Calibrating Stellar Models in the TESS Era

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With Zach Claytor and the
APOGEE-Kepler, APOGEE-TESS, & TESS Subgiant Collaborations

TESS Science Conference
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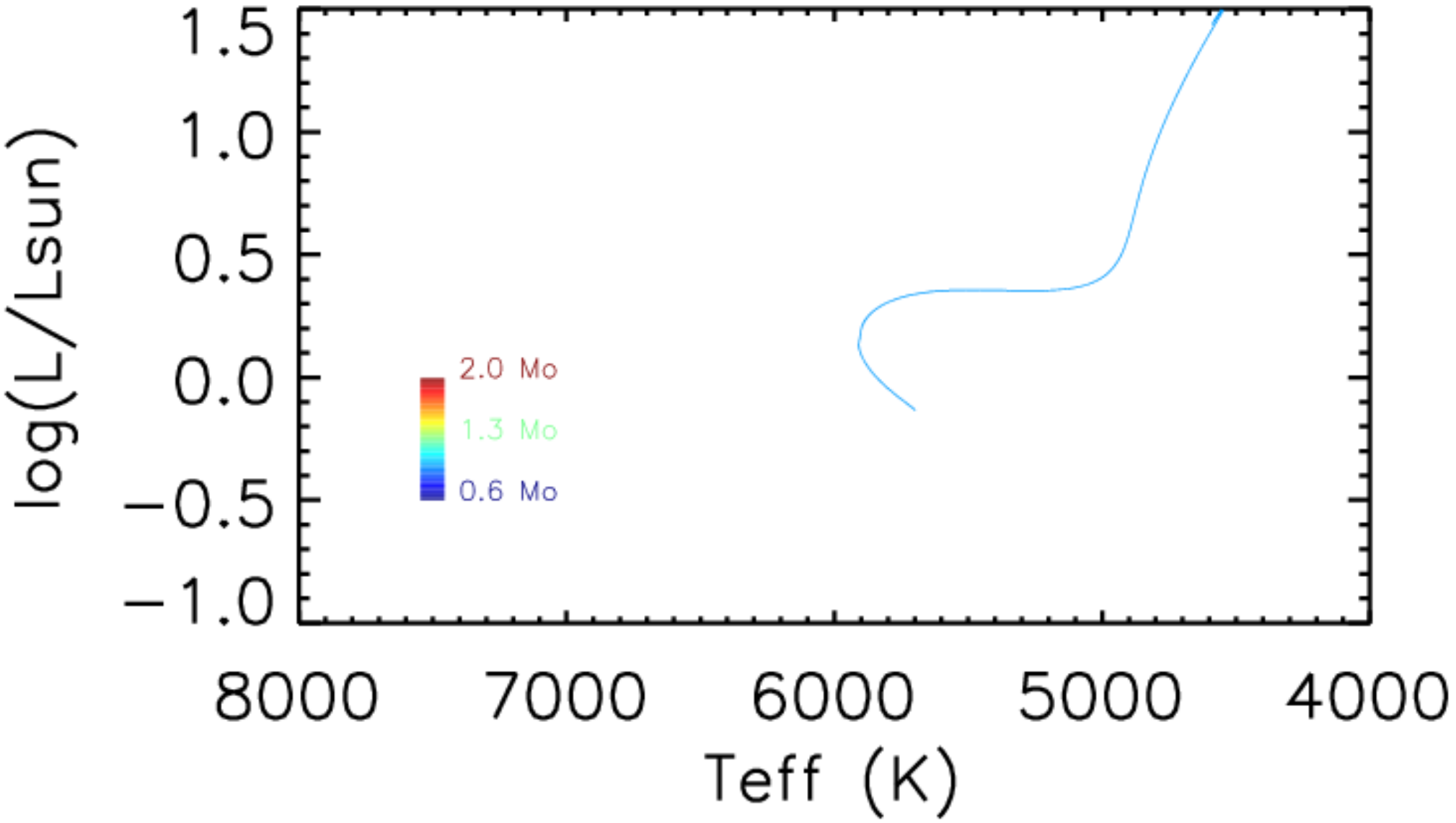
@StellarTayar

Hubble Fellow

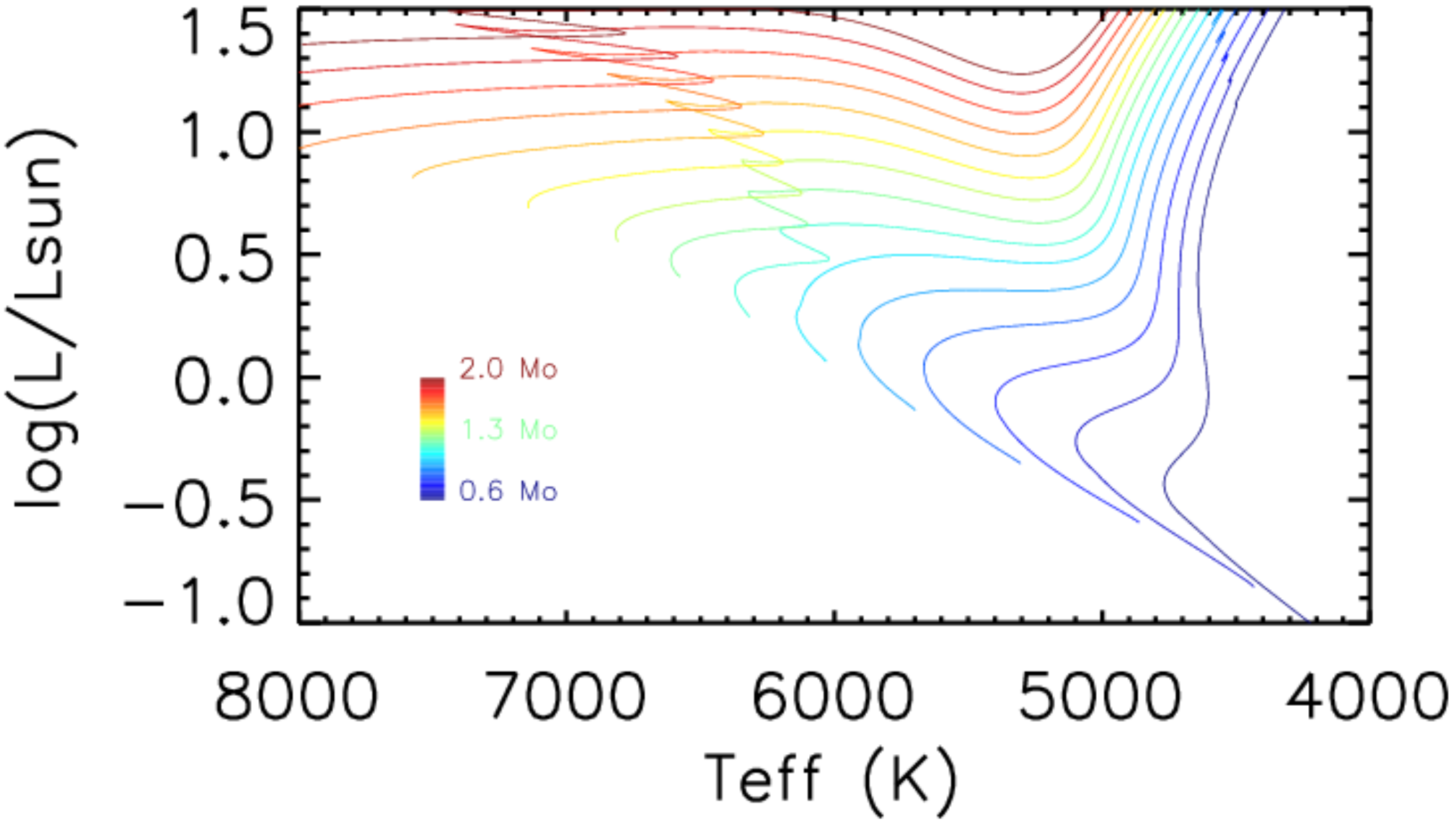
Stellar Model



Model Physics Uncertain

- Convection
- Rotation
- Mixing
- Diffusion
- Atmosphere Boundary Condition
- Helium
- Solar composition
- ...

Stellar Model Grid



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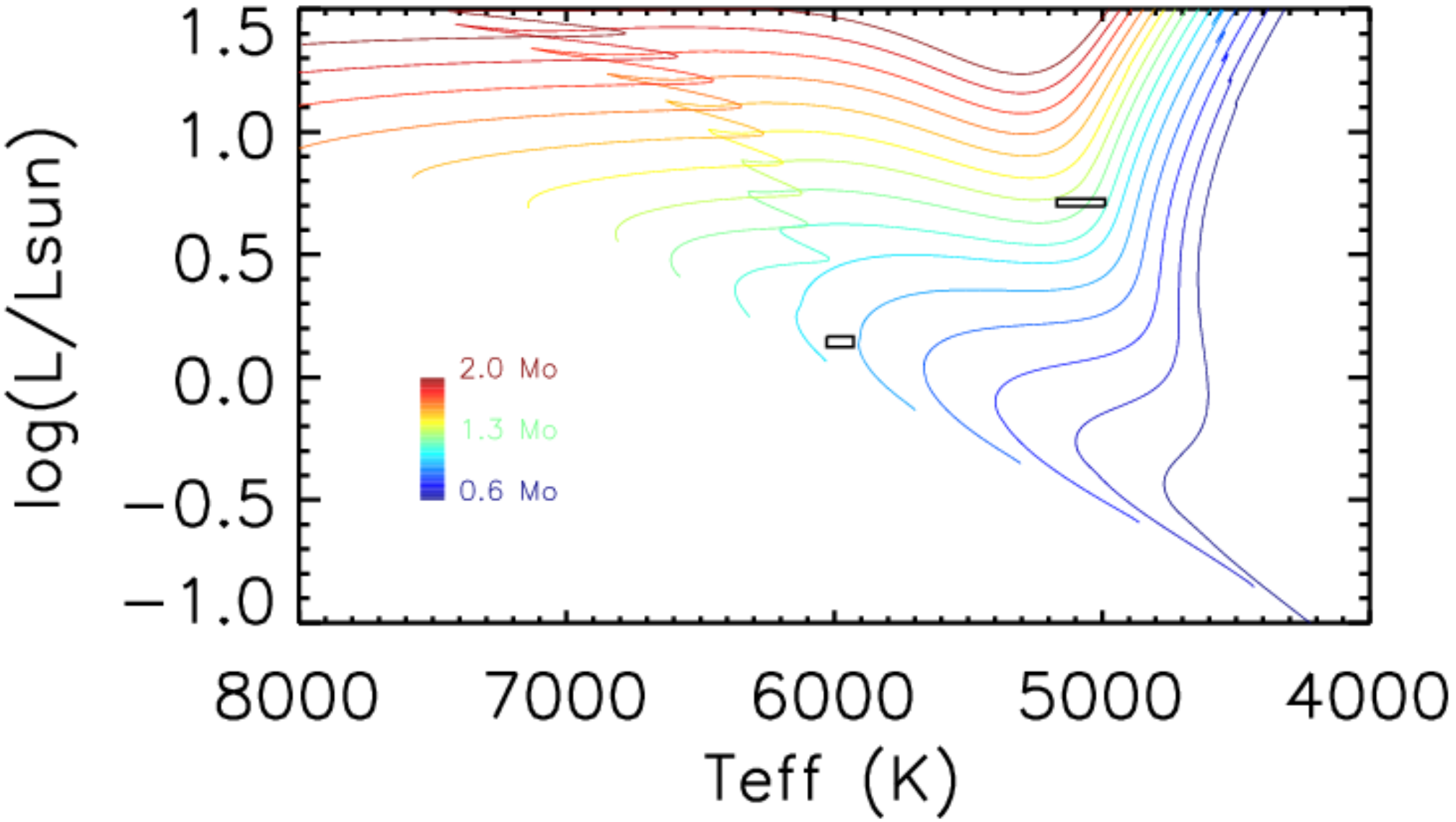
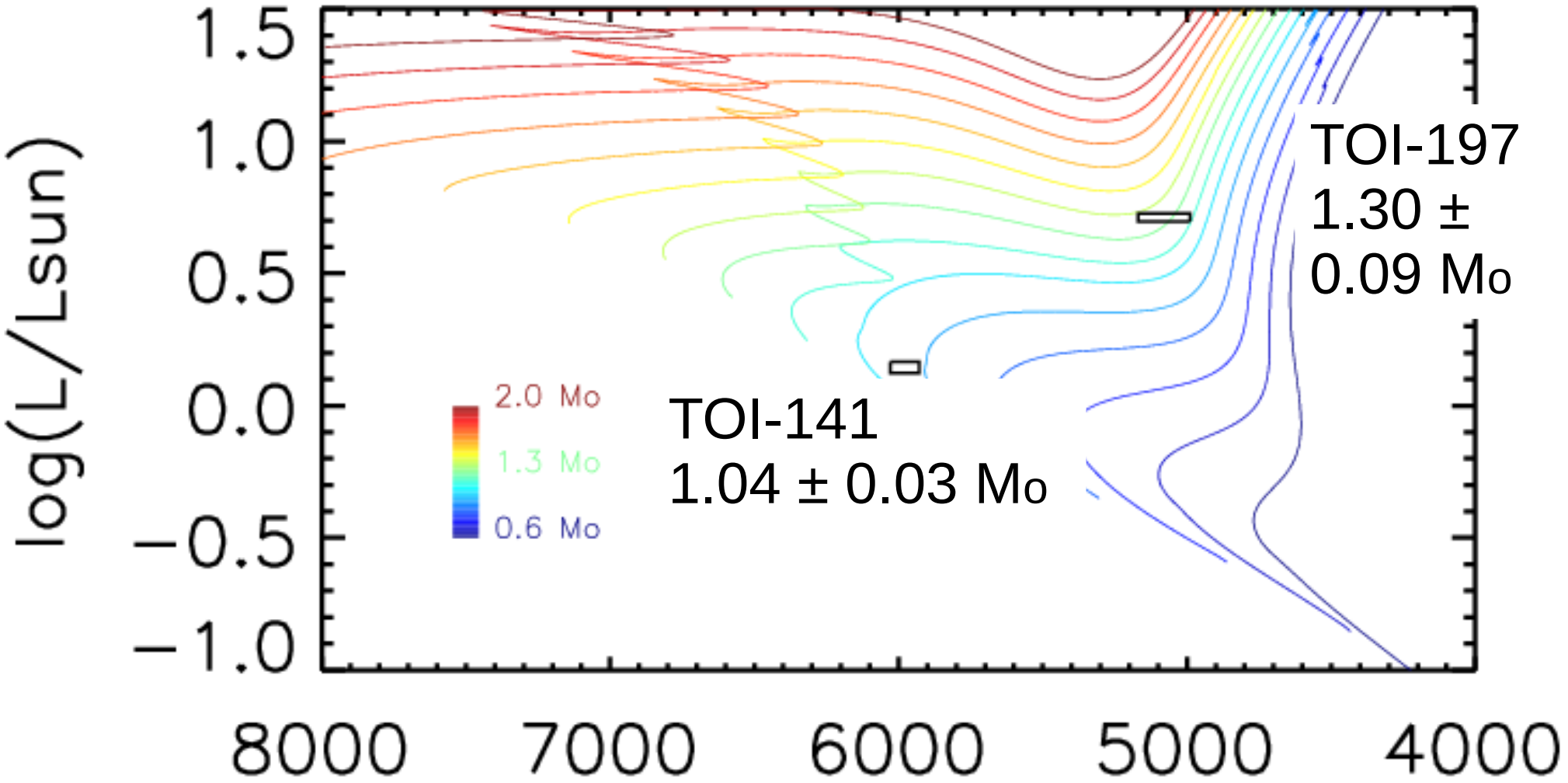


