

Investigating Stellar Interiors: Binaries & Asteroseismology

Cole Johnston

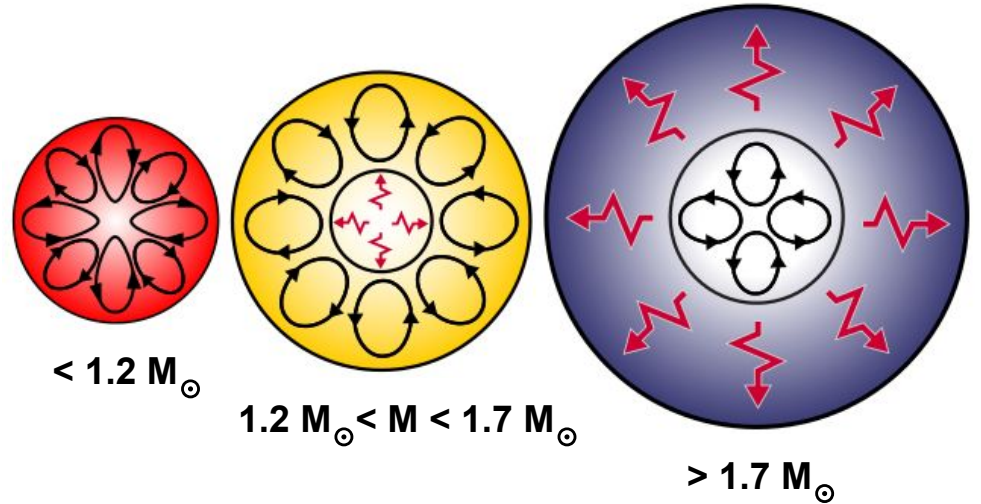
Supervisor: Prof. Conny Aerts

Collaborators



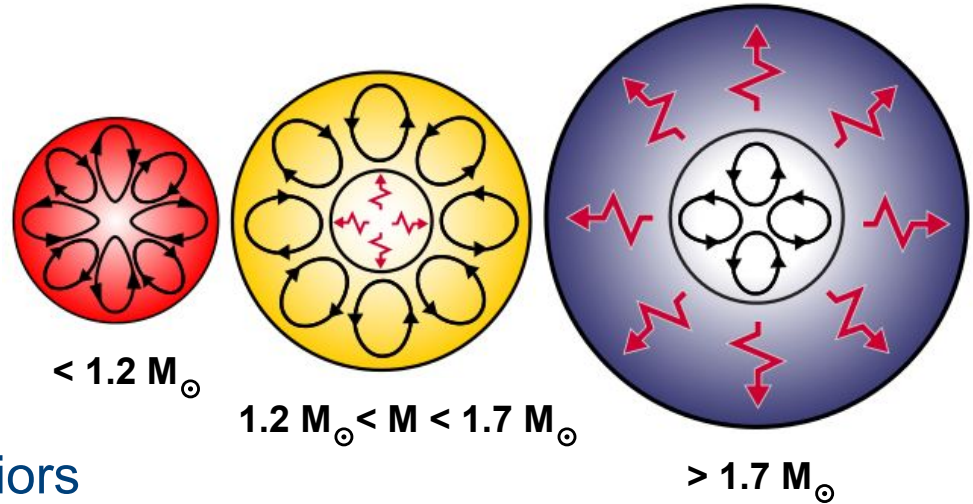
Stellar Structure & Evolution

- ❖ $M < 1.2 M_{\odot}$: Radiative Core
- ❖ $1.2 M_{\odot} < M < 1.7 M_{\odot}$:
Radiative \rightarrow Convective Core
- ❖ $M > 1.7 M_{\odot}$: Convective Core



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- Goal: Investigate Stellar Interiors
 - Rotation
 - Overshooting
 - Chemical Mixing

Traditional Methodologies

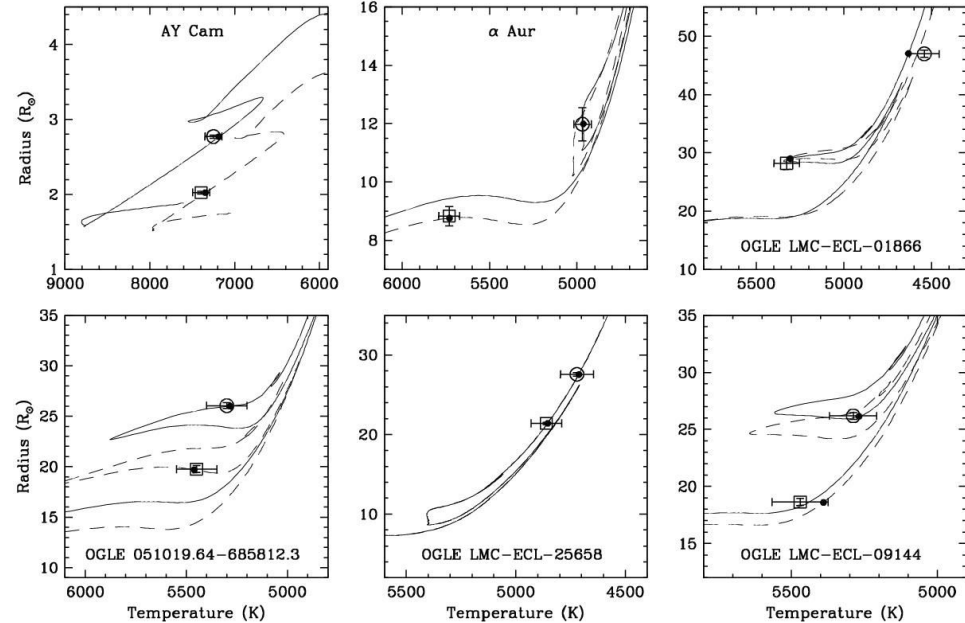
- ❖ Binary Isochrone Fitting
- ❖ Asteroseismology

Methodologies: Binarity

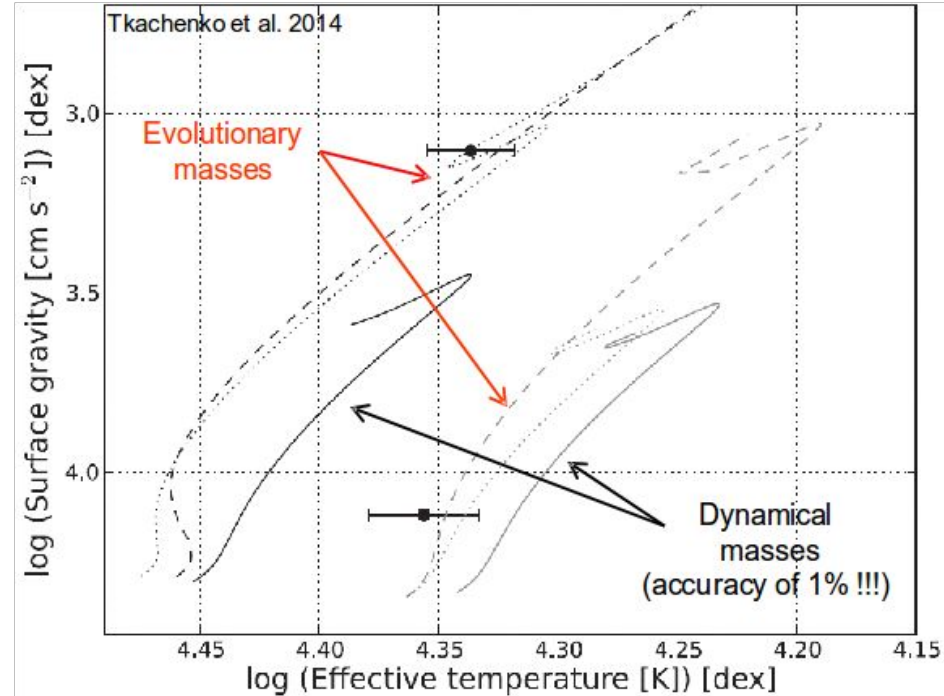
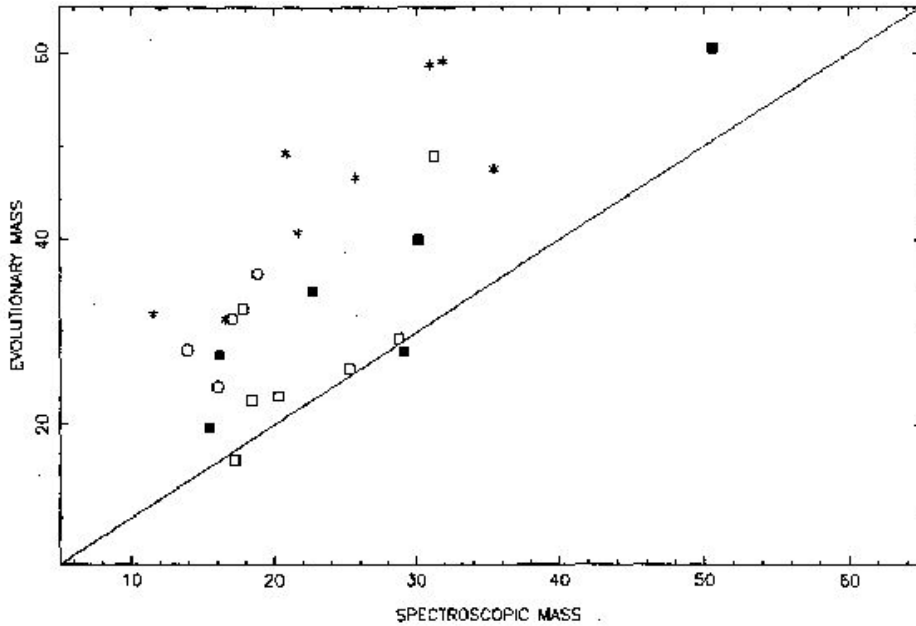


