Limits on radial differential rotation in Sun-like stars from parametric fits to oscillation power spectra

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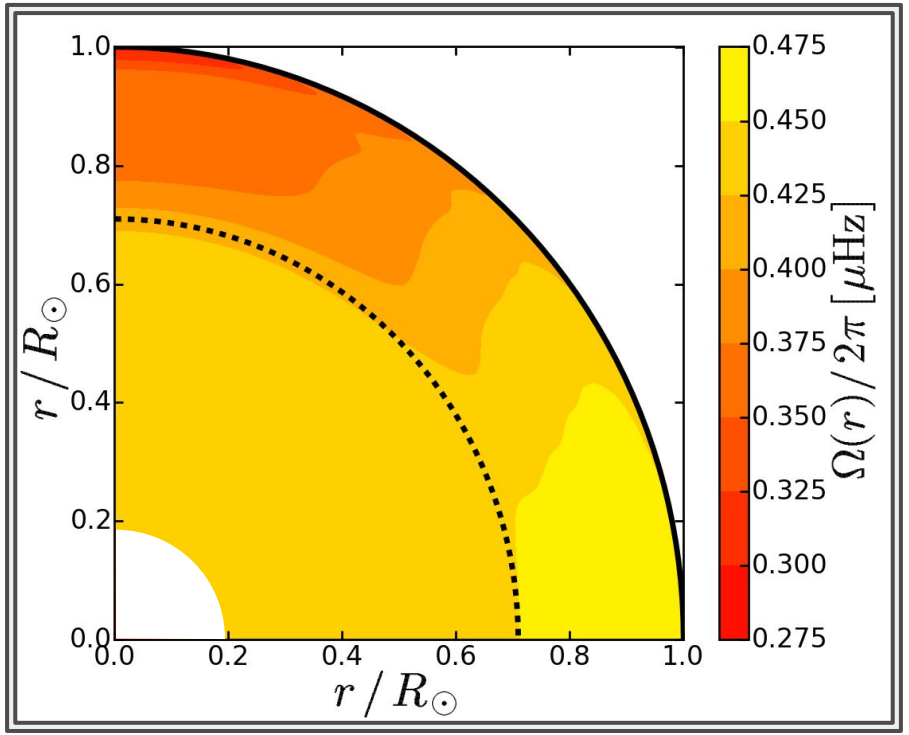
Rotation in Sun-like stars

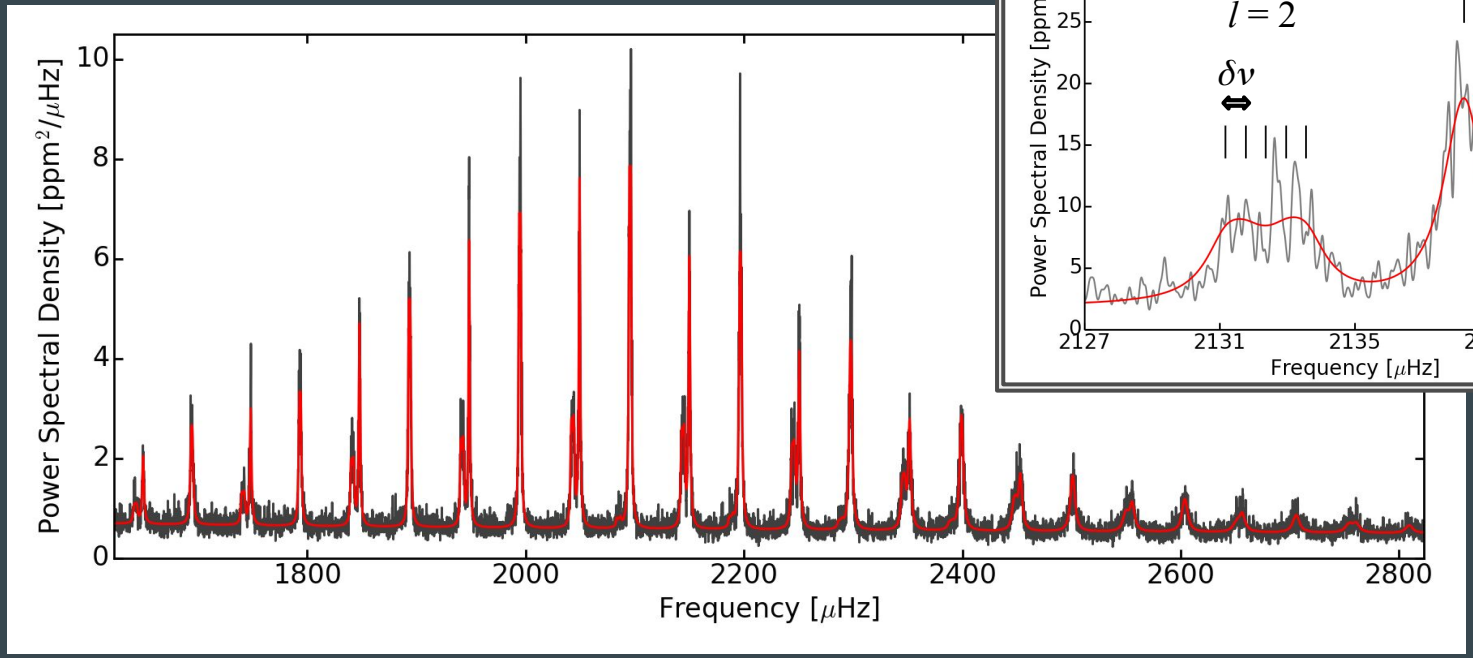
Combine:

