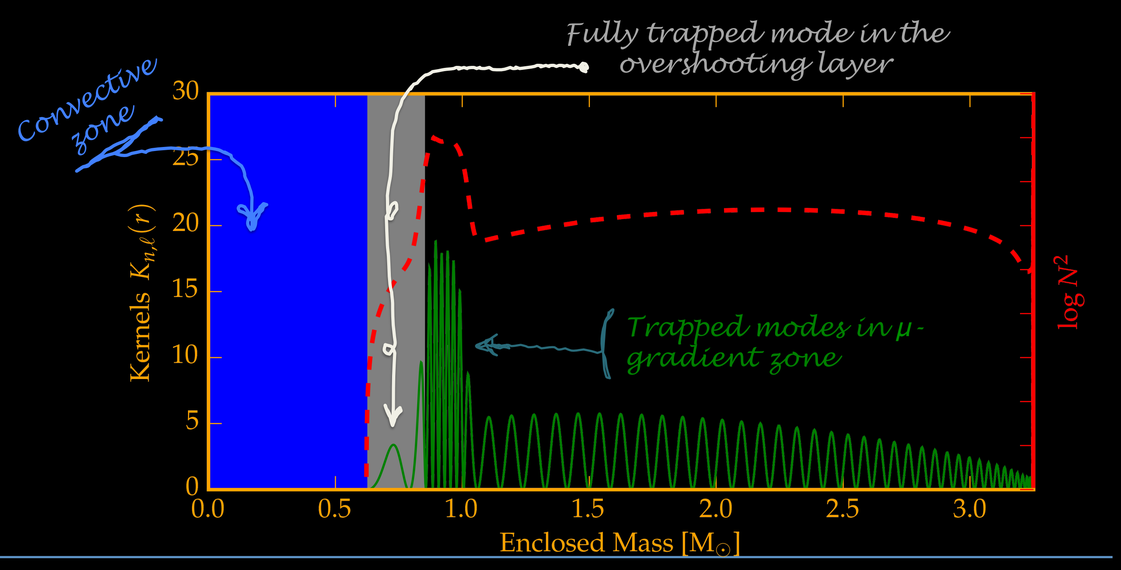
KIC 7760680
(3.25 $M_\odot$)
$v \sin i = 62 \pm 5$ km/s
36 g-modes: l=1, m=+1