What Is Assumed:

- Co-Evolutionary
- Same Chemical Composition
- Match Isochrones to observed T_{eff} , $\log g$, mass
- OR Assume Dynamic Mass \rightarrow Fit overshooting

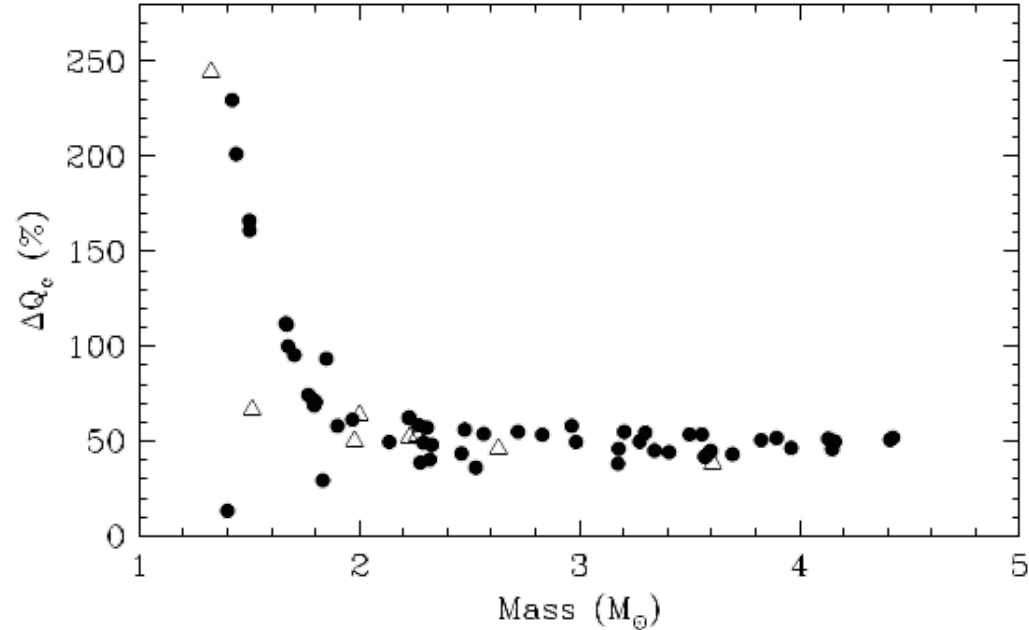
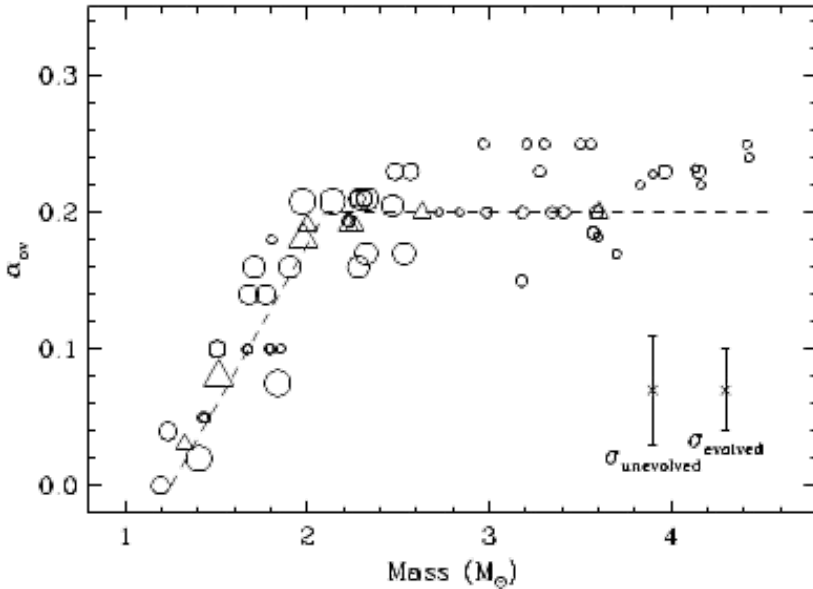


Problems: Binarity



7

Problems: Binarity

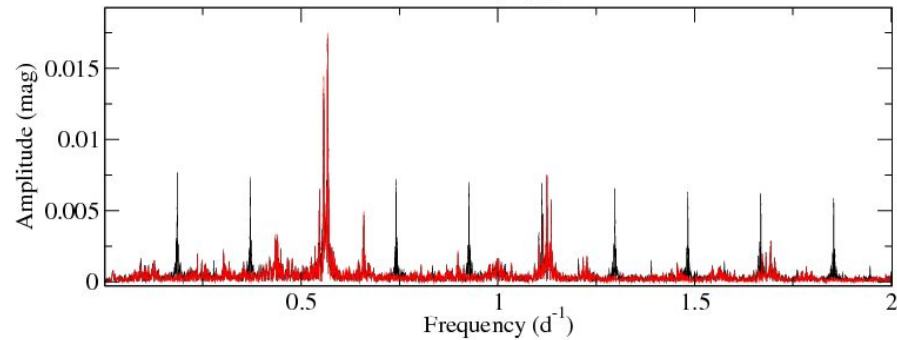
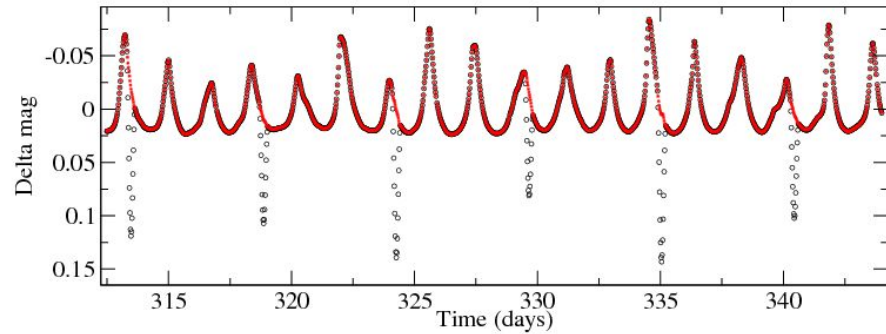
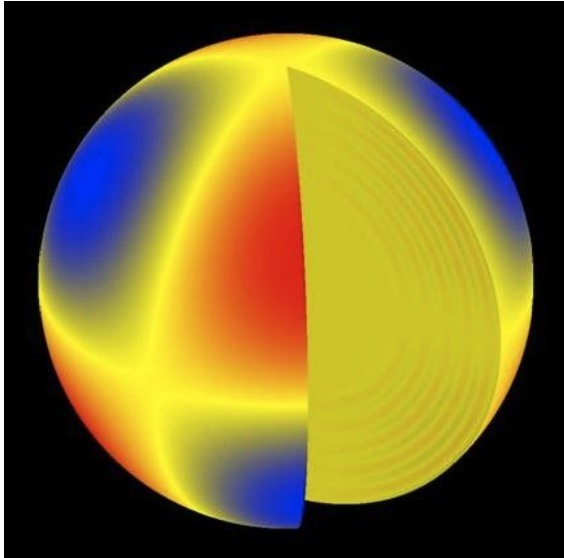


- ❖ Models Need More Massive Cores To Match Observations!!