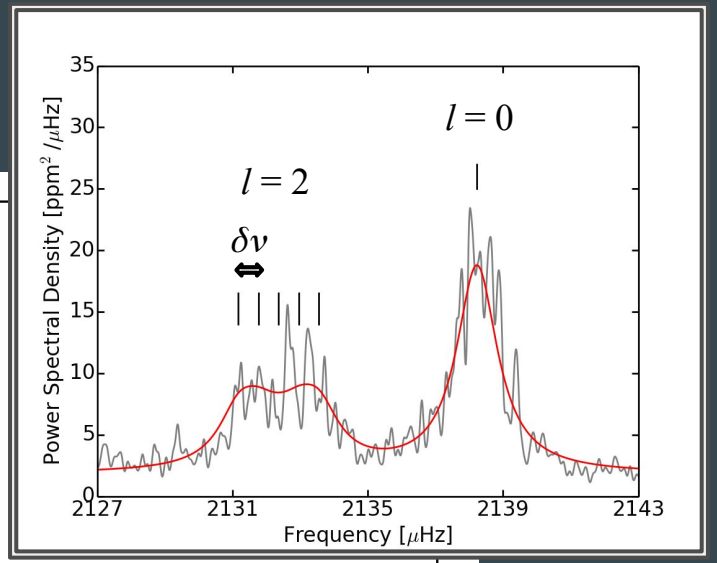
- Asteroseismology - sensitive to interior
- Starspot rotation - sensitive to surface



Adapted from Larson & Schou 2015

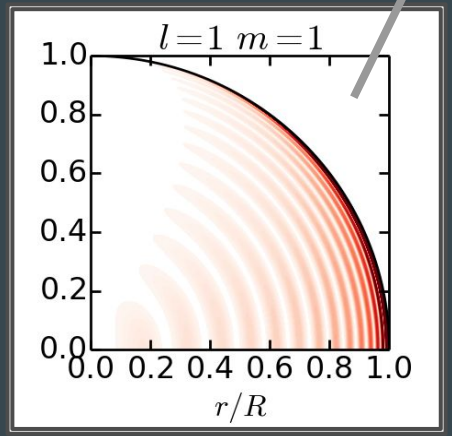
Measuring rotation with asteroseismology