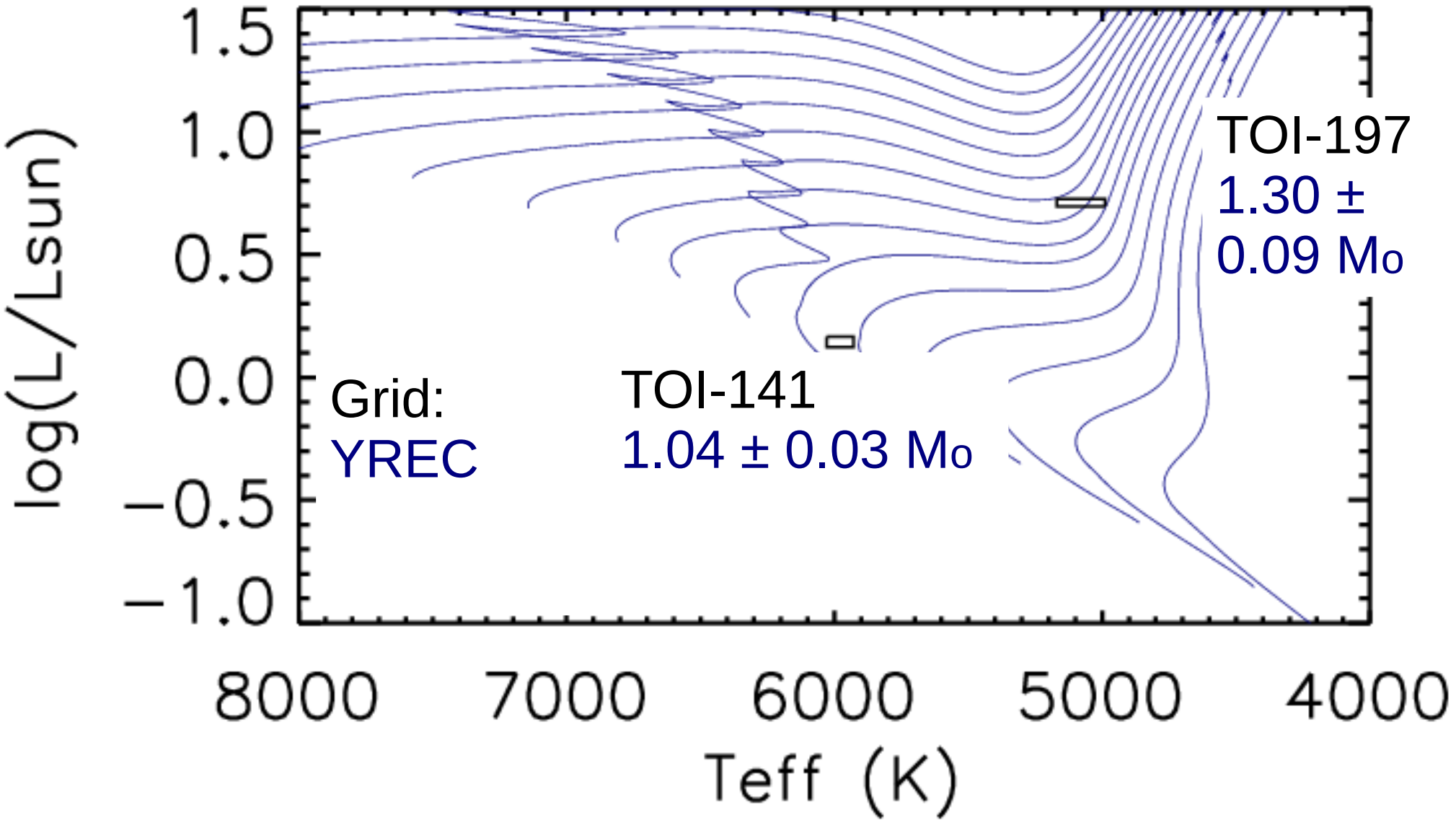
Estimate Stellar Properties



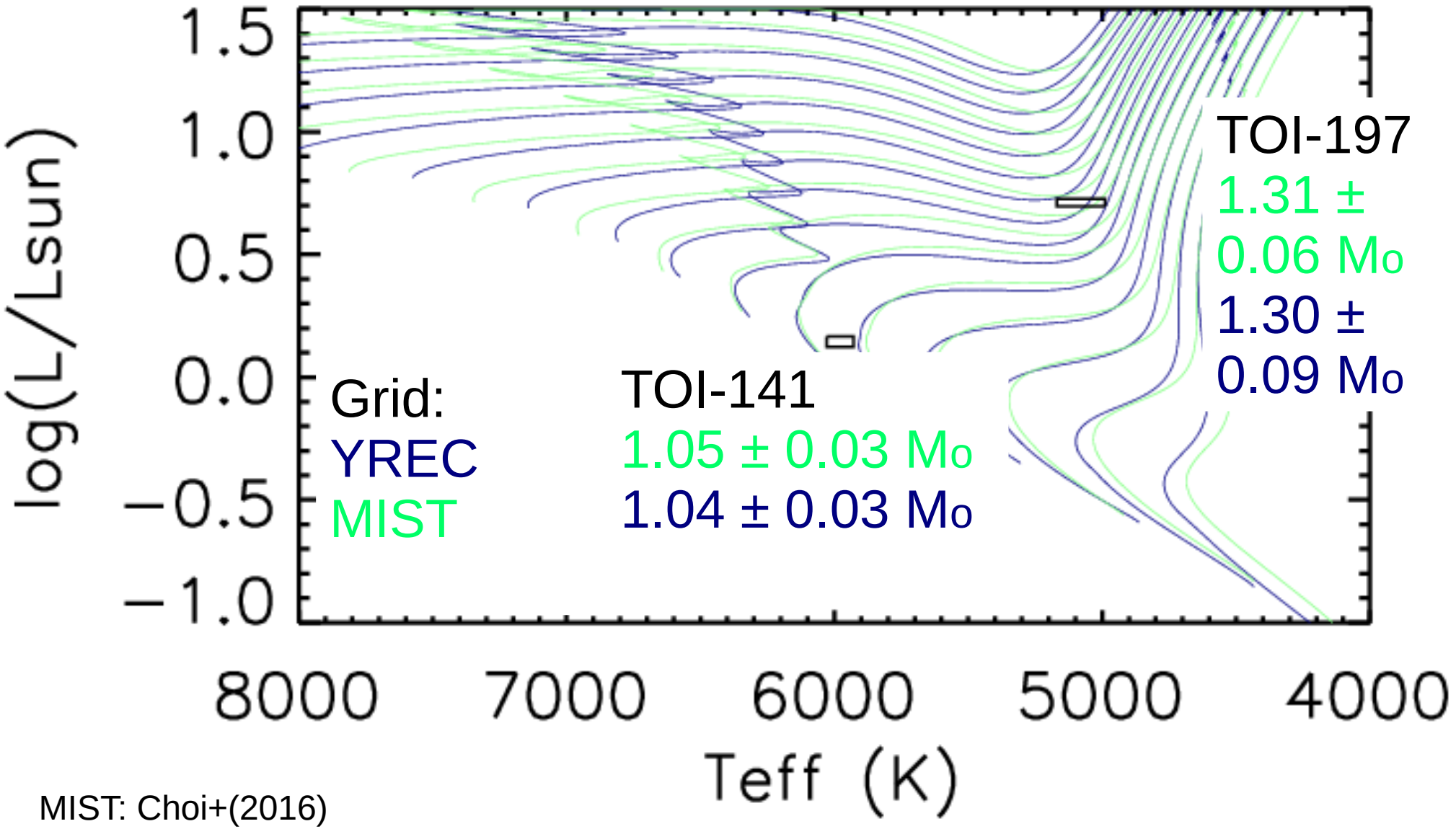
TOI-141
Espinoza+(2019)

TOI-197
Huber+ (2019)

Impact of Model Choice: YREC

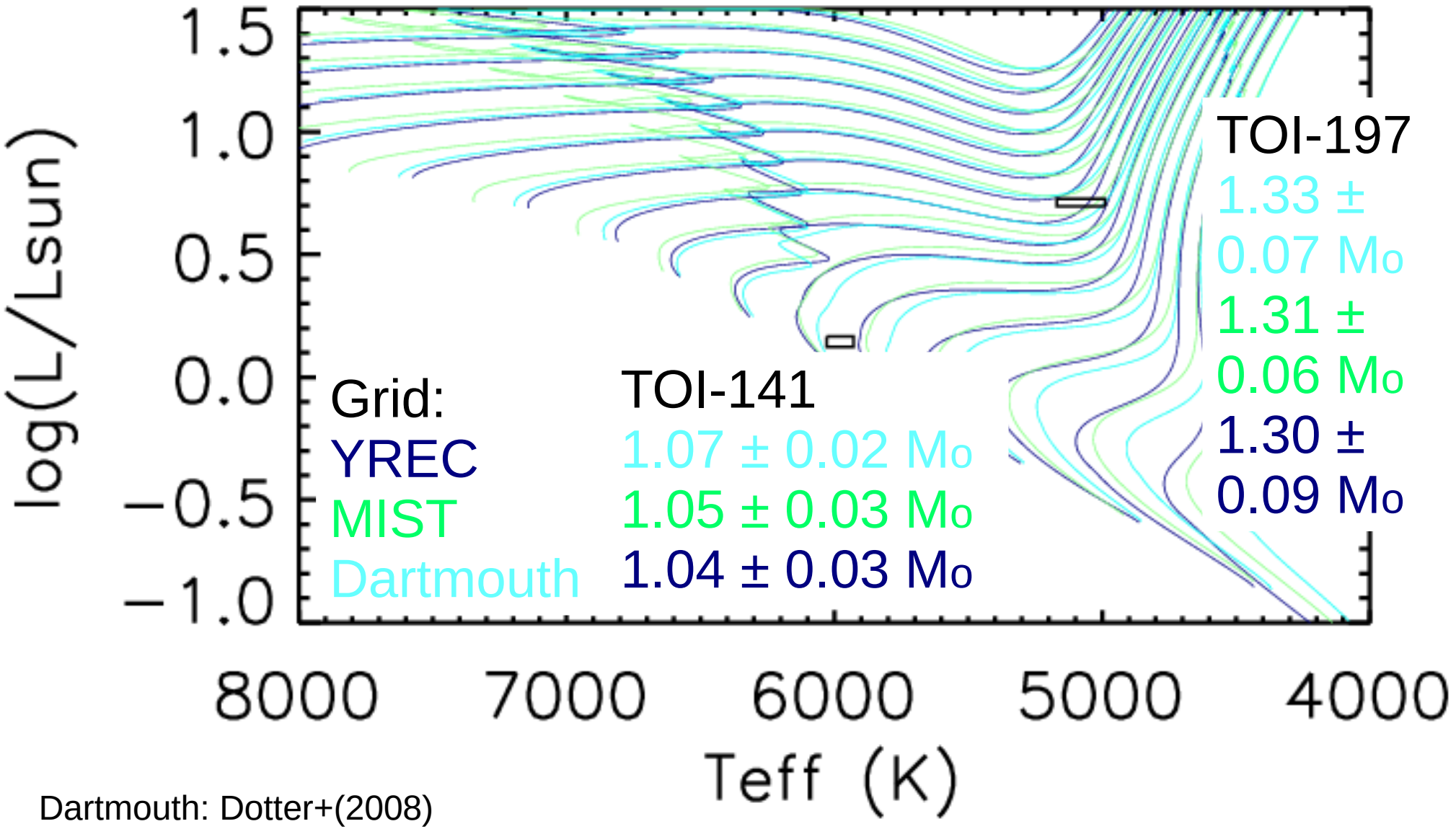


Impact of Model Choice: MIST



MIST: Choi+(2016)