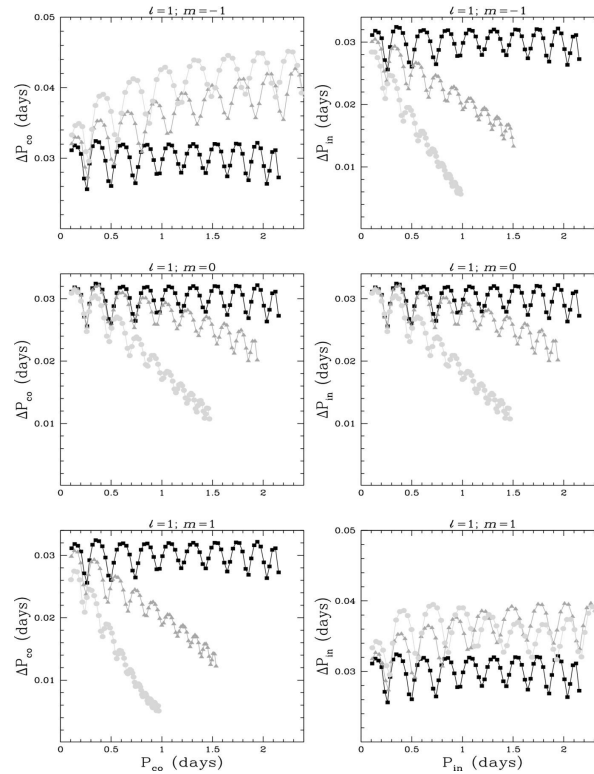
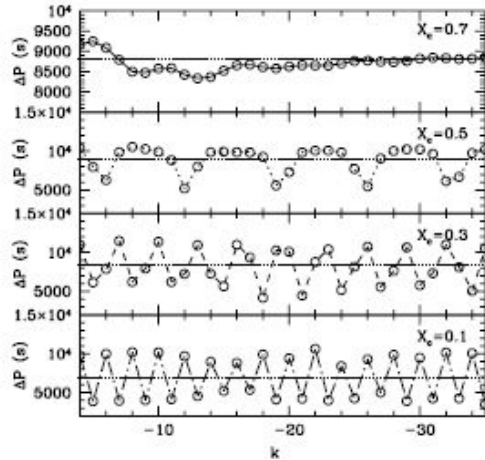
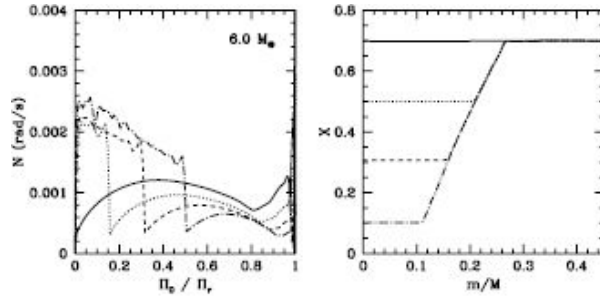
Methodologies: Asteroseismology



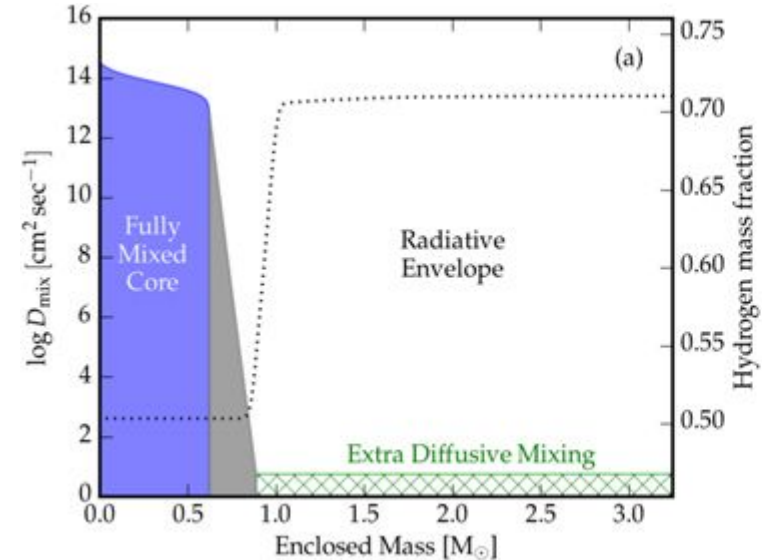
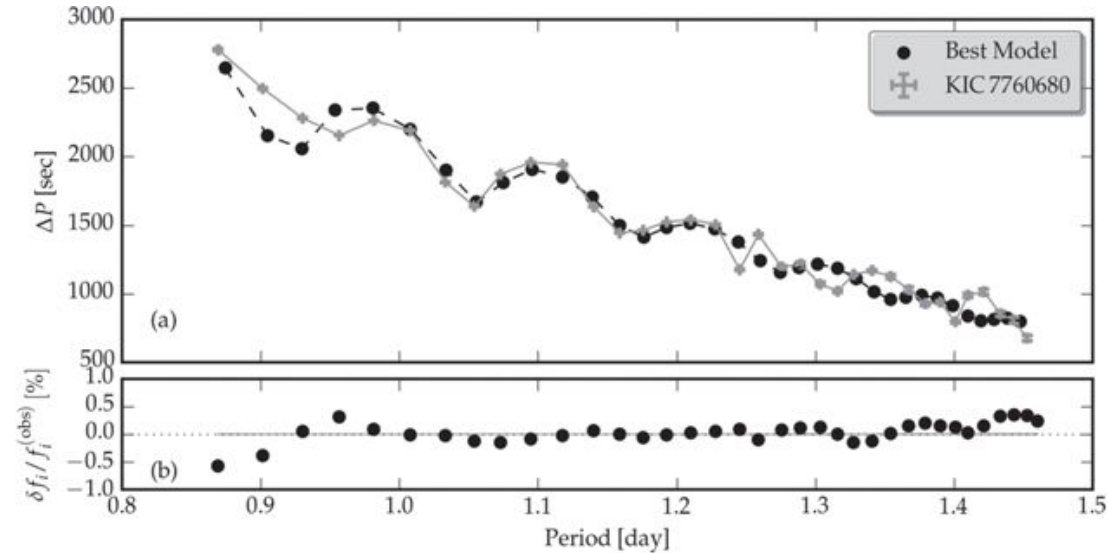
Methodologies: Asteroseismology



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Problems: Asteroseismology

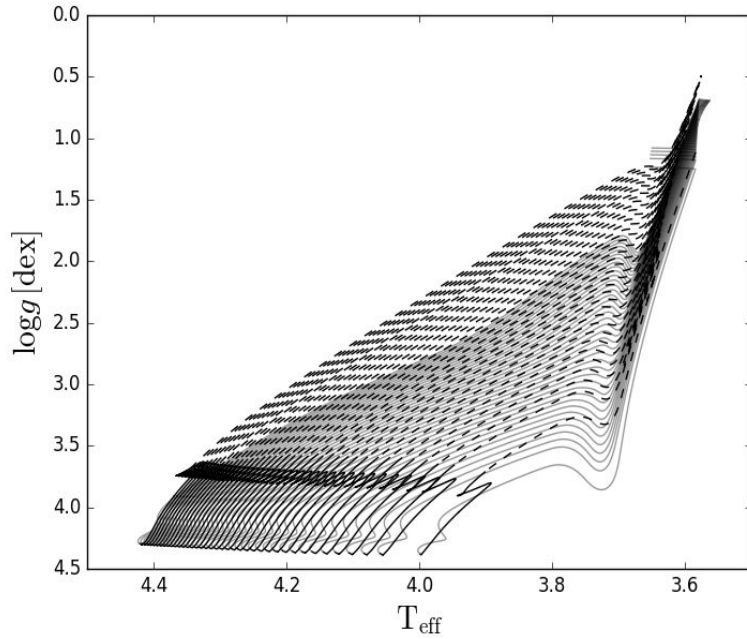


- ❖ Shape & Extent of Overshoot Region Matter!
 - Models Need Larger Cores

Stellar Structure & Evolution

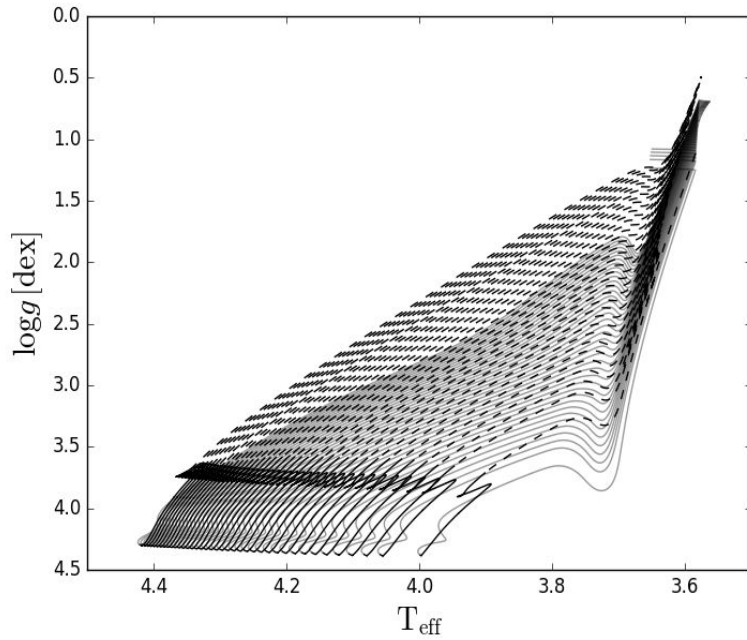
- ❖ Points to Missing or Incorrectly Parameterized Physics:
 - Rotation → impact on chemical Evolution
 - Atomic Diffusion
 - Mass Loss
 - Convection: MLT
 - Schwarzschild / Ledoux Criterion
 - Overshooting
 - Angular Momentum Transport

This Methodology:



- 1) Simultaneous ISO & SEISMOLOGY
- 2) Allow different mixing for Primary & Secondary
- 3) Hound & Hare:
→ Pulsating Star in SB2 / EB