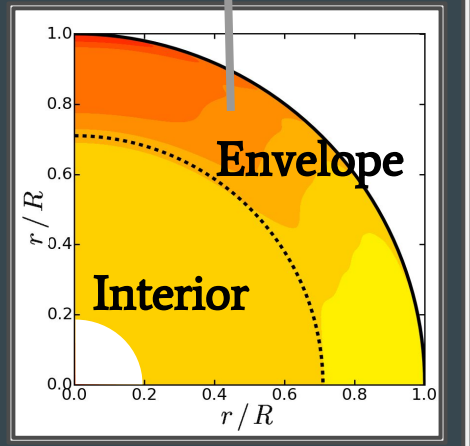


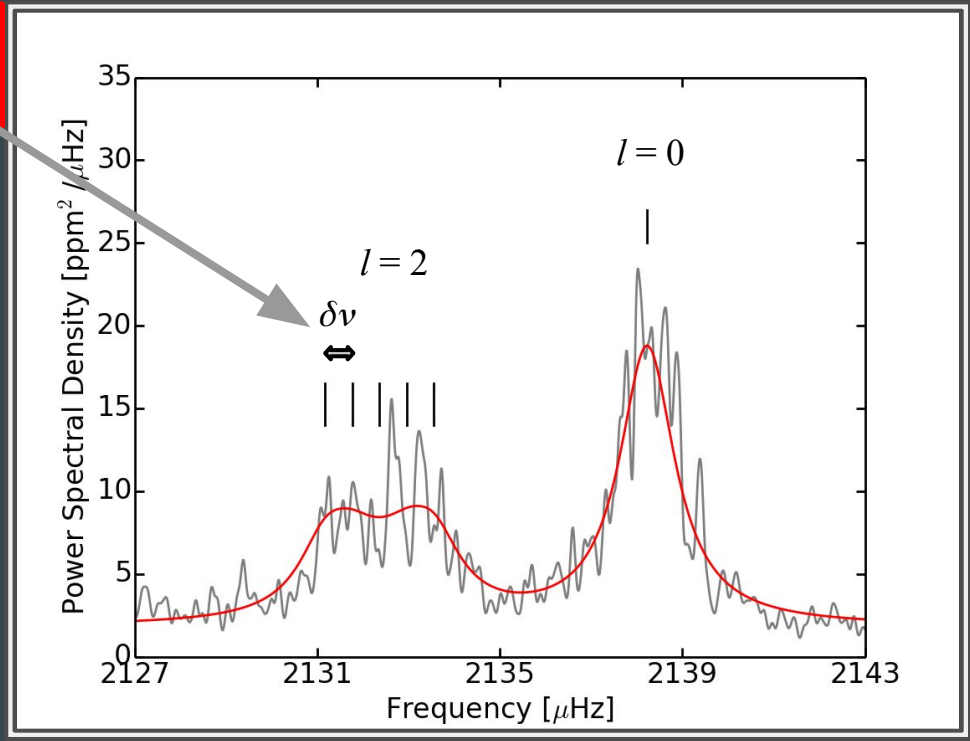


Measuring rotation with asteroseismology

$$\nu_{nlm} = \nu_{nl} + \frac{m}{2\pi} \int_0^{\pi} \int_0^{R} K_{nlm}(r,\theta)\,\Omega(r,\theta)\,dr\,d\theta$$