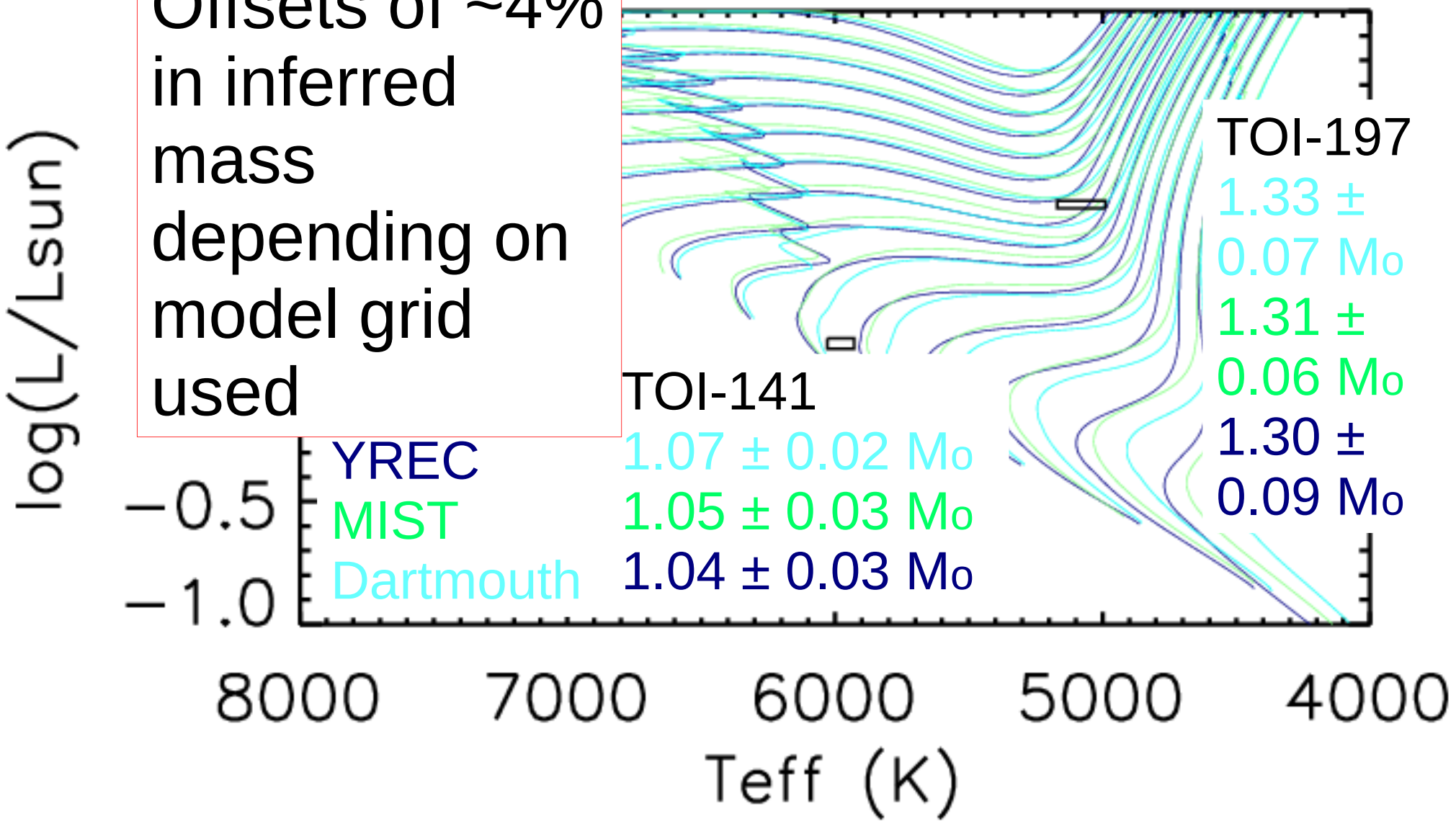
Impact of Model Choice: Dartmouth



Dartmouth: Dotter+(2008)

Model Choice Matters

Offsets of ~4% in inferred mass depending on model grid used



Model Choice Matters

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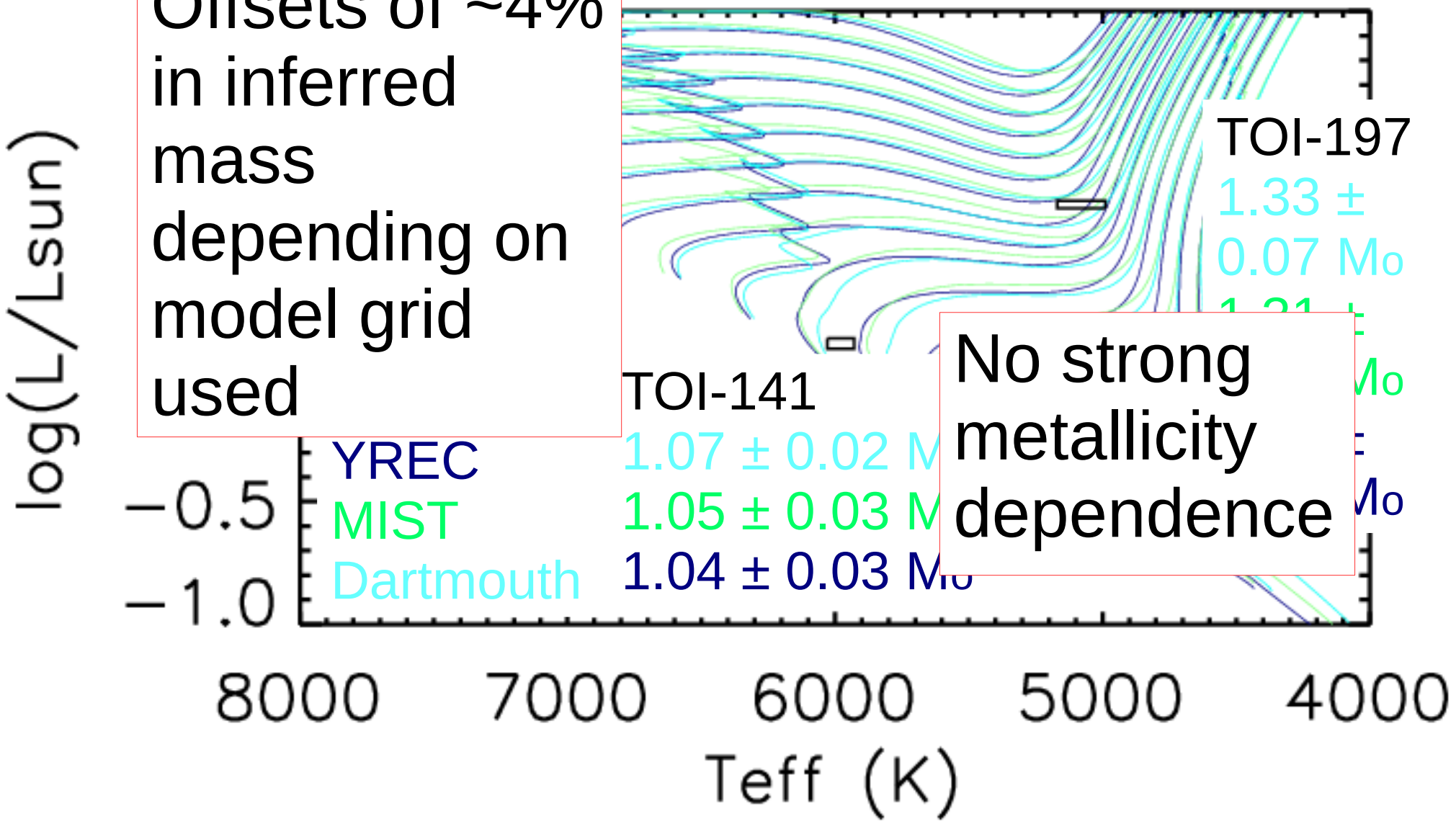
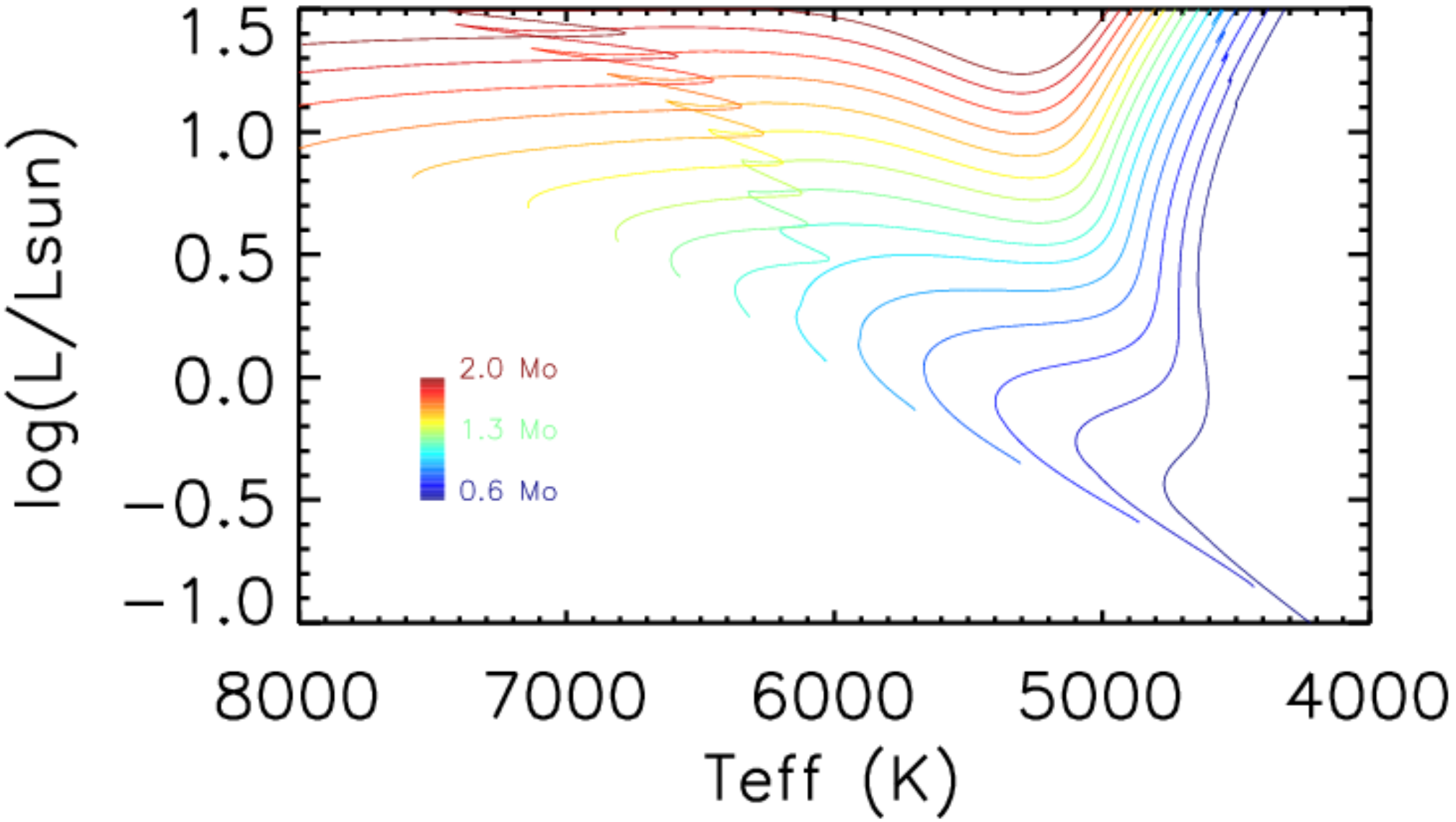