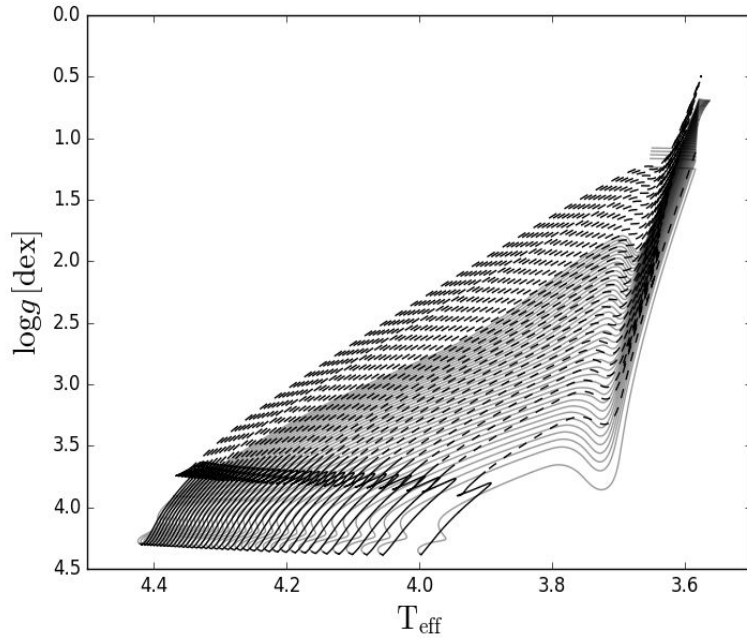
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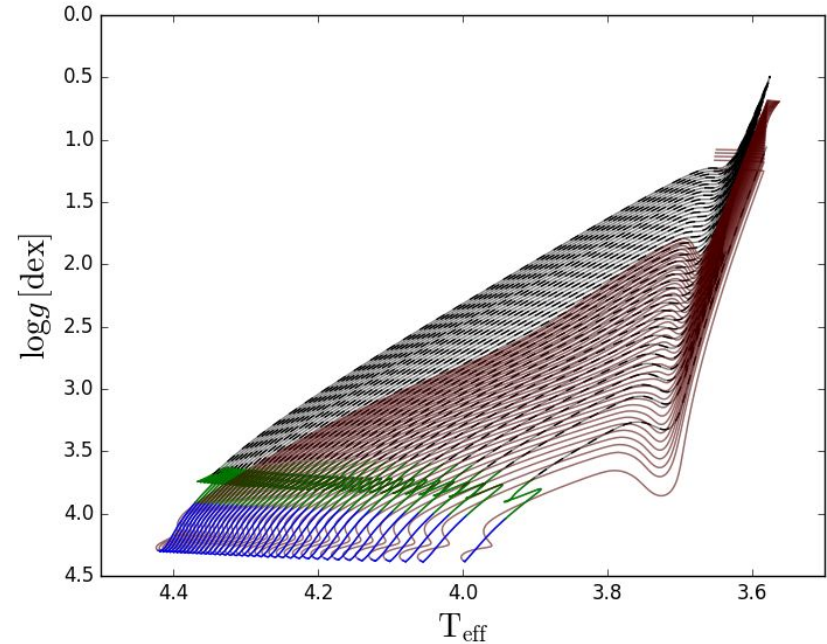
MESA & GYRE

- ❖ Sample parameters:
 - $M_{\text{ini}}, Z_i, f_{\text{ov}}, D_{\text{mix}}, X_C(\text{age}), \Omega_{\text{rot}}$

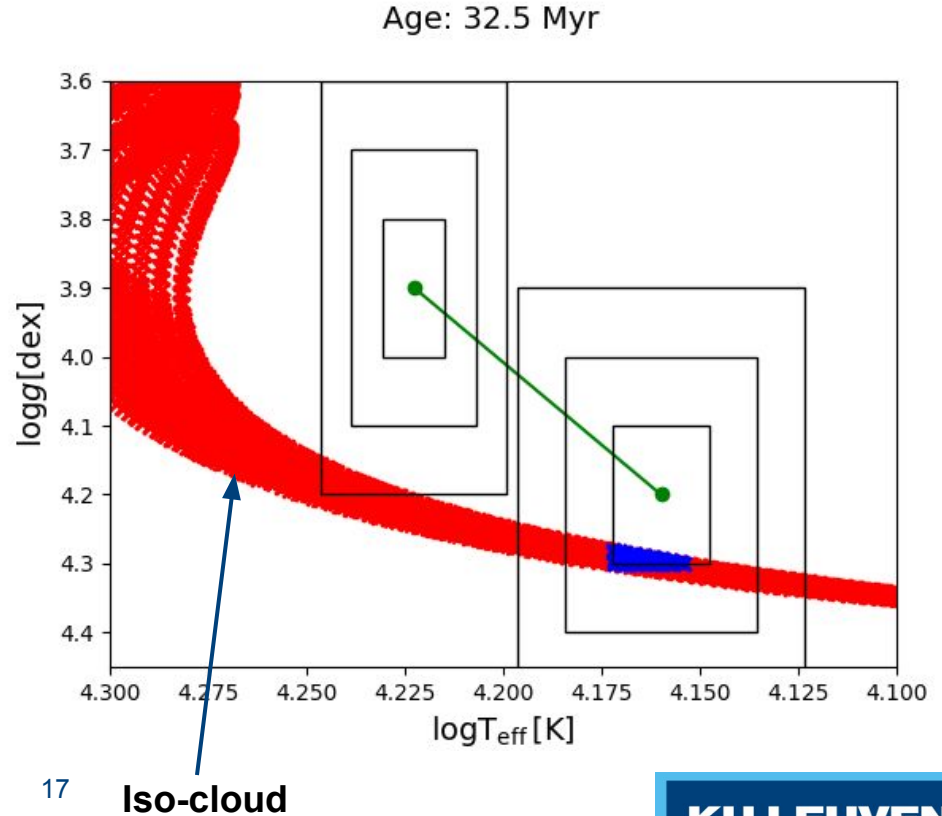
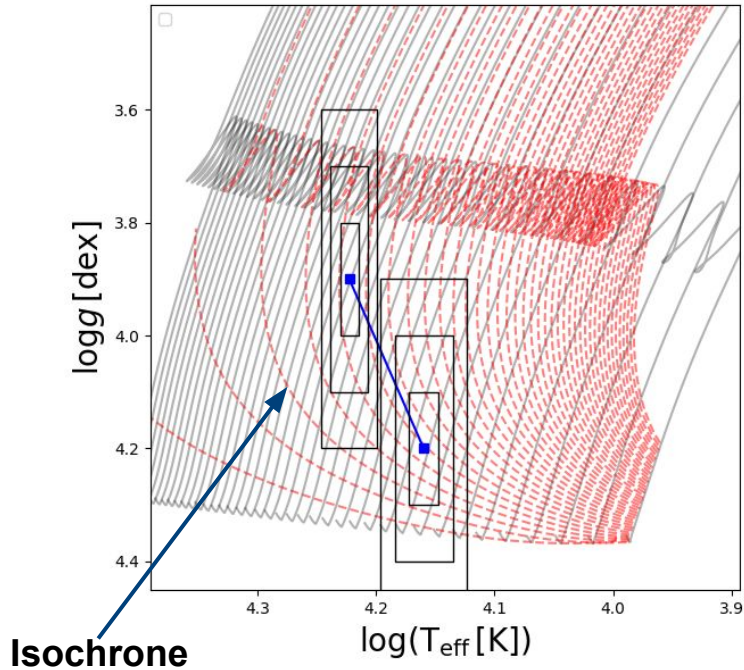
This Methodology:



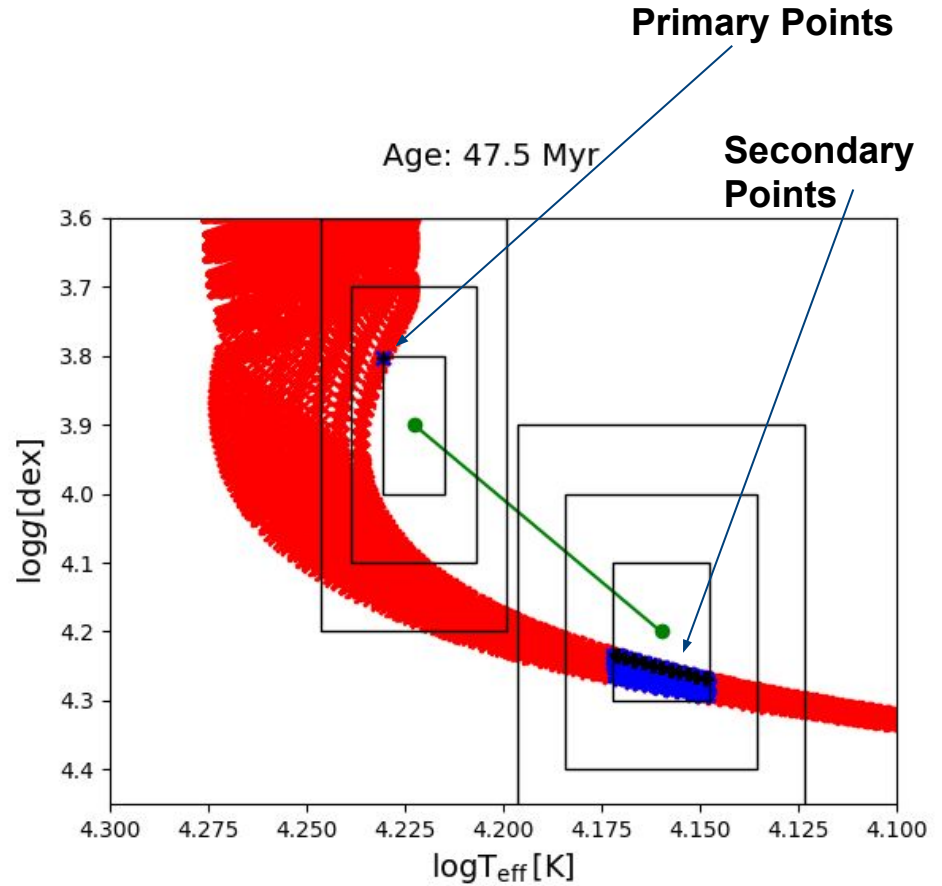
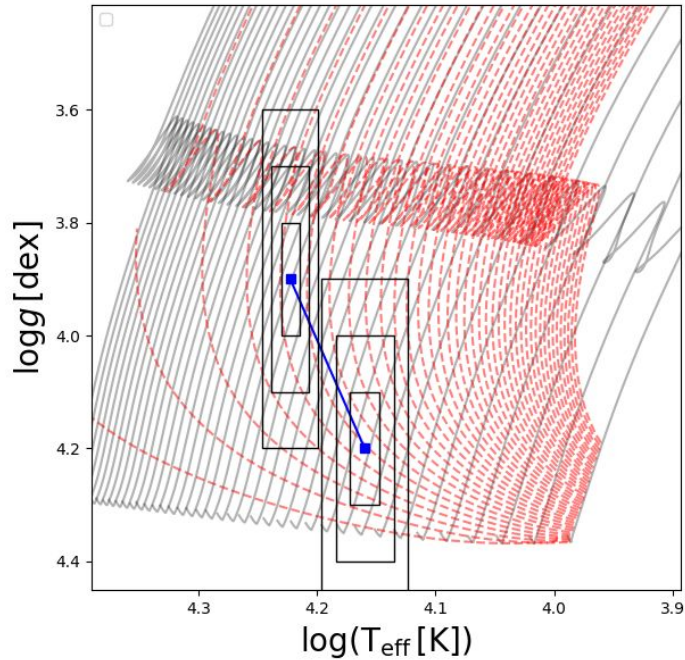
Dotter 2017 (MIST 0): Isochrone Construction



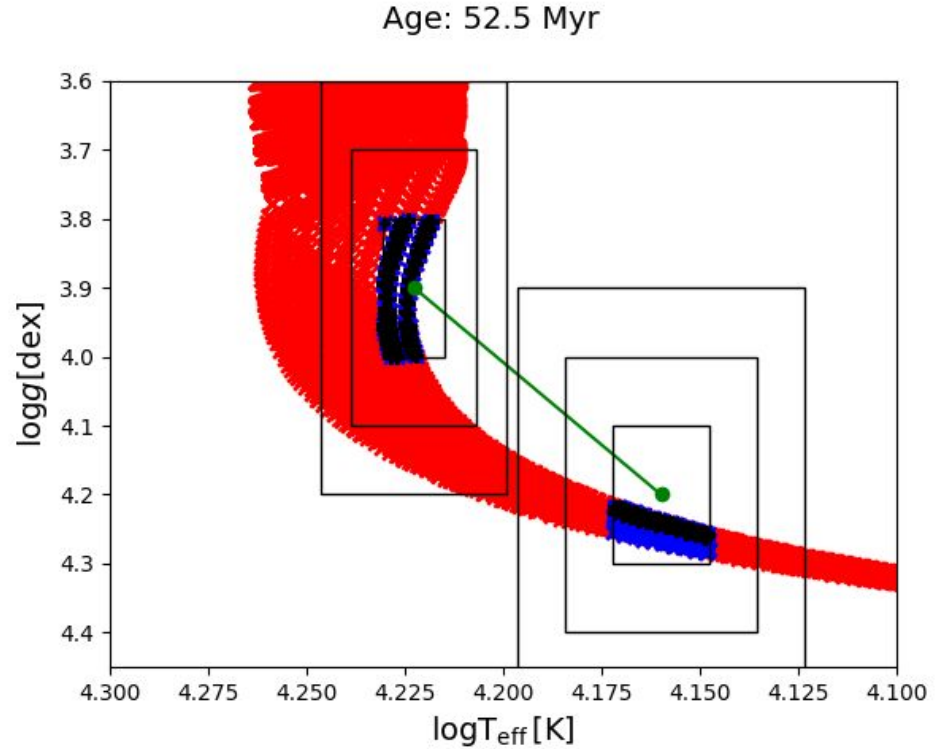
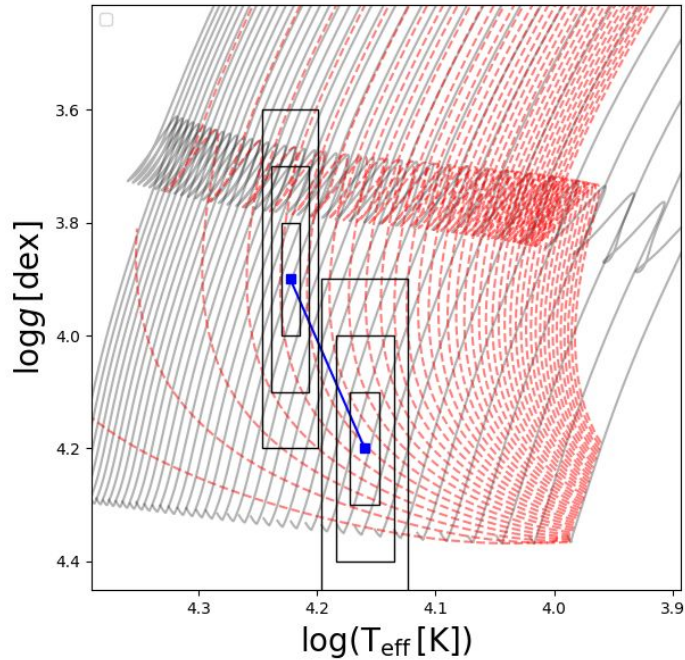
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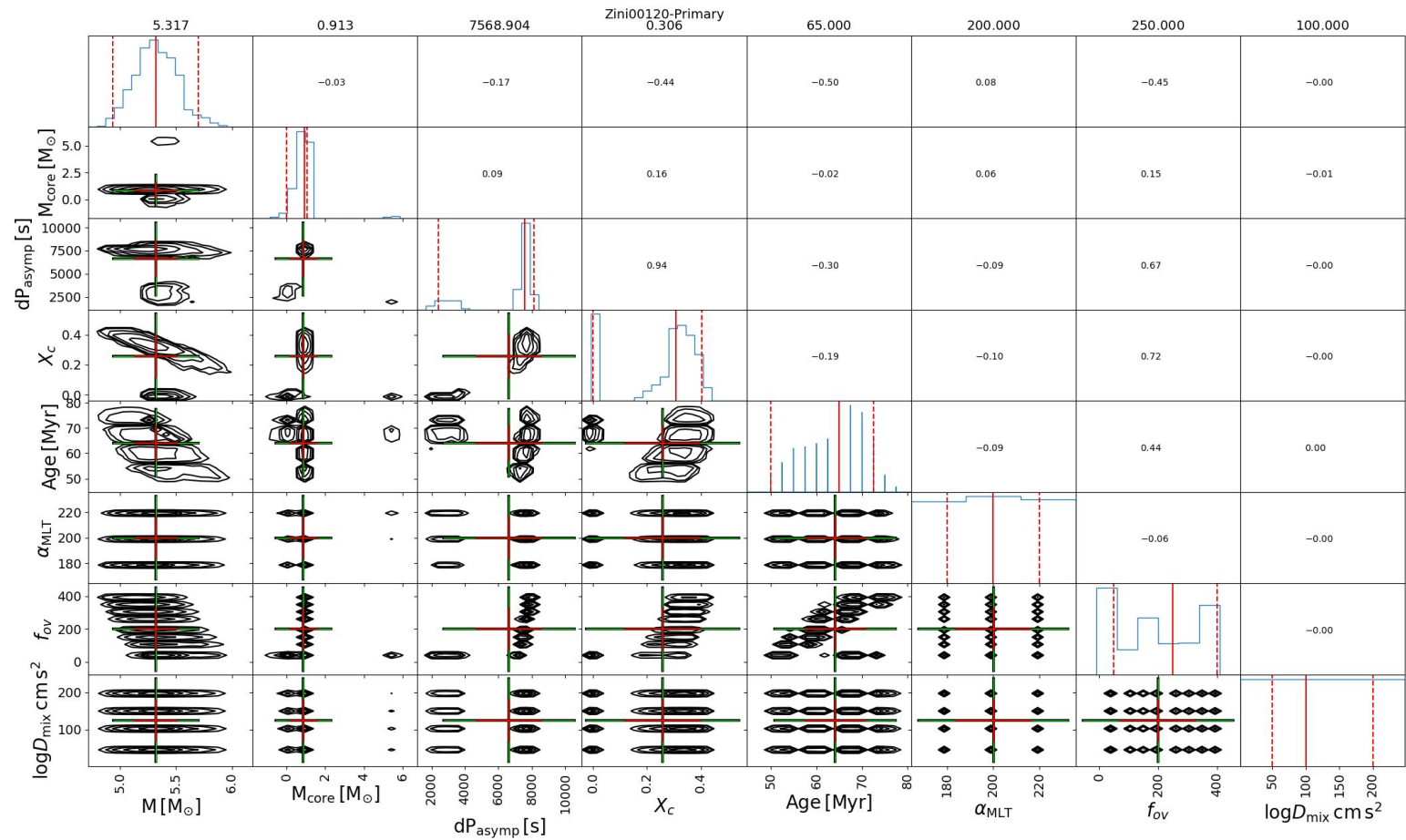