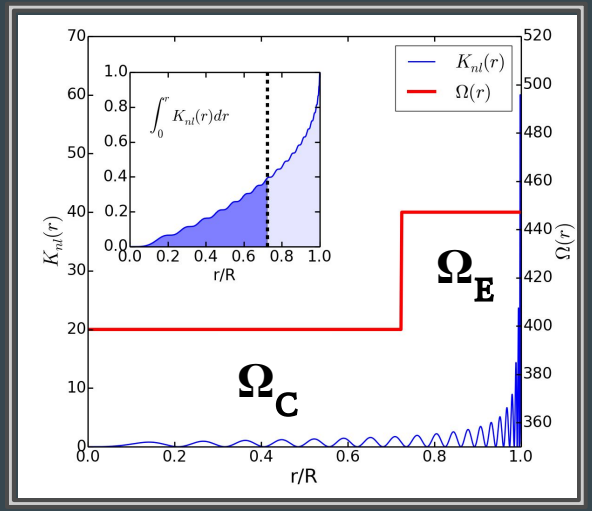


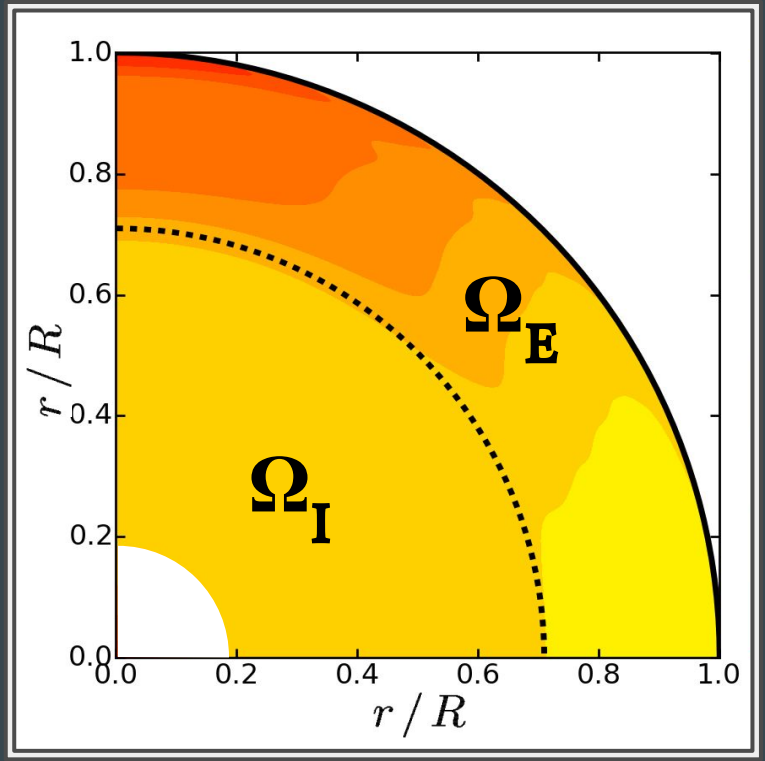


Distinguishing core and envelope rotation

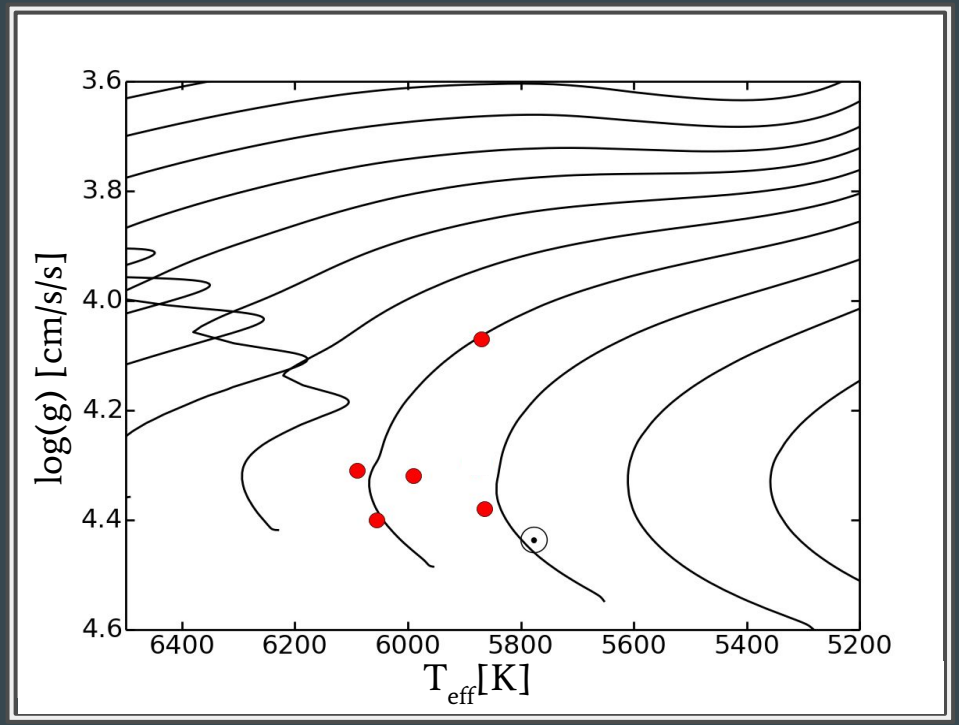
$$\delta\nu_{nlm} = \frac{m}{2\pi}\int_0^R K_{nl}(r)\Omega(r)dr$$

$$\delta\nu_{nlm} = \frac{m}{2\pi}\Omega_I\int_0^{r_{cz}} K_{nl}(r)dr + \frac{m}{2\pi}\Omega_E\int_{r_{cz}}^R K_{nl}(r)dr$$