No strong metallicity dependence

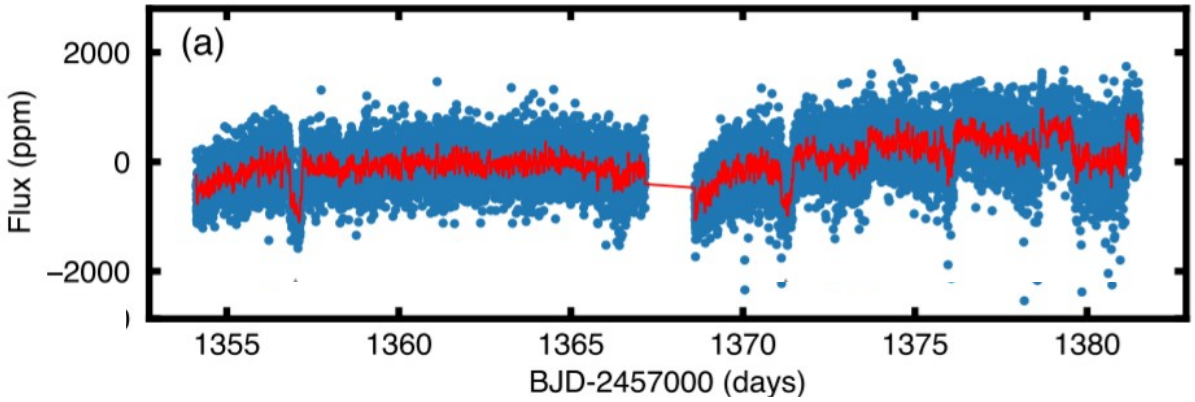
Take Away

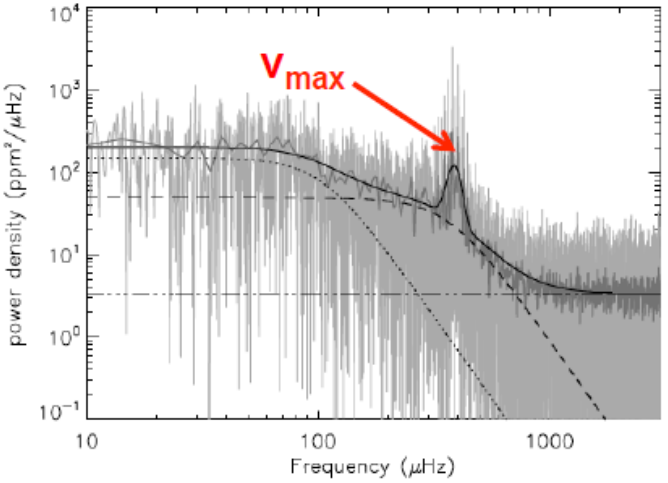
When estimating stellar properties from models, either inflate the error bars to account for model systematics or compare to multiple models.

Stellar Model Grid



Asteroseismic Masses

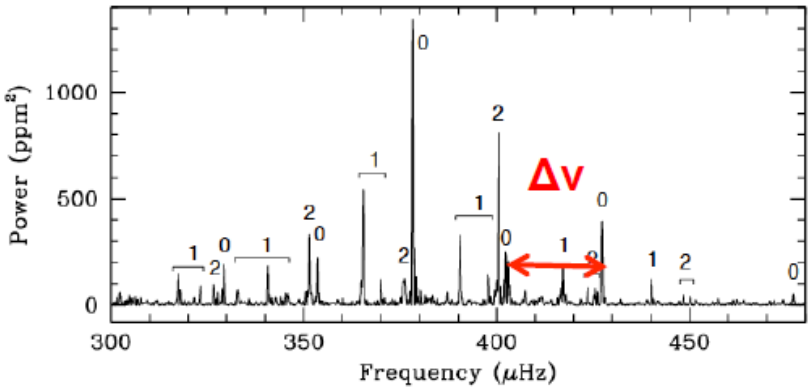




- Sample light curve from Huber+ (2019)

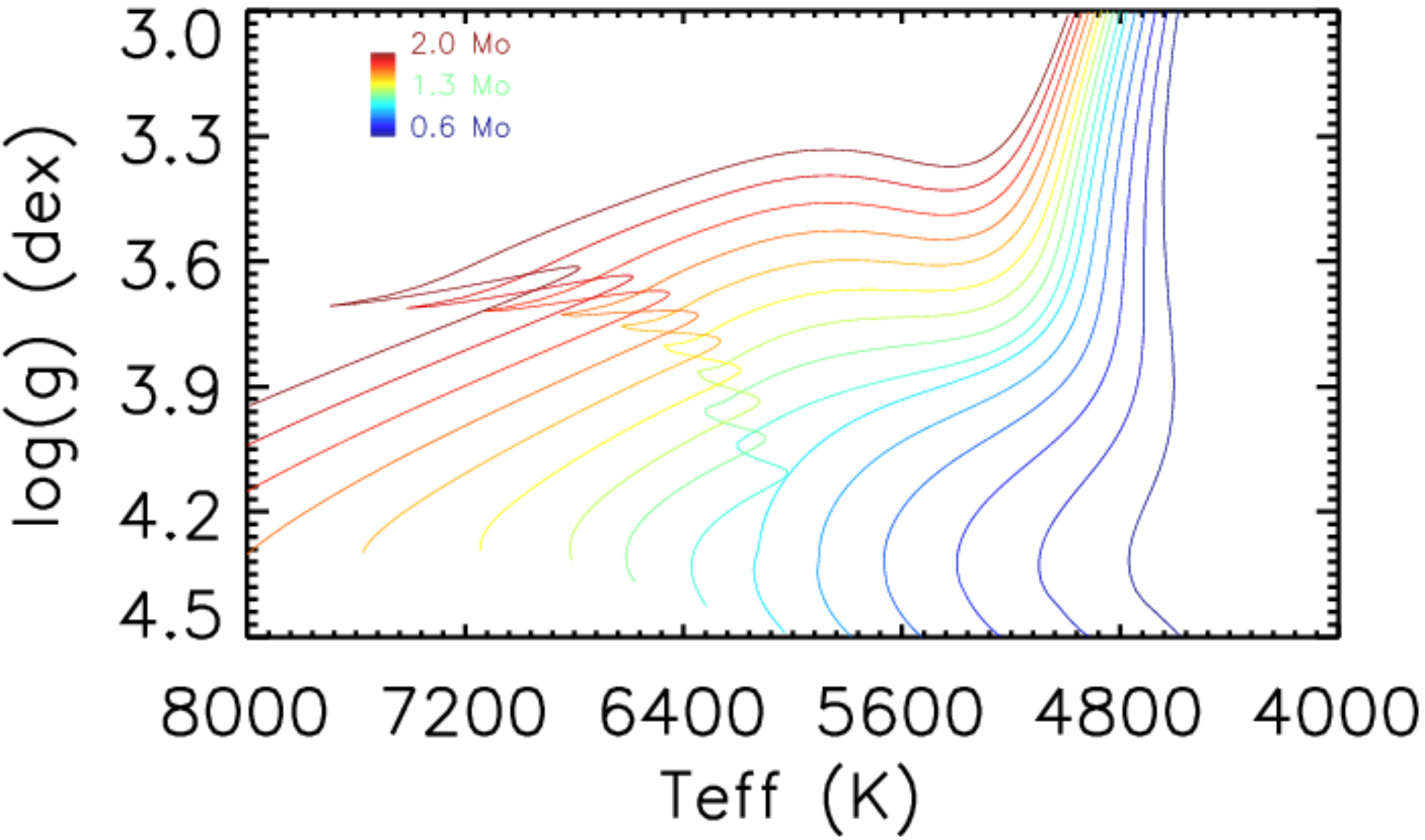
$$\frac{\Delta\nu}{\Delta\nu_\odot} = \sqrt{\frac{M/M_\odot}{(R/R_\odot)^3}}$$

$$\frac{\nu_{max}}{\nu_{max,\odot}} = \frac{M/M_\odot}{(R/R_\odot)^2\sqrt{(T_{eff}/T_{eff,\odot})}}$$

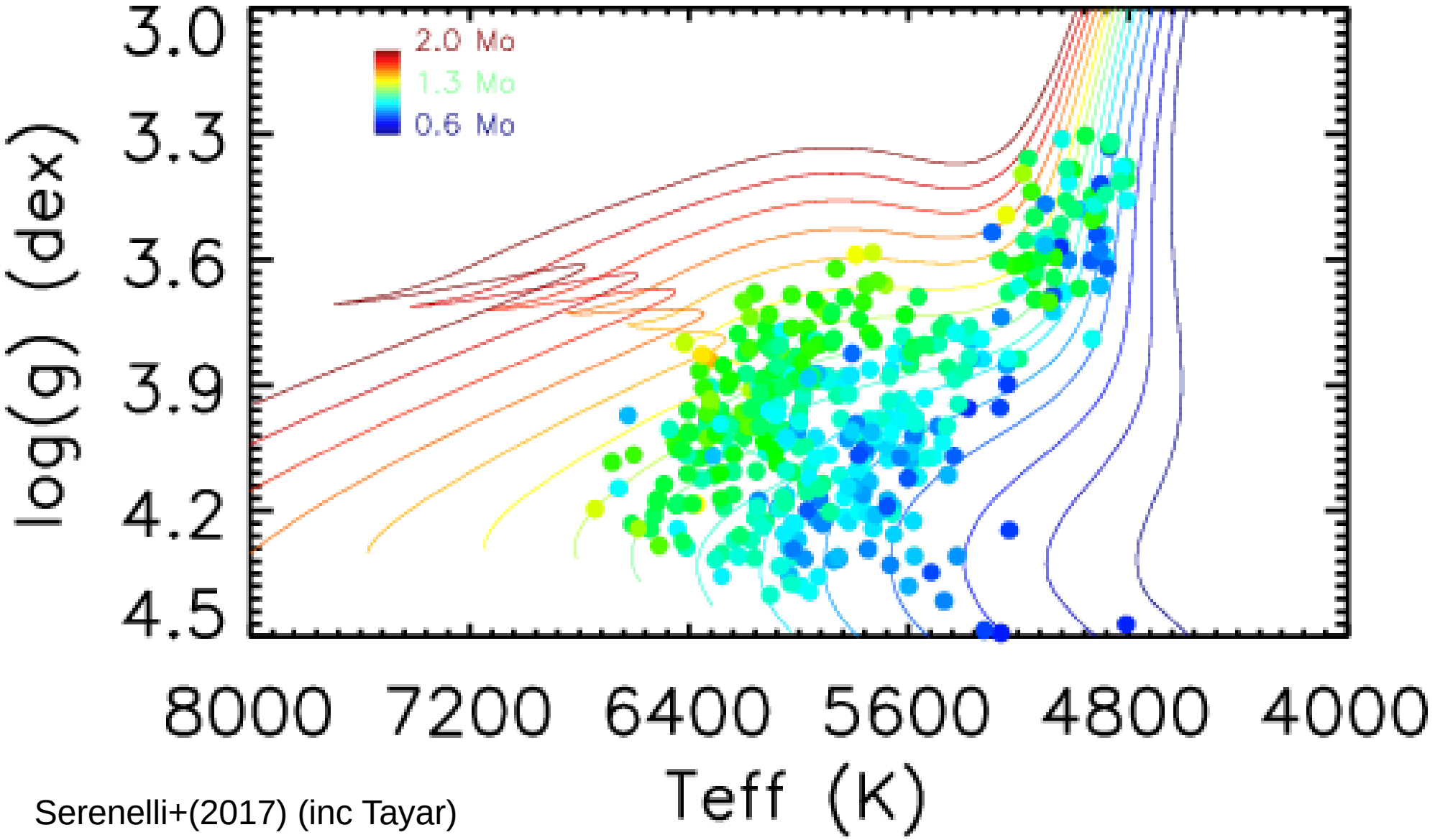


Di Mauro+ (2011)