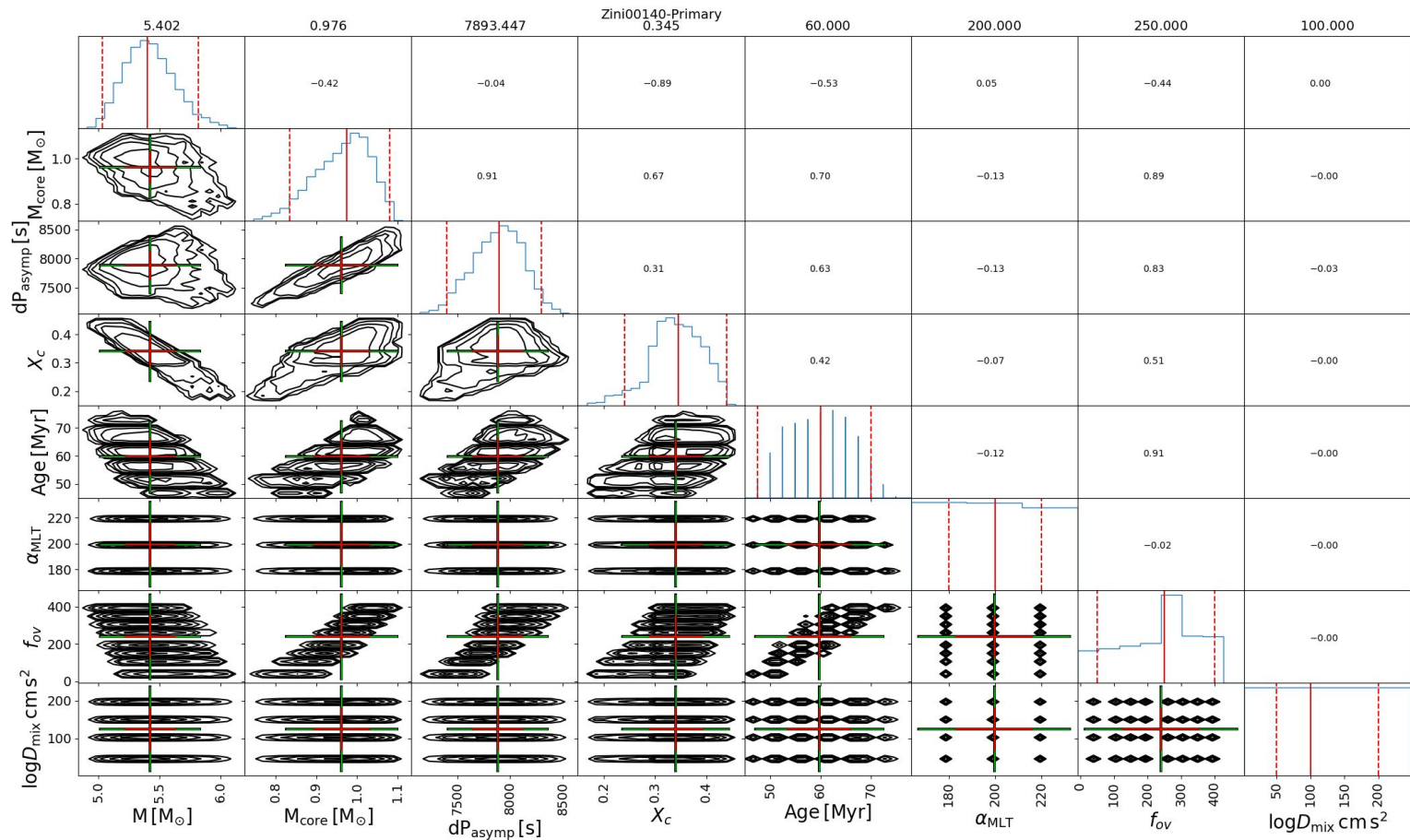
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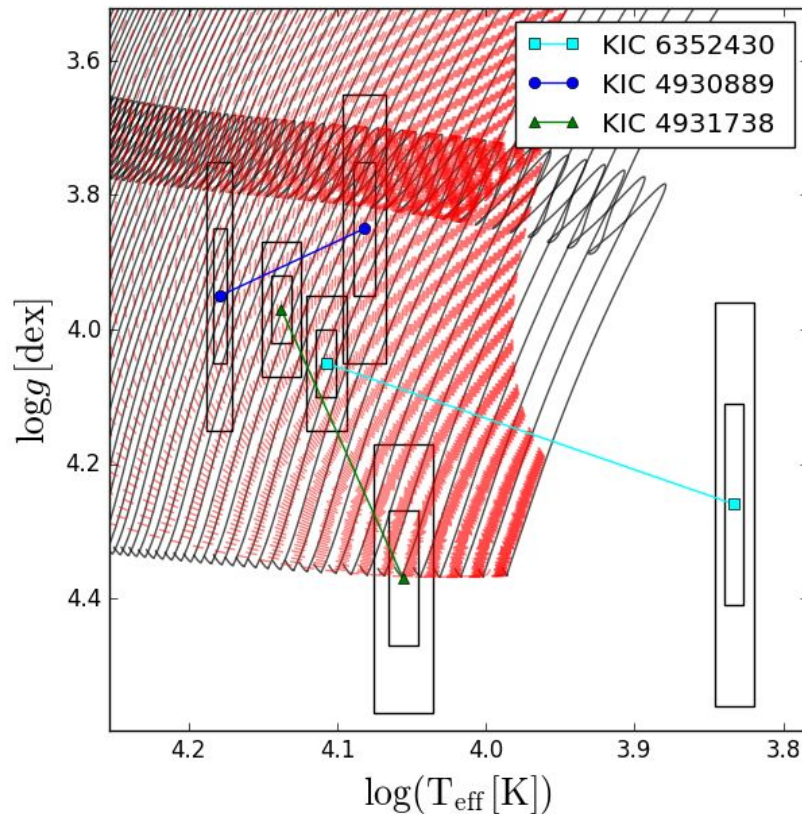






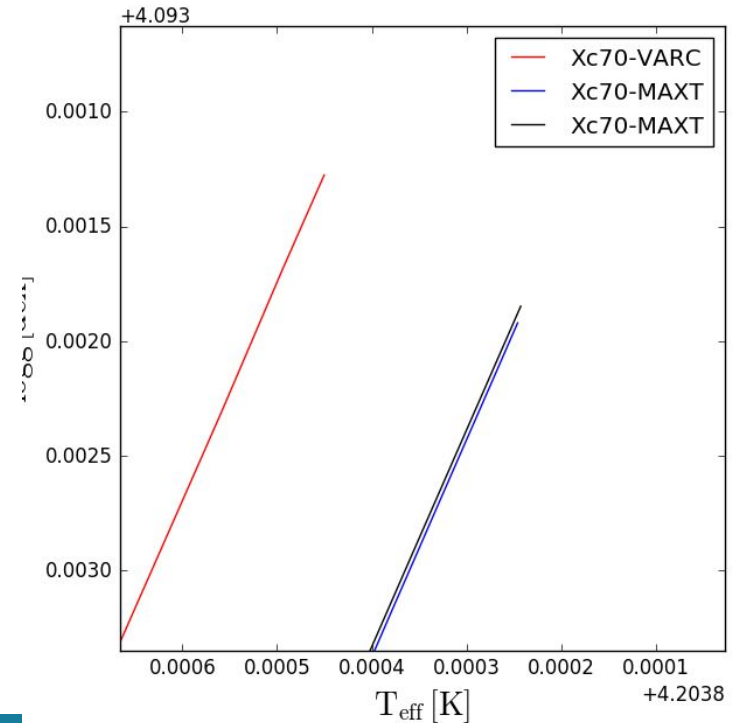
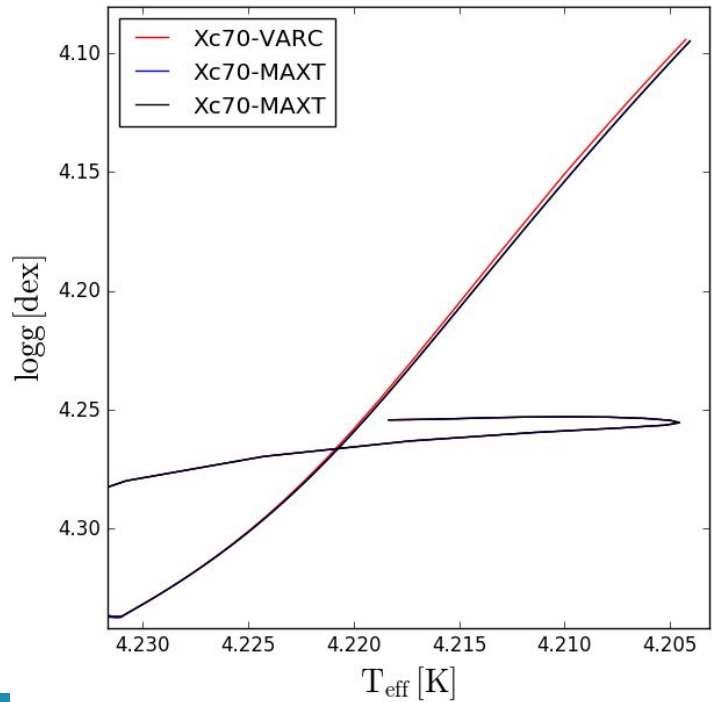
Next Steps:

- ❖ Apply Period-Spacing Pattern Modeling
- ❖ Model as:
 - Single Field Star
 - SB2
 - Pulsating Star in SB2
- ❖ Compare & hope they agree

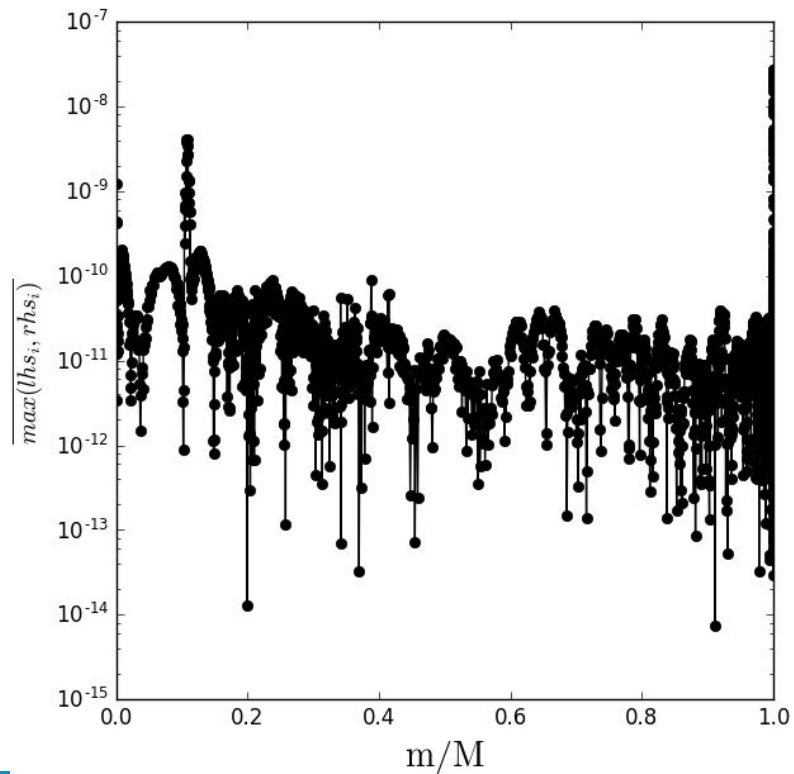


Thank You

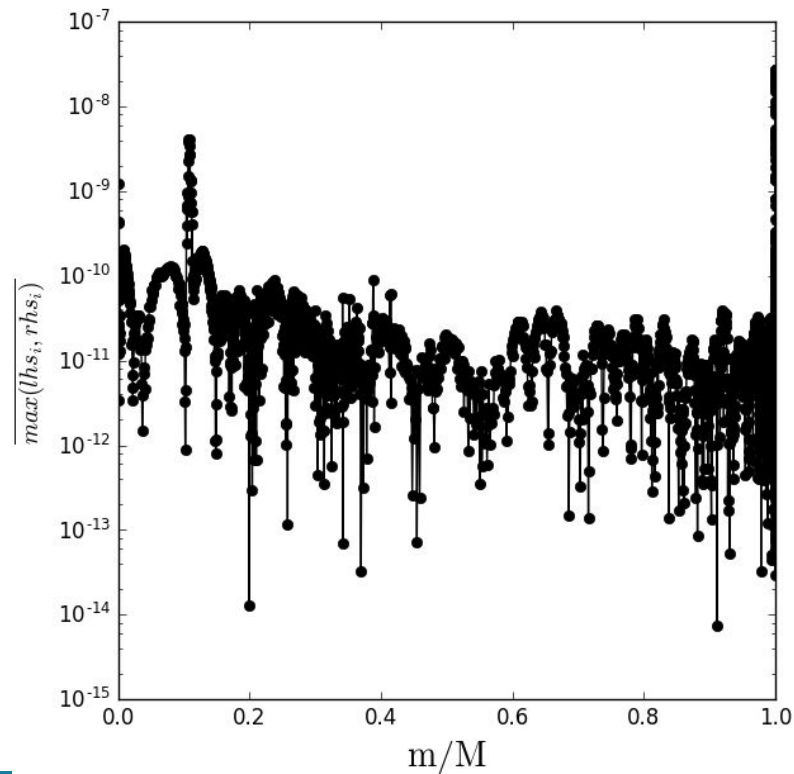
Tests with MESA & GYRE



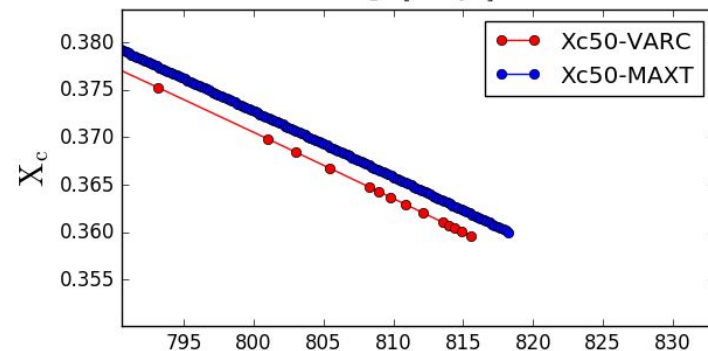
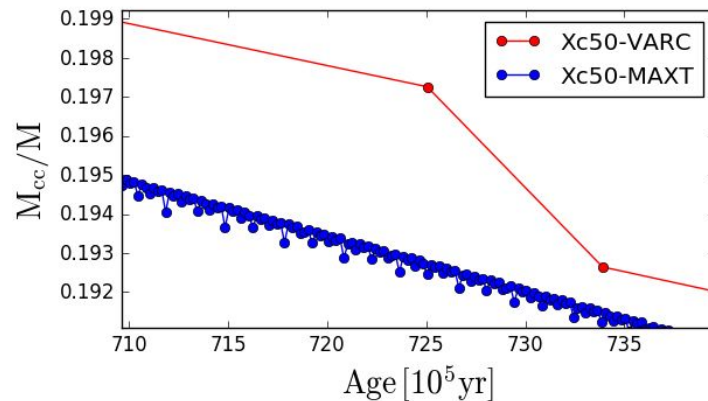
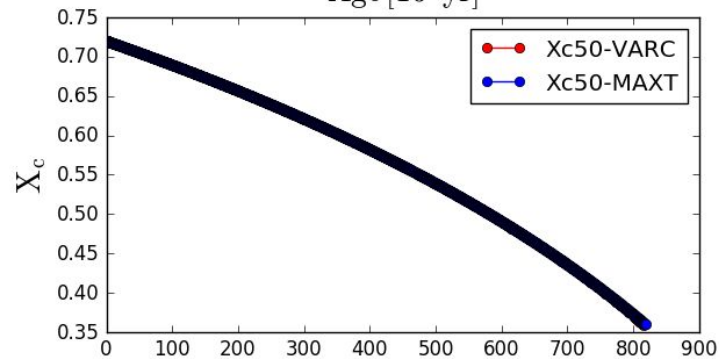
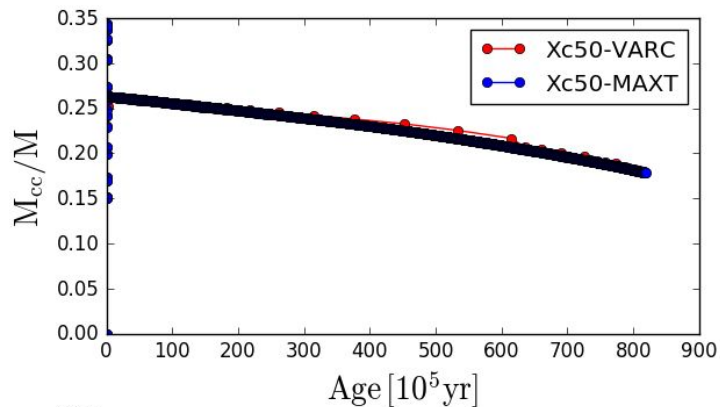