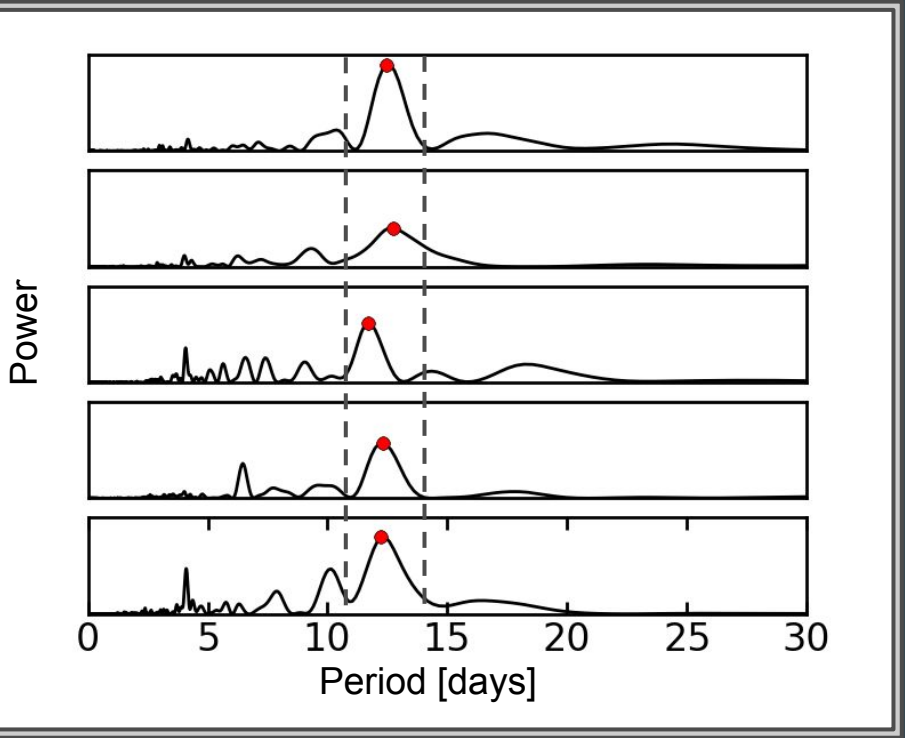
Selection of Sun-like Kepler stars

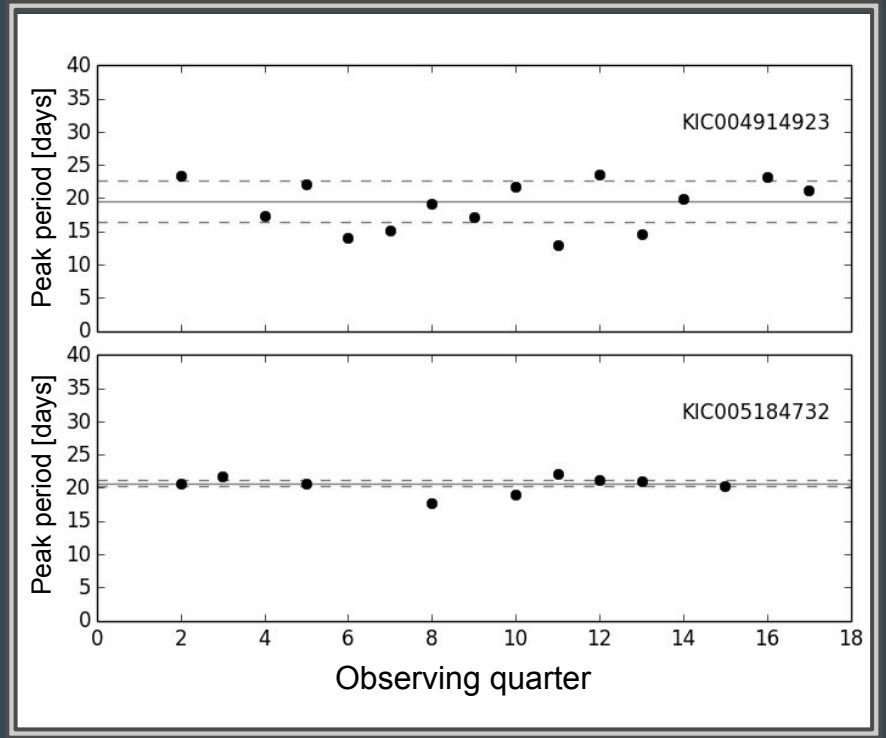


T_{eff} and log(g) by Bruntt et al. (2012)