Stellar Models

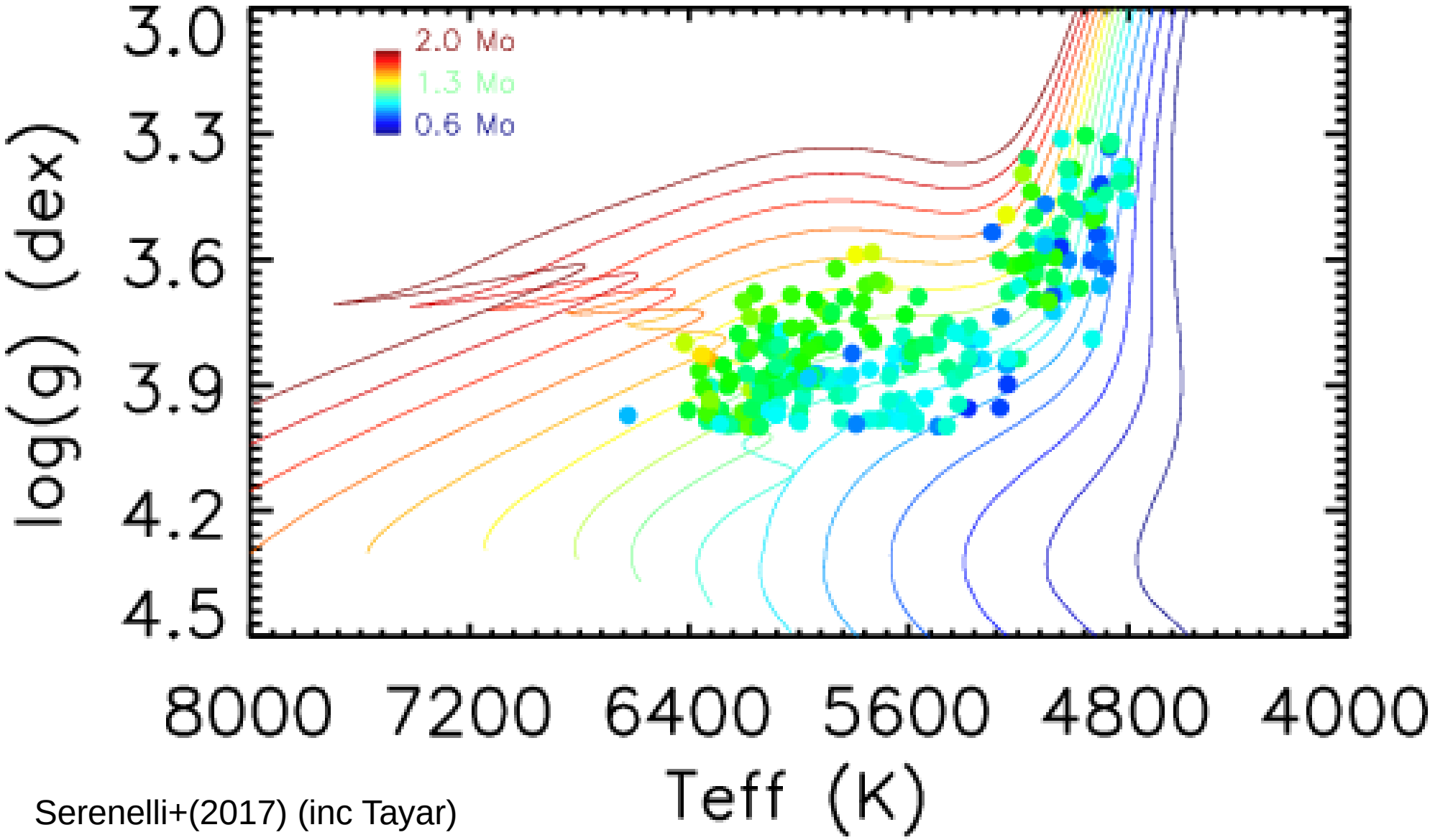


APOGEE-Kepler Subgiants



Serenelli+(2017) (inc Tayar)

APOGEE-Kepler Subgiants



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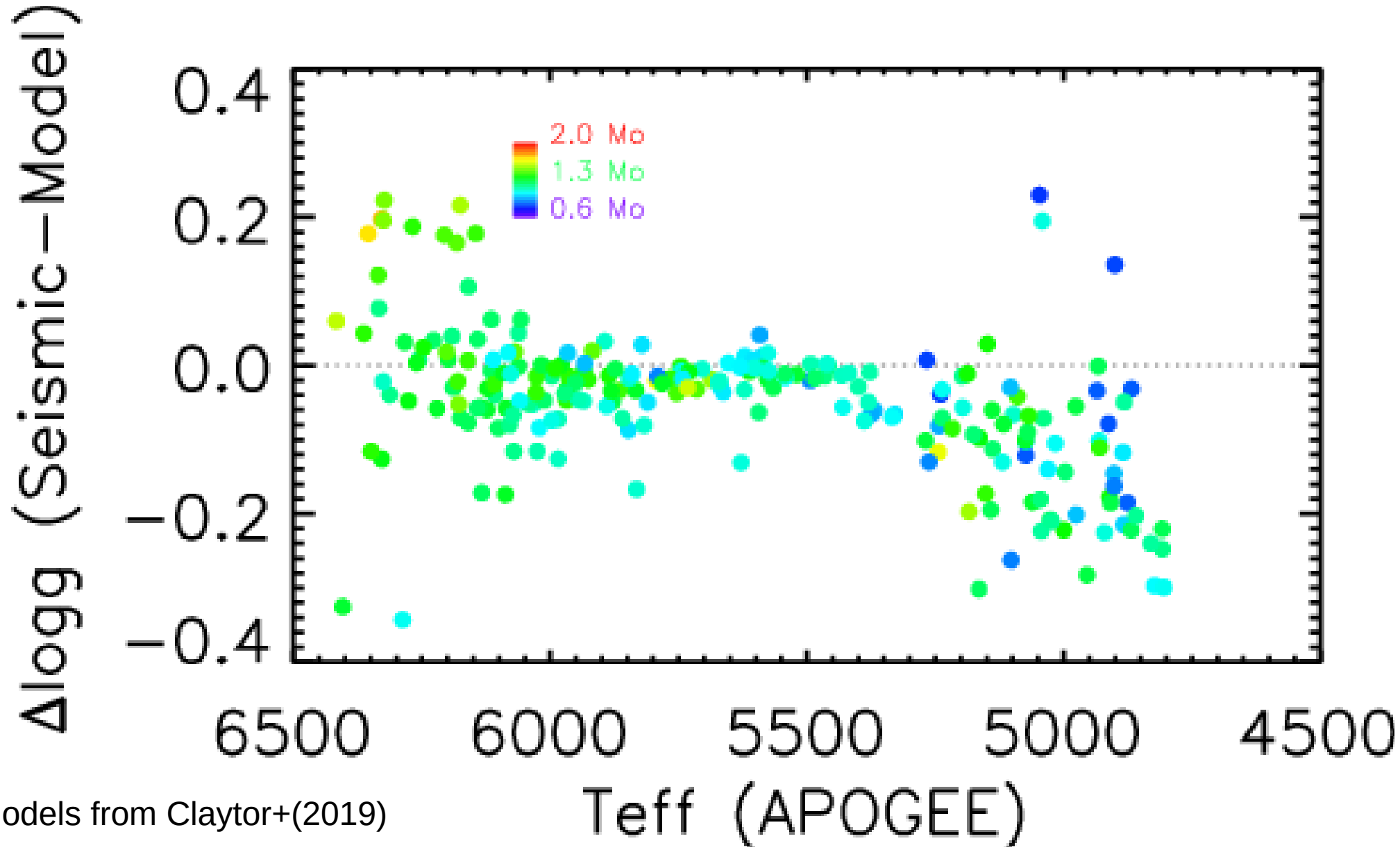
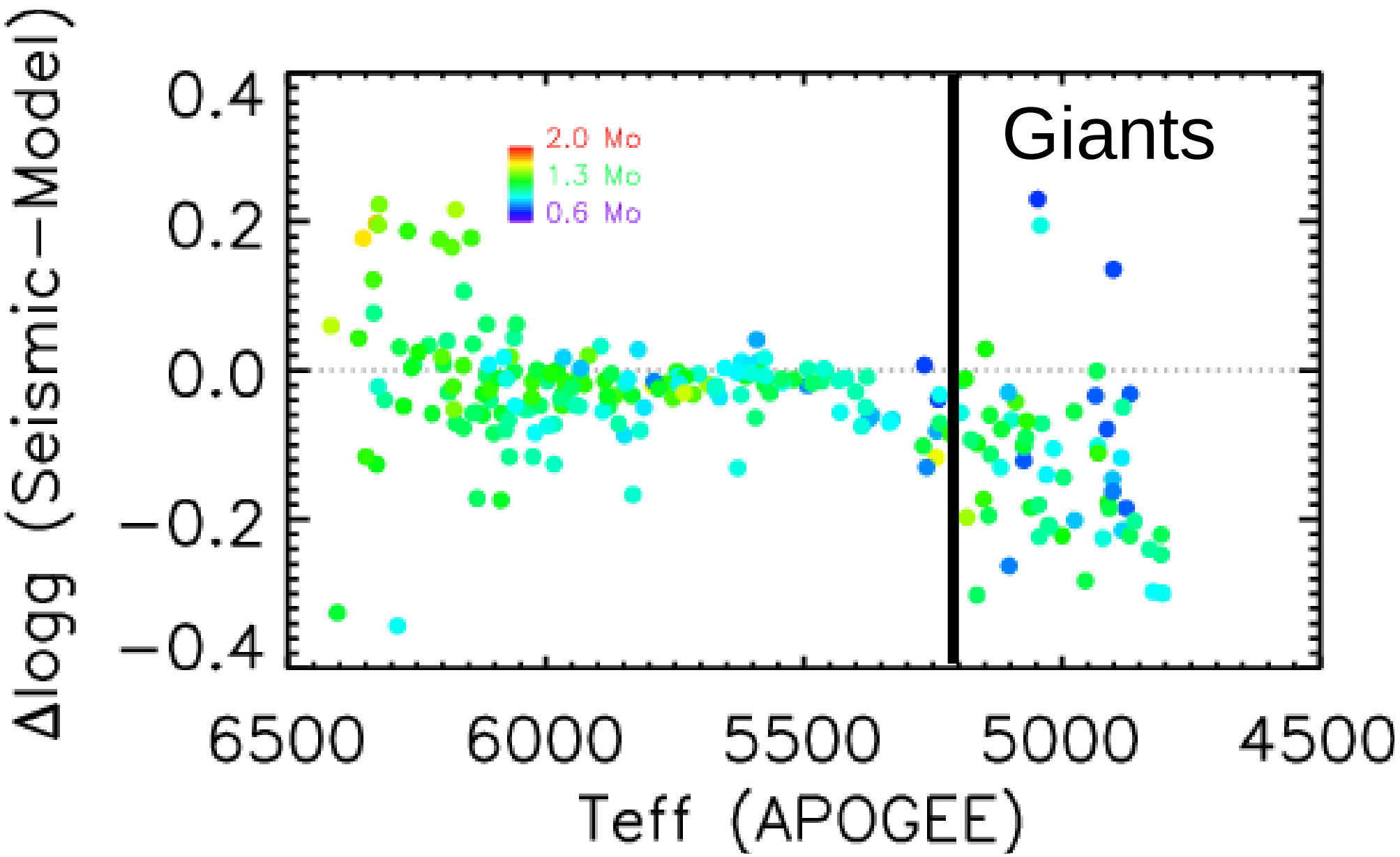


Models from Claytor+(2019)

APOGEE-Kepler Subgiants



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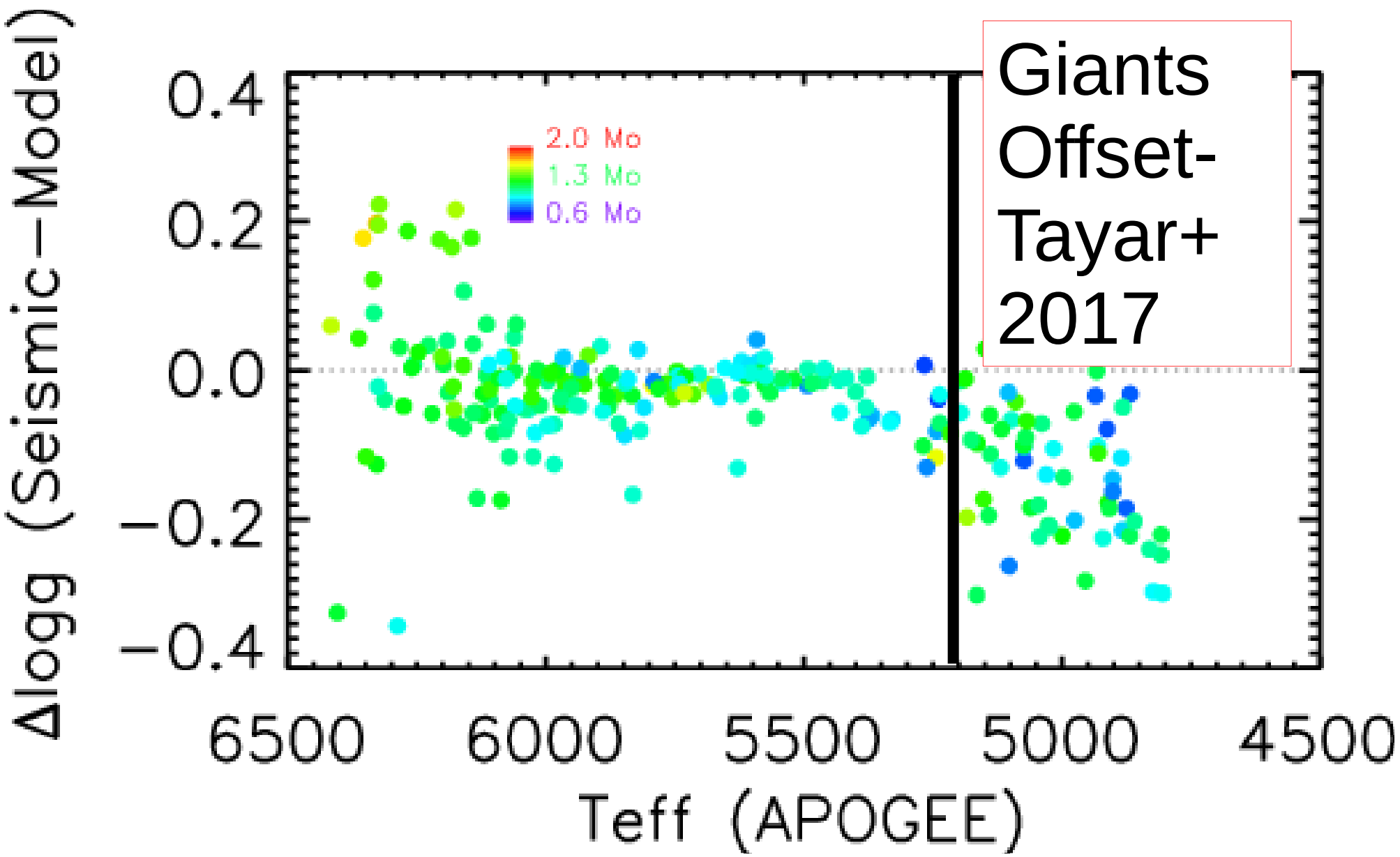

