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

Martin Bo Nielsen
Hannah Schunker, Laurent Gizon, Jesper Schou, Warrick Ball

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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

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

\[ \delta \nu_{nlm} = \frac{m}{2\pi} \Omega_I \int_0^{rc_z} K_{nl}(r) dr + \frac{m}{2\pi} \Omega_E \int_{rc_z}^R K_{nl}(r) dr \]
Selection of Sun-like Kepler stars

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

$T_{\text{eff}}$ and log(g) by Bruntt et al. (2012)
Rotation from surface variability

![Graph showing rotation from surface variability with power and peak period as variables.](image)

KIC004914923
KIC005184732
Combining asteroseismology and spots

- Poor constraints from asteroseismology alone
- Surface rotation as prior on $\Omega_E$
- Restricts possible $\Omega_E$ and $\Omega_I$
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
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<th>KIC</th>
<th>Cat</th>
<th>Teff [K]</th>
<th>logg [cm/s/s]</th>
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</table>
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

Nielsen et al. (2015)