- 5 Bright Sun-like stars
- Clear oscillation spectra,
- Clear spot modulation

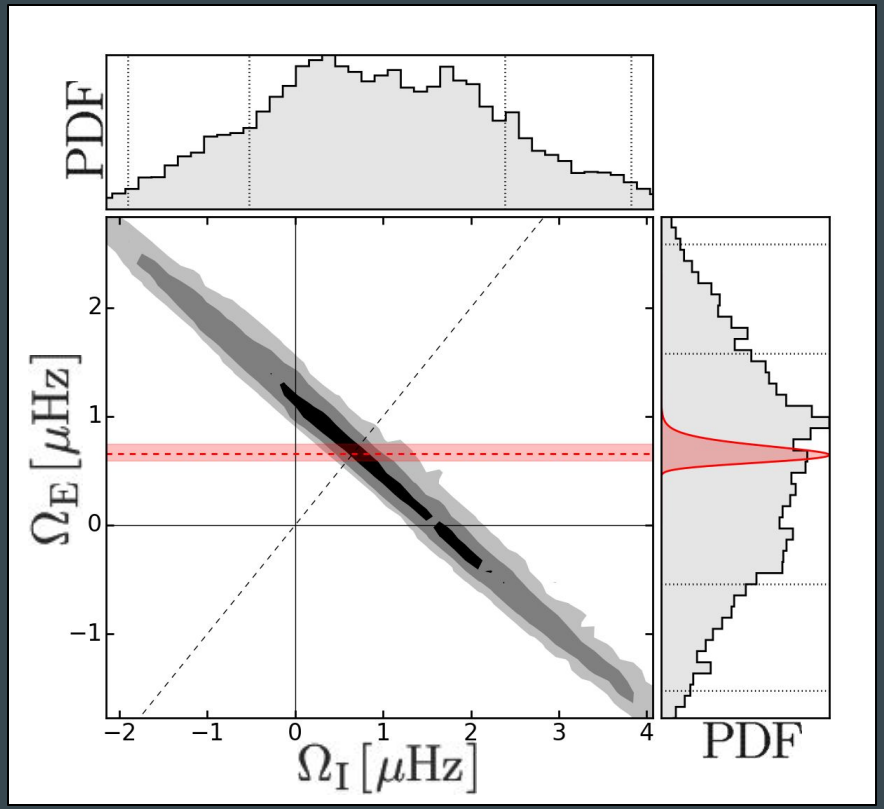
Rotation from surface variability





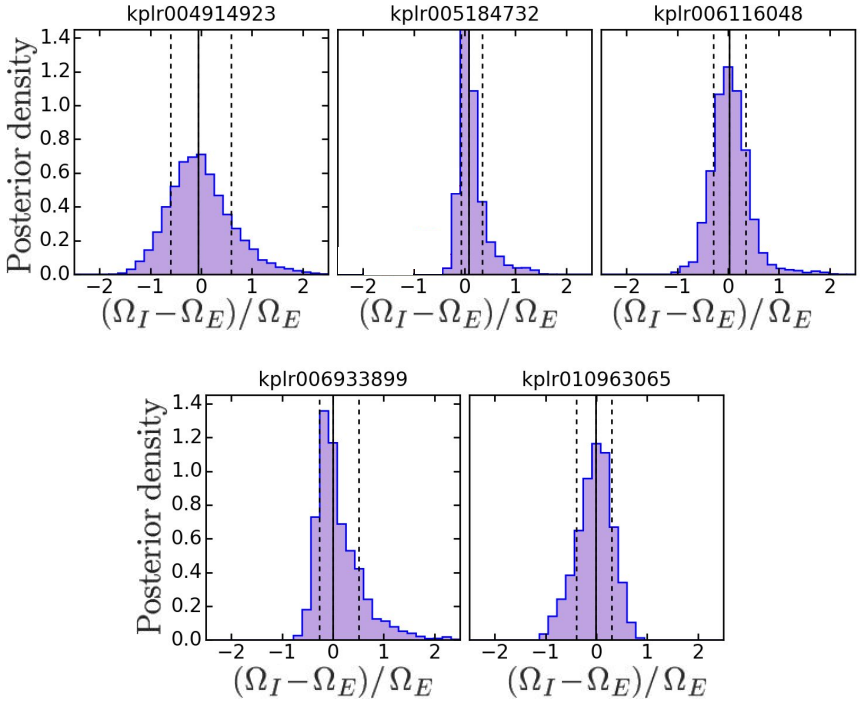
Combining asteroseismology and spots

- Poor constraints from asteroseismology alone
- Surface rotation as prior on Ω_E
- Restricts possible Ω_E and Ω_I



Limits on radial differential rotation

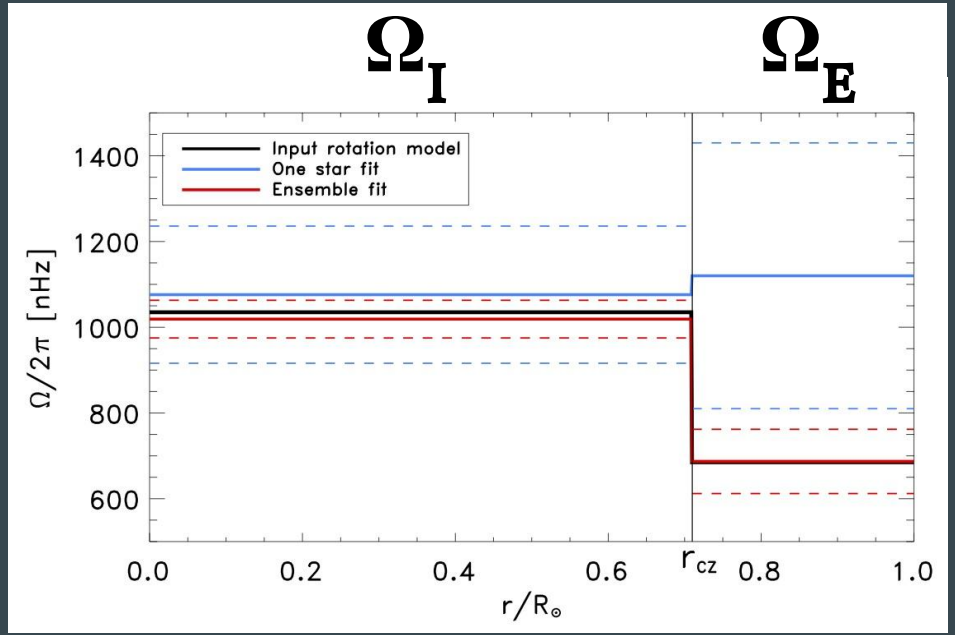
- Centered around 0%
- Average range: ±30%
- No clear asymmetry



(Nielsen et al. 2017)

Outlook

- Further reduce shear range
- Ensemble fits (Schunker et al. 2016)
- Simultaneously fit 10-100 stars
- Measure average $\Delta\Omega$ value for all
- PLATO can deliver this



Summary

- Combined asteroseismology with spot rotation
- Shear limited to a range of ± 30%
- PLATO can push this lower for ensembles

KIC	Cat	Teff [K]	logg [cm/s/s]
4914923	Vitto	5880 ± 70	4.30 ± 0.08
5184732	Kitty	5865 ± 70	4.38 ± 0.08
6116048	Nunny	5990 ± 70	4.32 ± 0.08
6933899	Fred	5870 ± 70	4.07 ± 0.08
10963065	Rudy	6090 ± 70	4.31 ± 0.08
6106415	~~Perky~~	6055 ± 70	4.40 ± 0.08

Comparing seismic and surface rotation rates

- **Average** seismic and surface rotation rates agree within errors

- Constrain the envelope rotation rate in the radial step model