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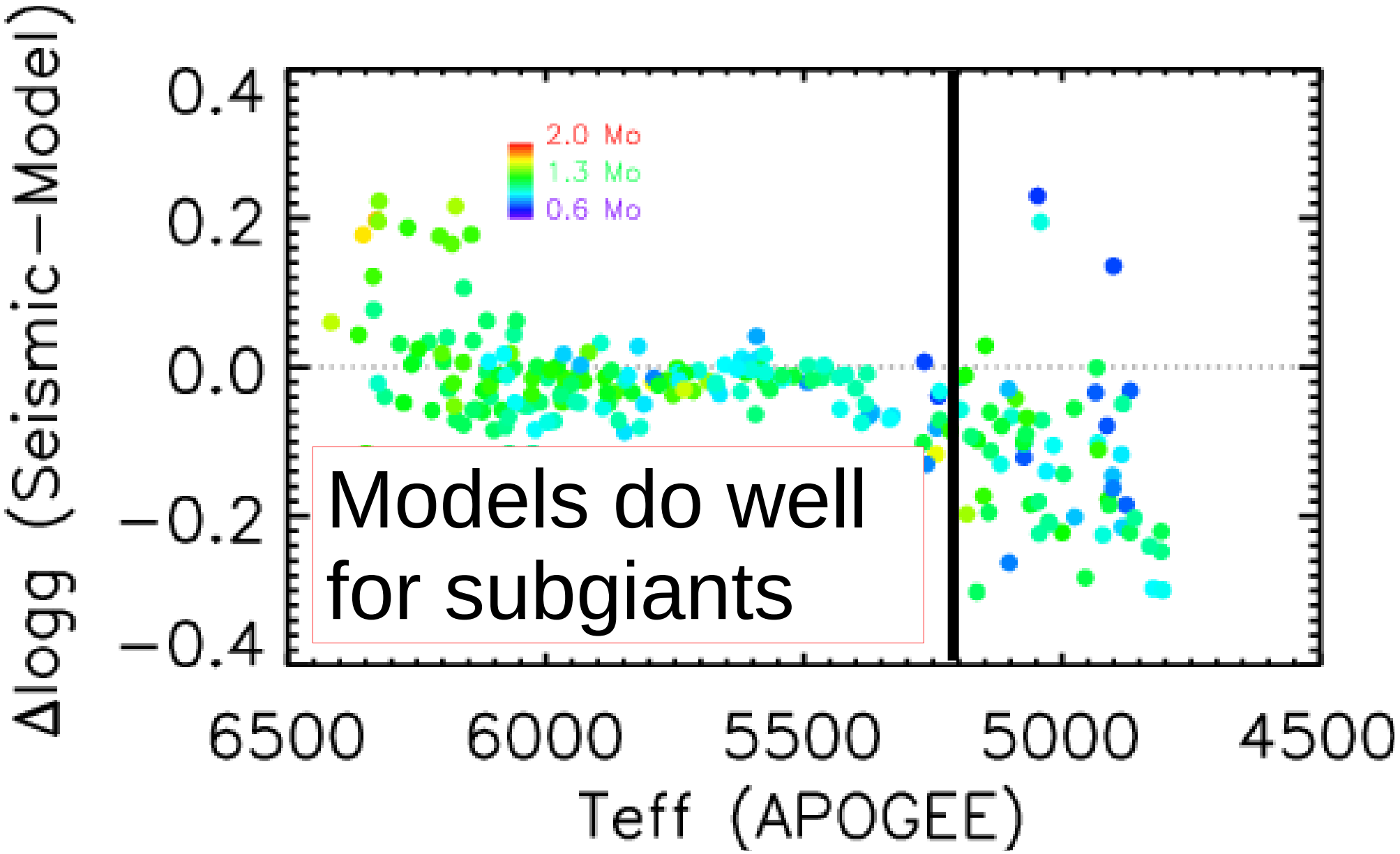

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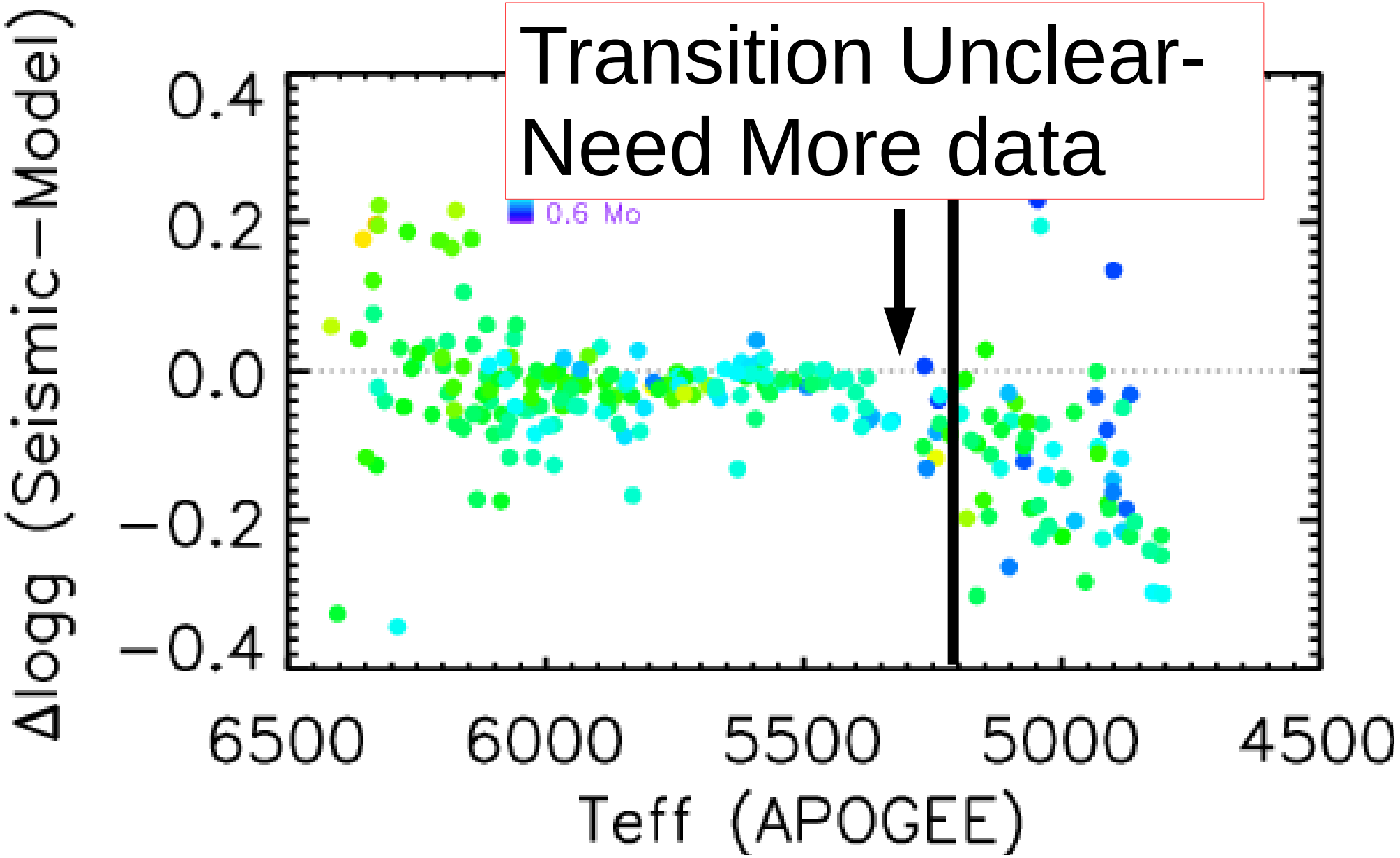
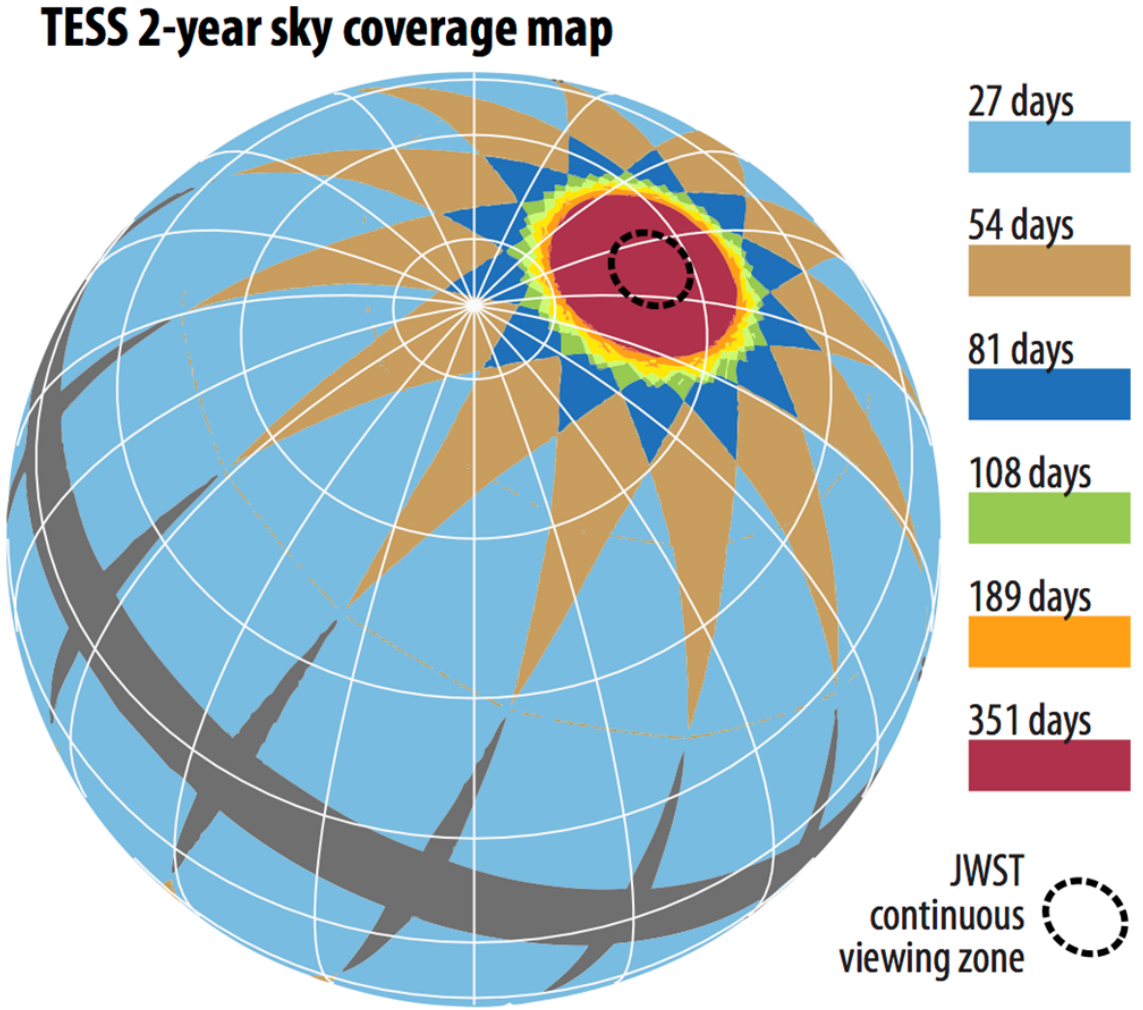
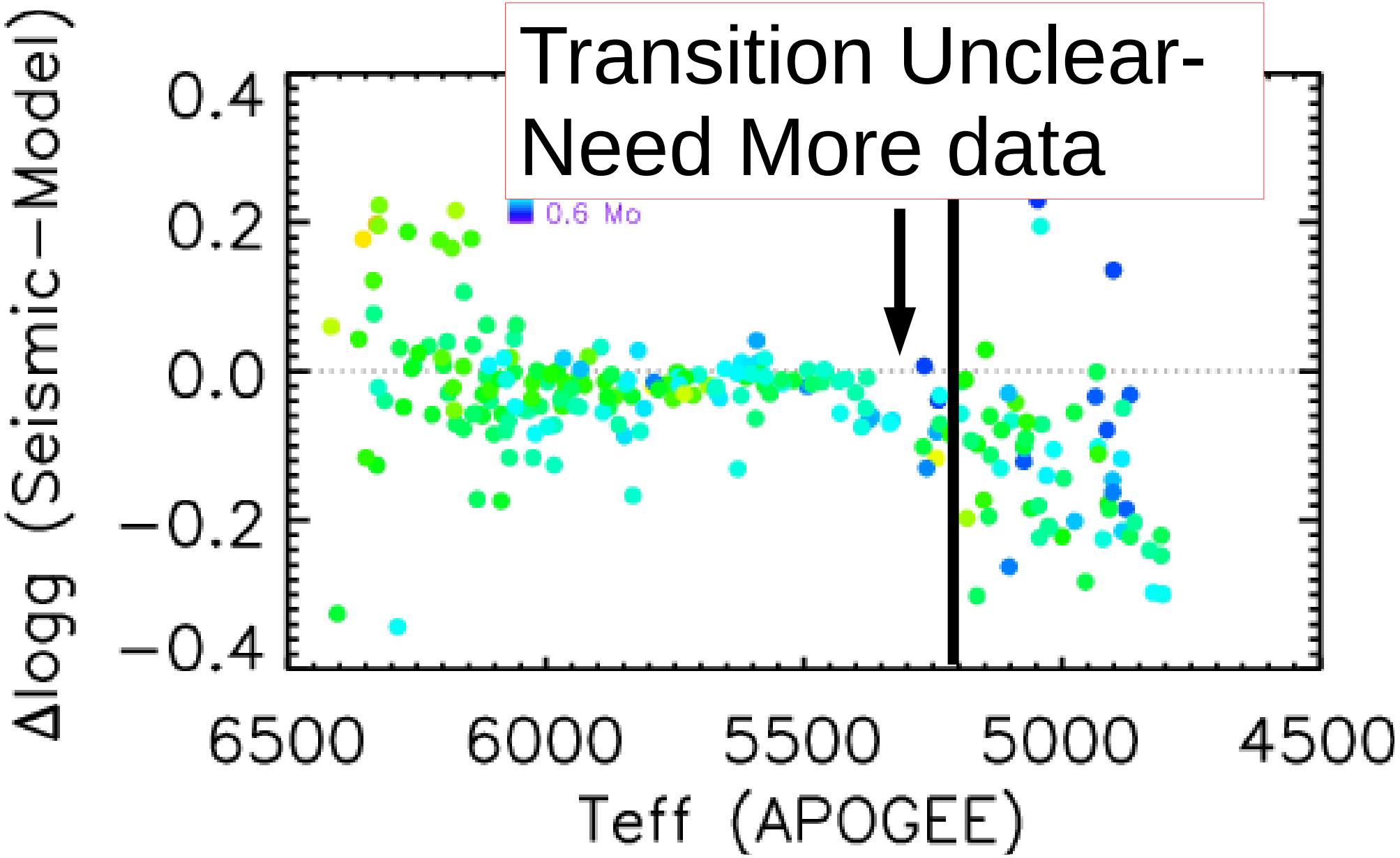