For more recent SPBs, see Poster PA S7.27



(2) Mode Trapping

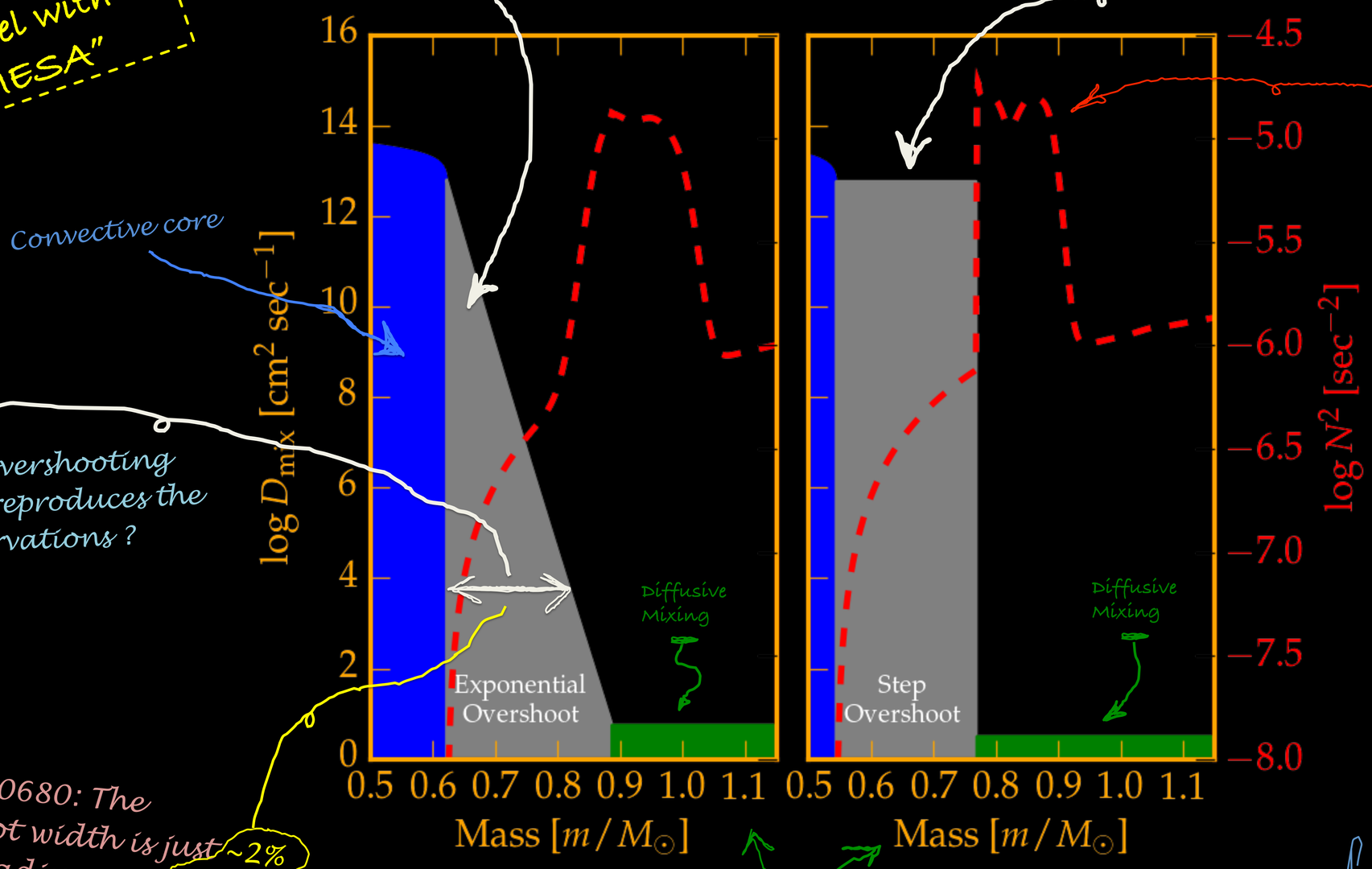
We use trapped g-modes (from GYRE) to constrain the core overshooting, and vertical diffusive mixing in the envelope, through forward modelling.



Modelling of Mixing in SPB.

(3) Simple SPB model with "MESA"

Exponential overshoot works much better than the step-function overshoot !



What overshooting "width" reproduces the observations ?

KIC 7760680: The overshoot width is just ~2% of star radius, and ~8% of the whole star mass.

We also vary diffusive mixing in the radiative envelope, from zero to ... a lot.

Notice : different overshoot shapes give different Brunt-Väisälä profiles.

Detected g-modes require little mixing of 5 to 55 cm²/sec.

Theory (rotational mixing) predicts at least a 1000 times stronger mixing in the envelope!

What's missing here?

Results

(4) Agreement with Numerical Simulations

- For KIC 10526294: $f_{ov}=0.017\pm0.001$, and $\log D_{mix}=1.75\pm0.25$ cm²/sec.
- For KIC 7760680: $f_{ov}=0.024\pm0.001$, and $\log D_{mix}=0.75\pm0.25$ cm²/sec. It rotates at 26% Roche break-up frequency.
- For KIC 7760680 which rotates faster, higher overshoot was needed, perfectly agreeing with 3D simulations of Browning et al. (2004, ApJ).

(5) Plans for the Future

- Modelling the new Kepler SPBs (Poster PA.S7.27)
- Computing a large grid of massive stars, and modelling all SPB + β Cep stars in the literature.
- Does core overshooting and diffusive mixing depend on stellar mass? on age, or on rotation rate?
- Do our findings agree with 2D/3D simulations?
- Can we calibrate 1D evolutionary tracks?

More Info?

ASAMBA (AsteroSeismic Approach towards understanding Massive B stArs) is a Marie Curie FP7 funded project, hosted by KU Leuven, Belgium.

With ASAMBA, we share our opacity tables, and seismic models with you. Just scan this QR code and get started ...

Please, help yourself with a free copy of: the poster, KIC 10526294 paper, and KIC 7760680 paper.