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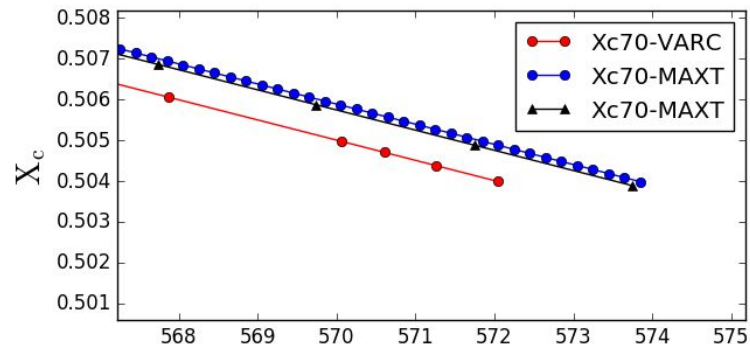
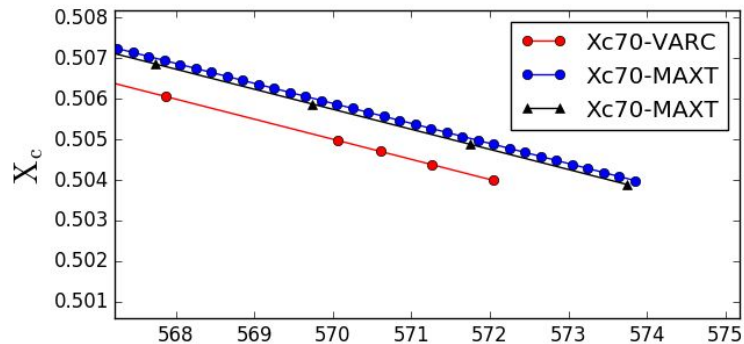
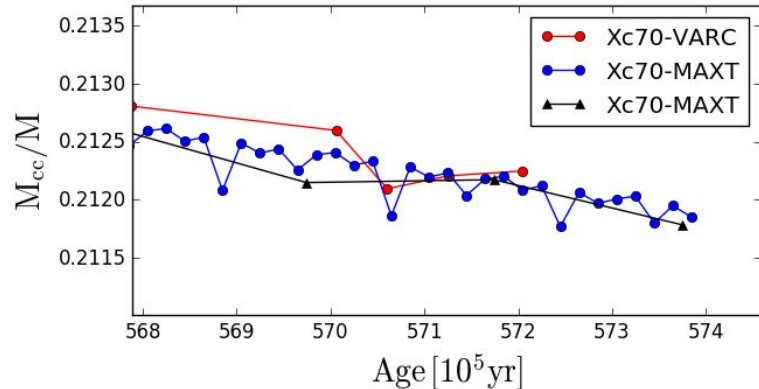
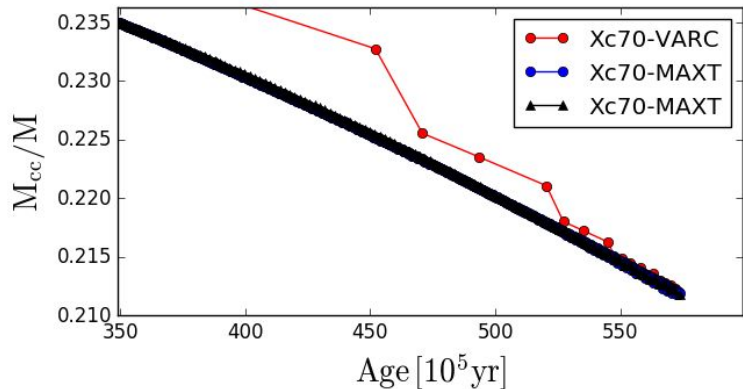
27



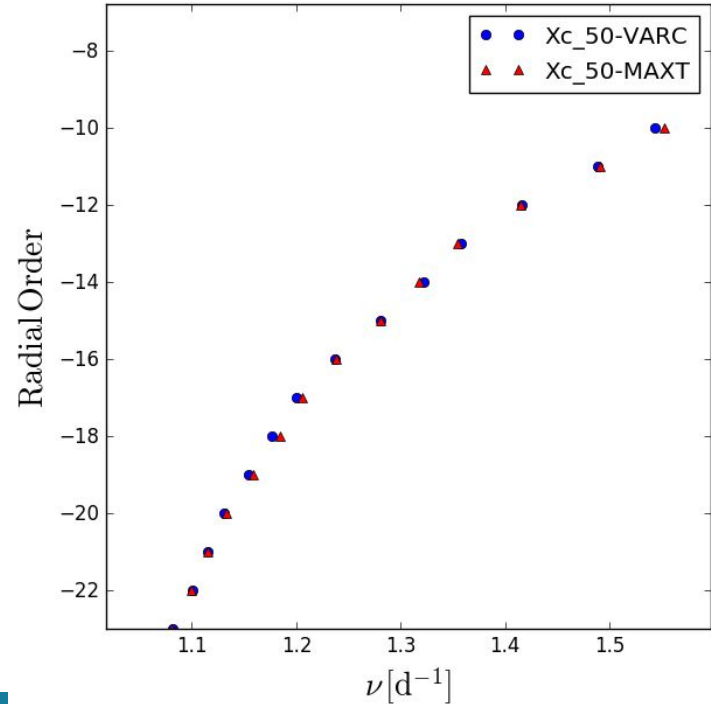
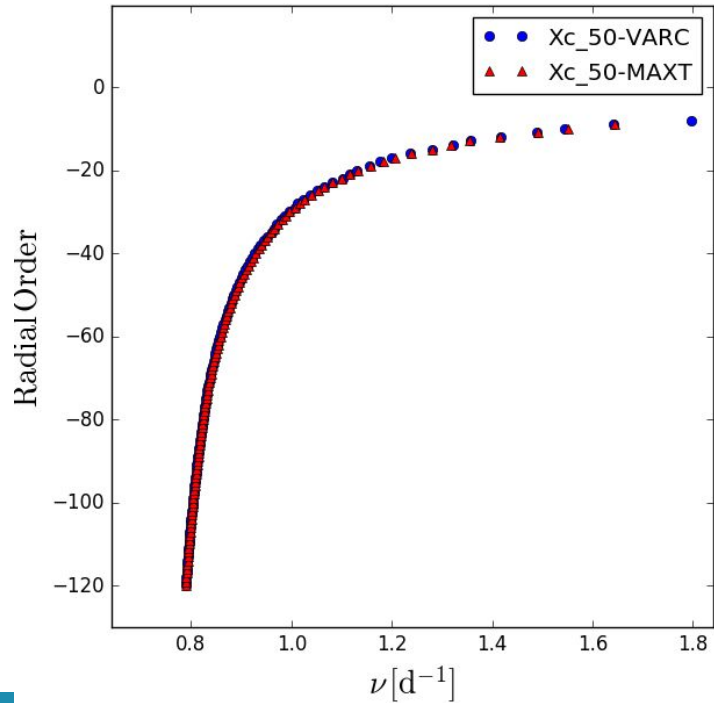
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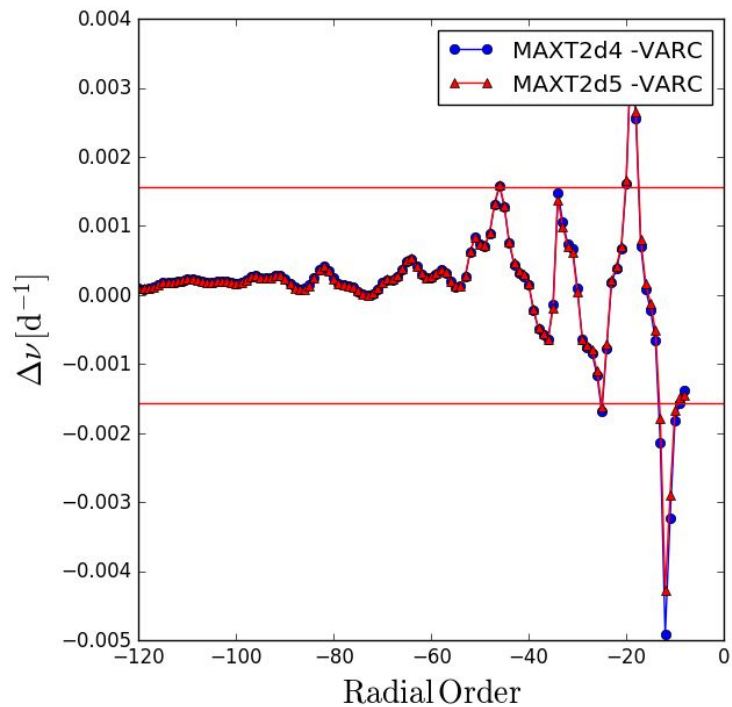
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Tests with MESA & GYRE



Tests with MESA & GYRE



31