TESS

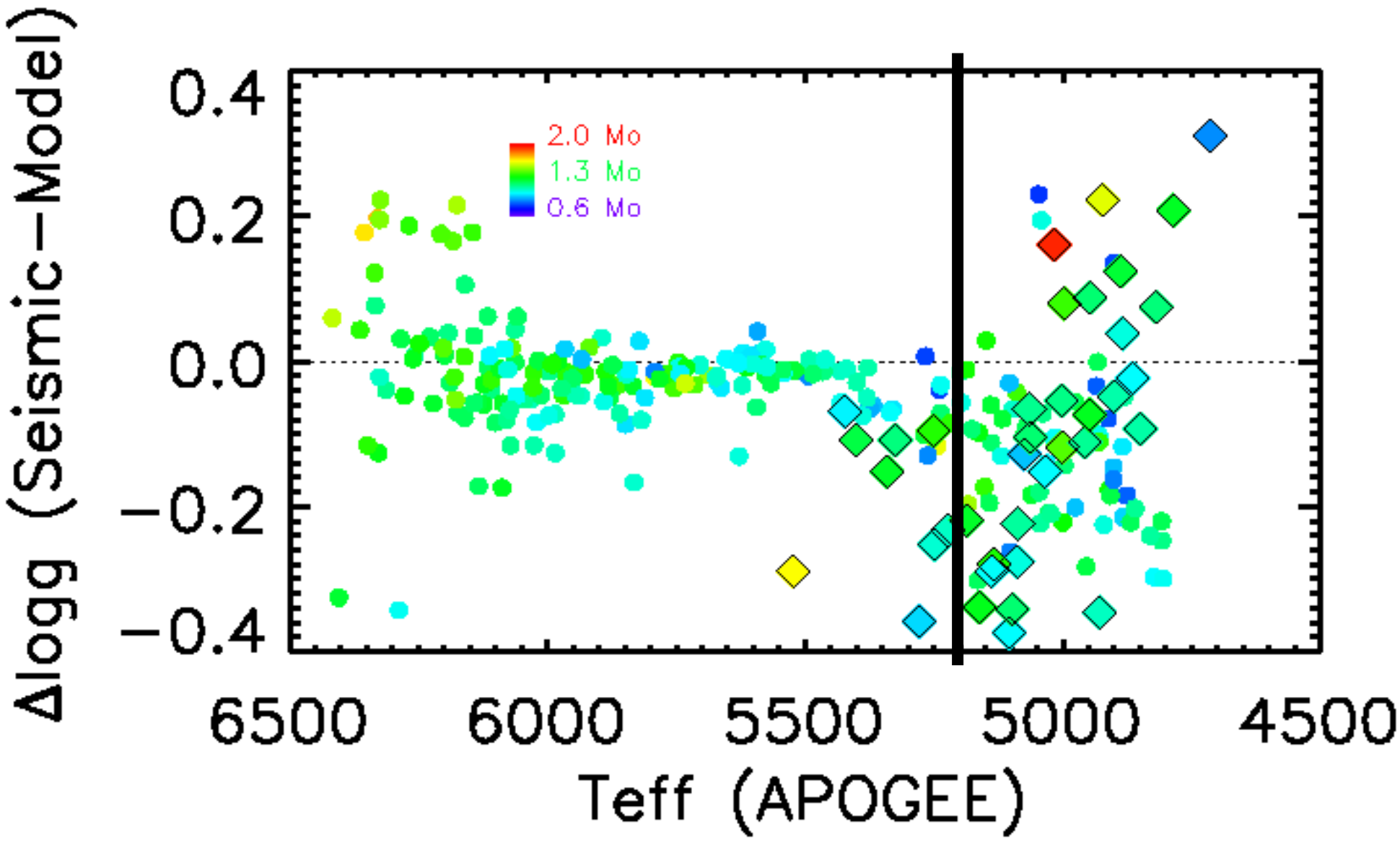

TESS


TESS 2-year sky coverage map
27 days
54 days
81 days
108 days
189 days
351 days
JWST
continuous
viewing zone

APOGEE-Kepler Subgiants



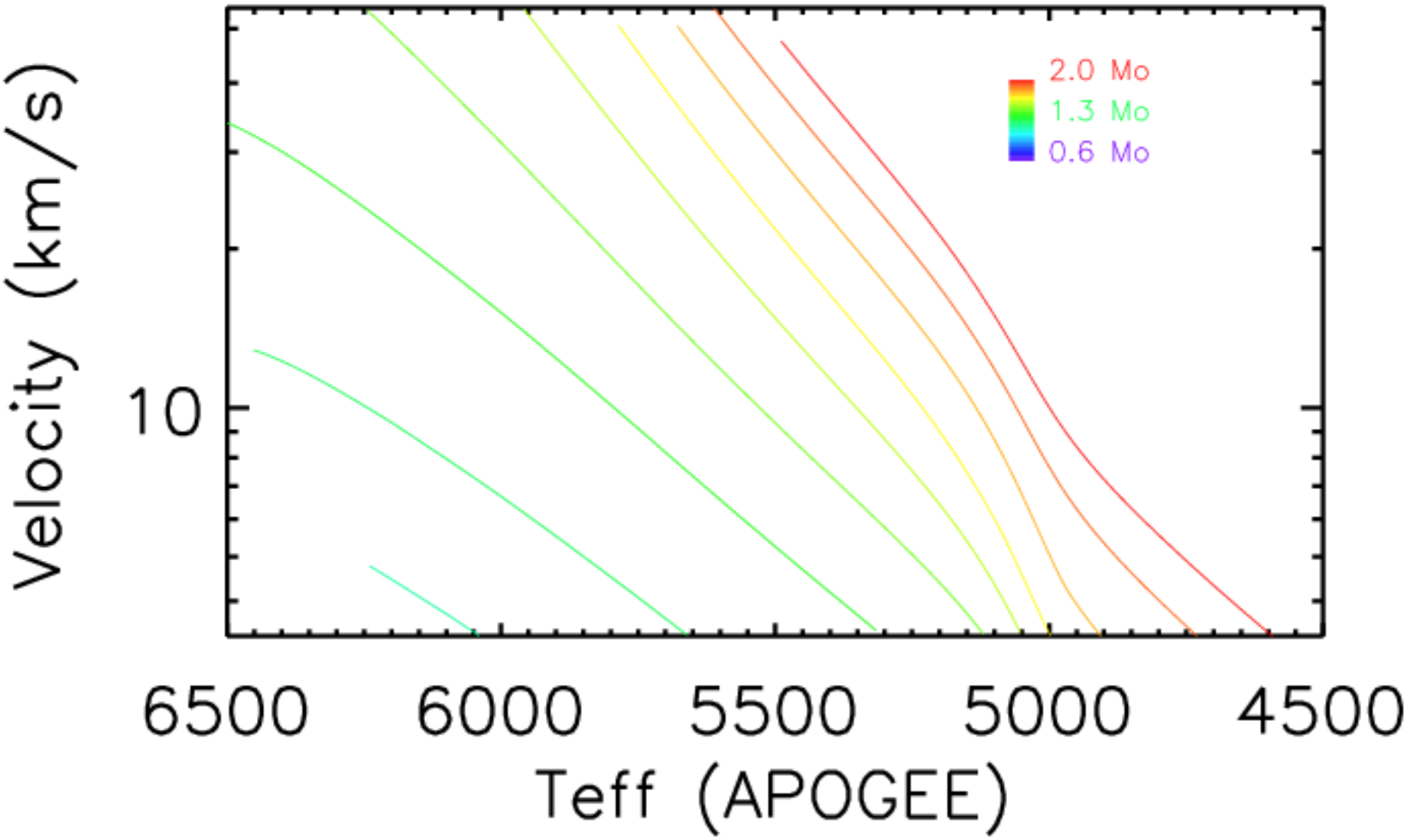
TESS Subgiants



Summary

- Stellar models need calibration
- Model choice impacts inferred mass by ~4%
- Predicted HR diagram position ~ correct
- *Kepler* stars are a good but insufficient sample for testing models of subgiants
- *TESS* will allow us to add up to 300 more similarly well characterized subgiants

Expected Rotation



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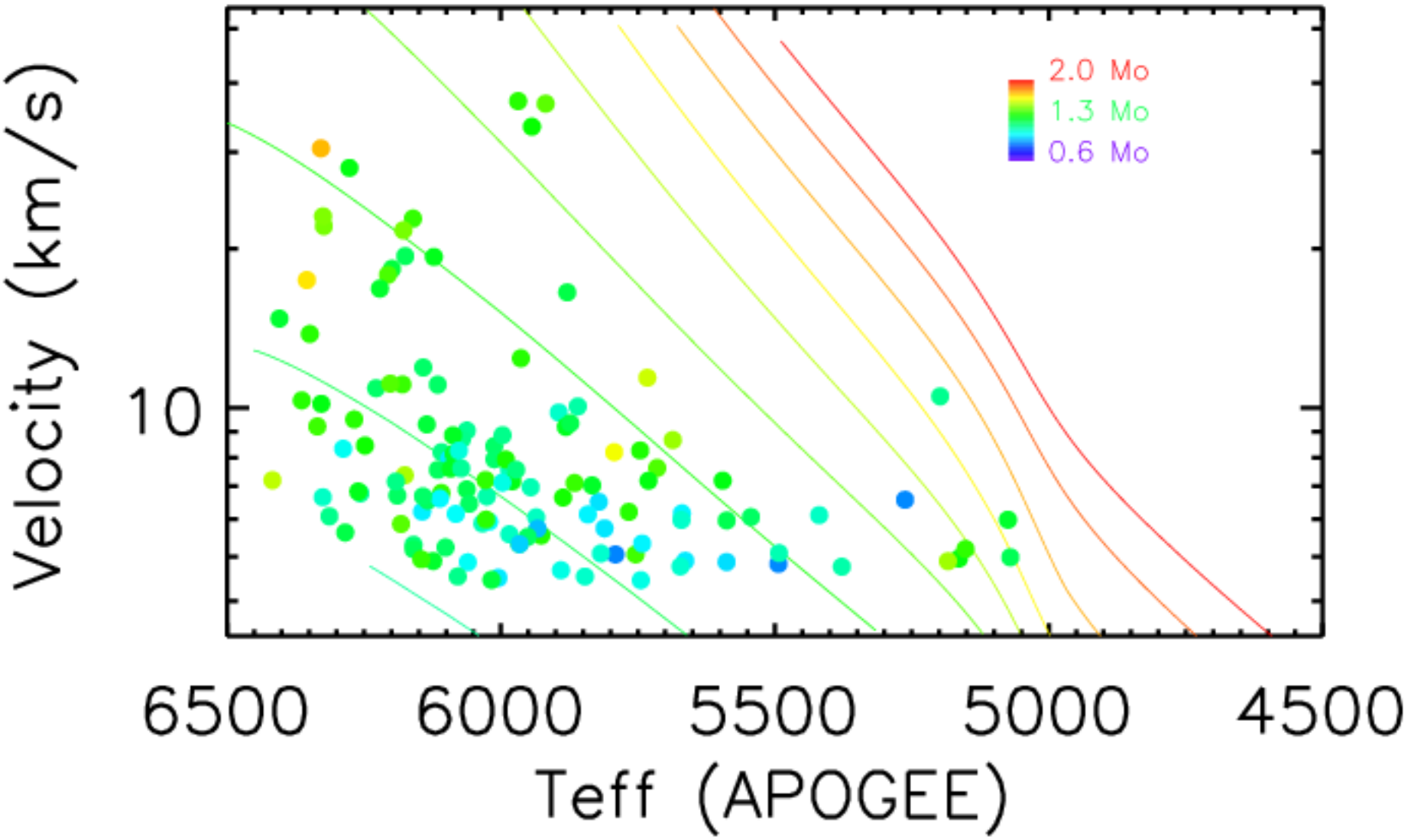
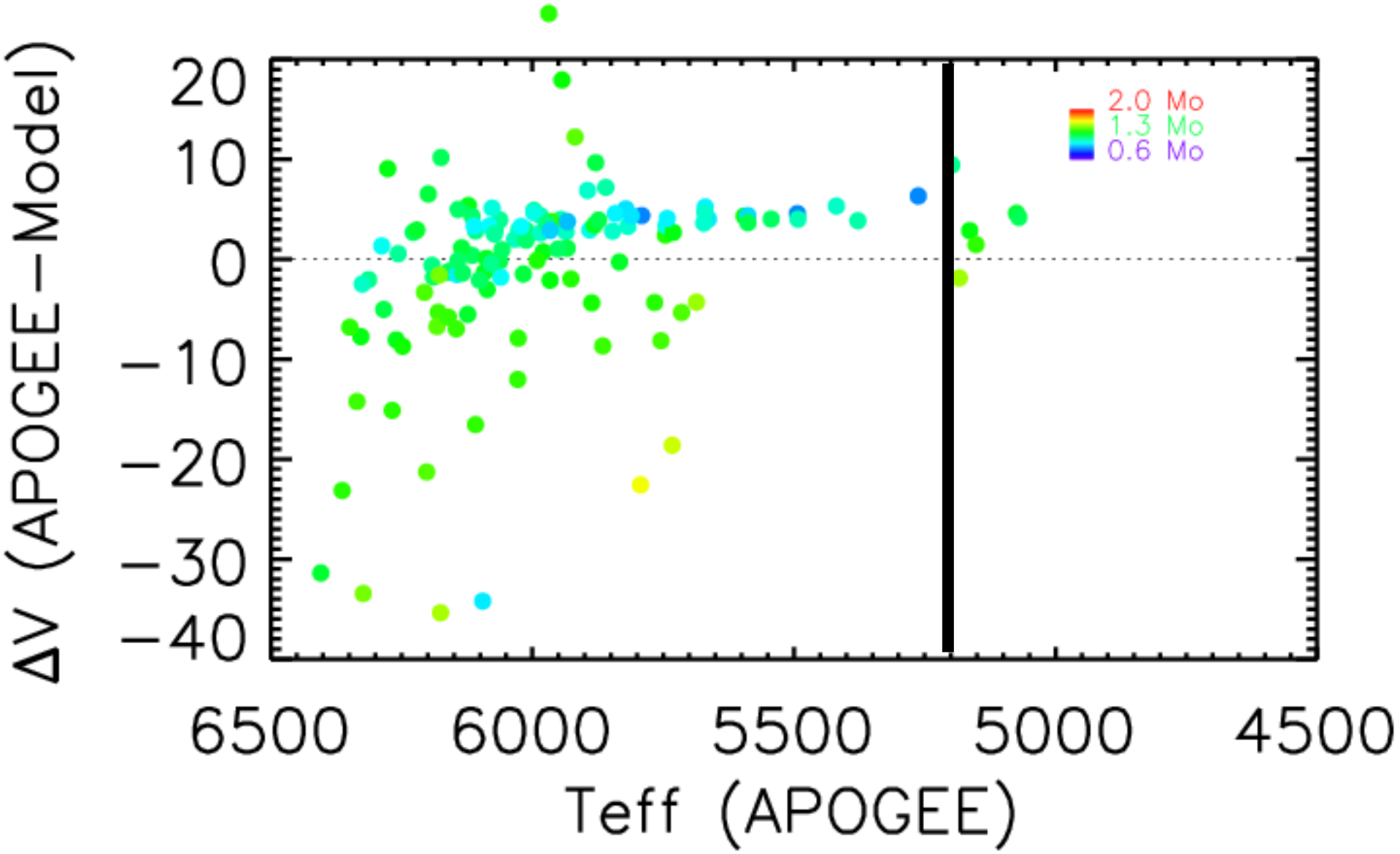


Rotation Difference



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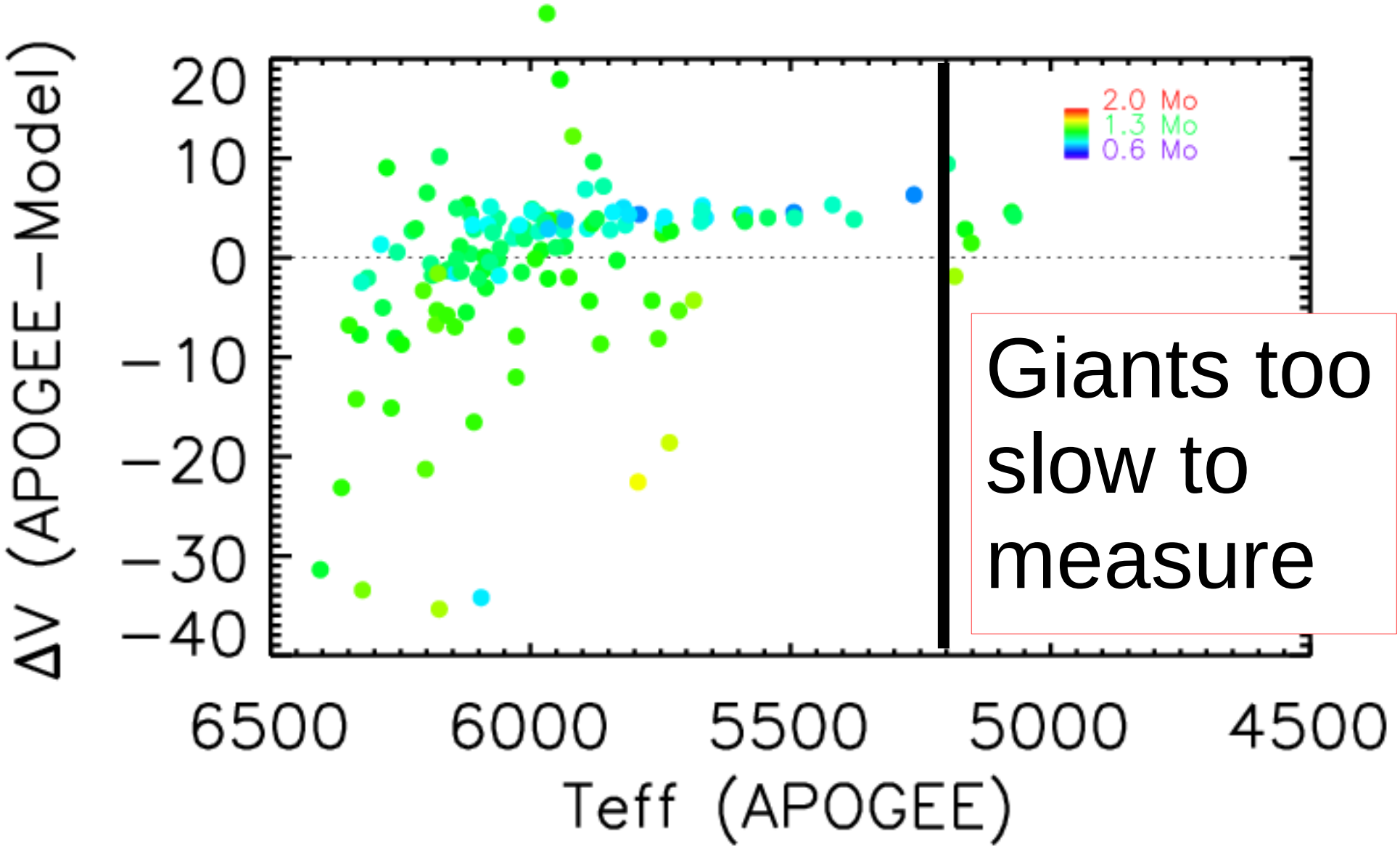

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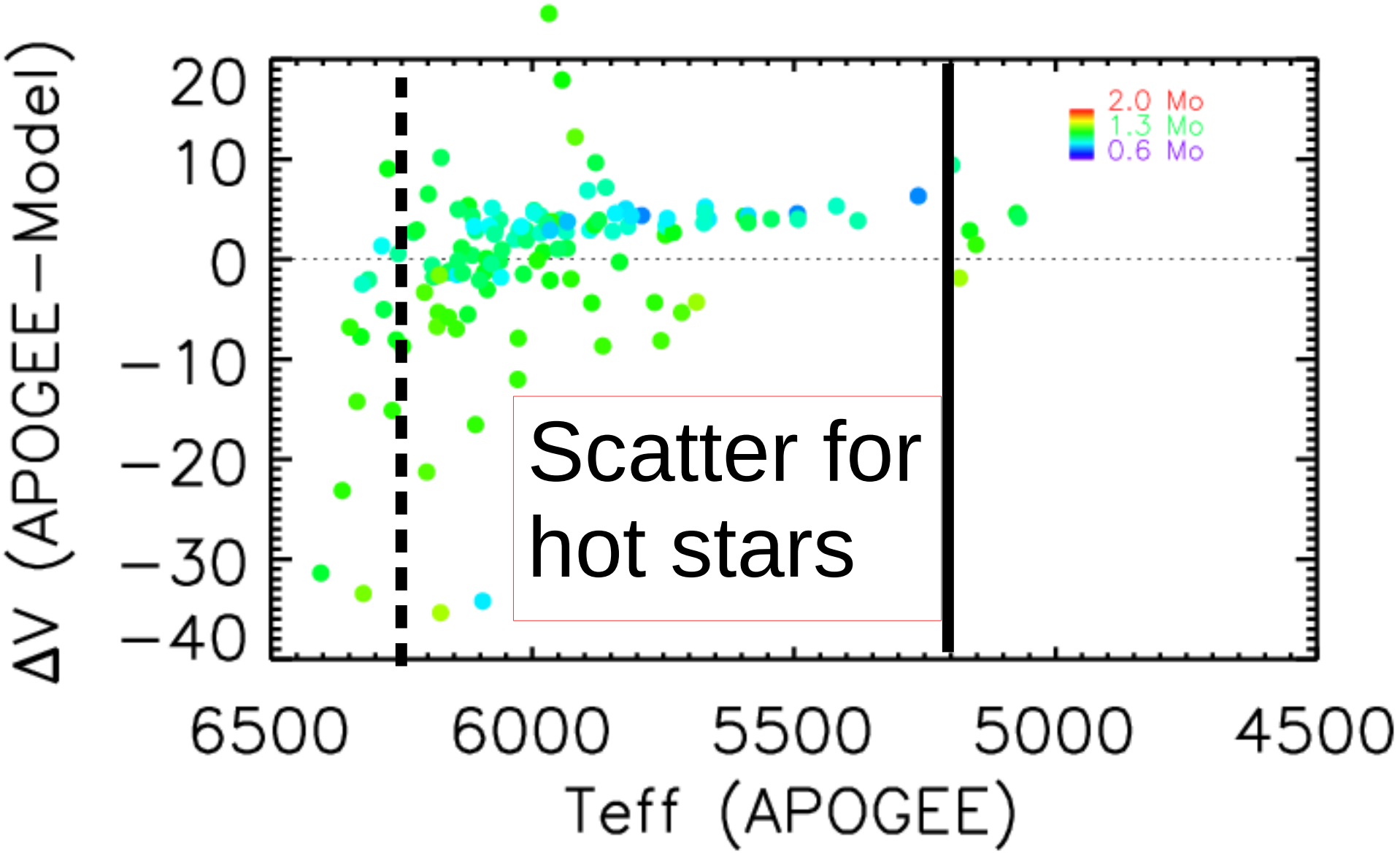

Rotation Difference