Internal **rotation** and **mixing** in the massive star HD192575

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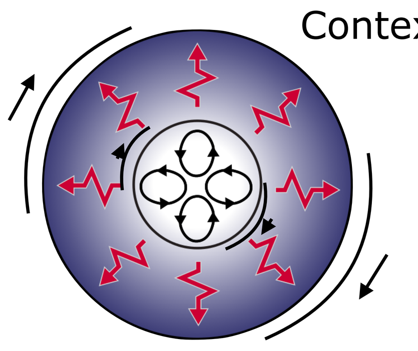
Key message:

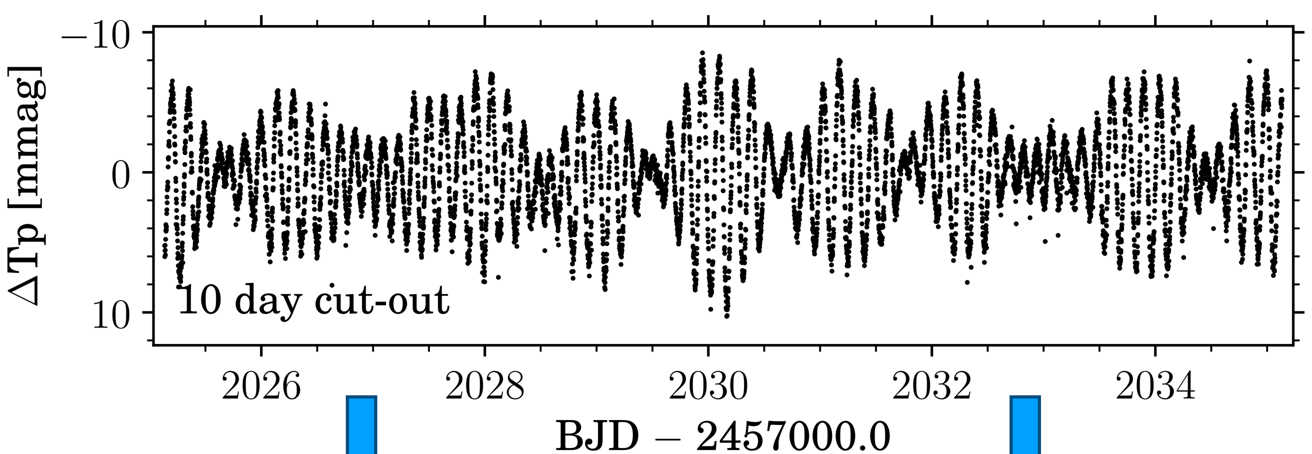
High-precision TESS data reveals *differential rotation* between the near-core and envelope of the high-mass star HD192575, providing a new anchor in the study of *angular momentum transport* inside massive stars.

1. Data

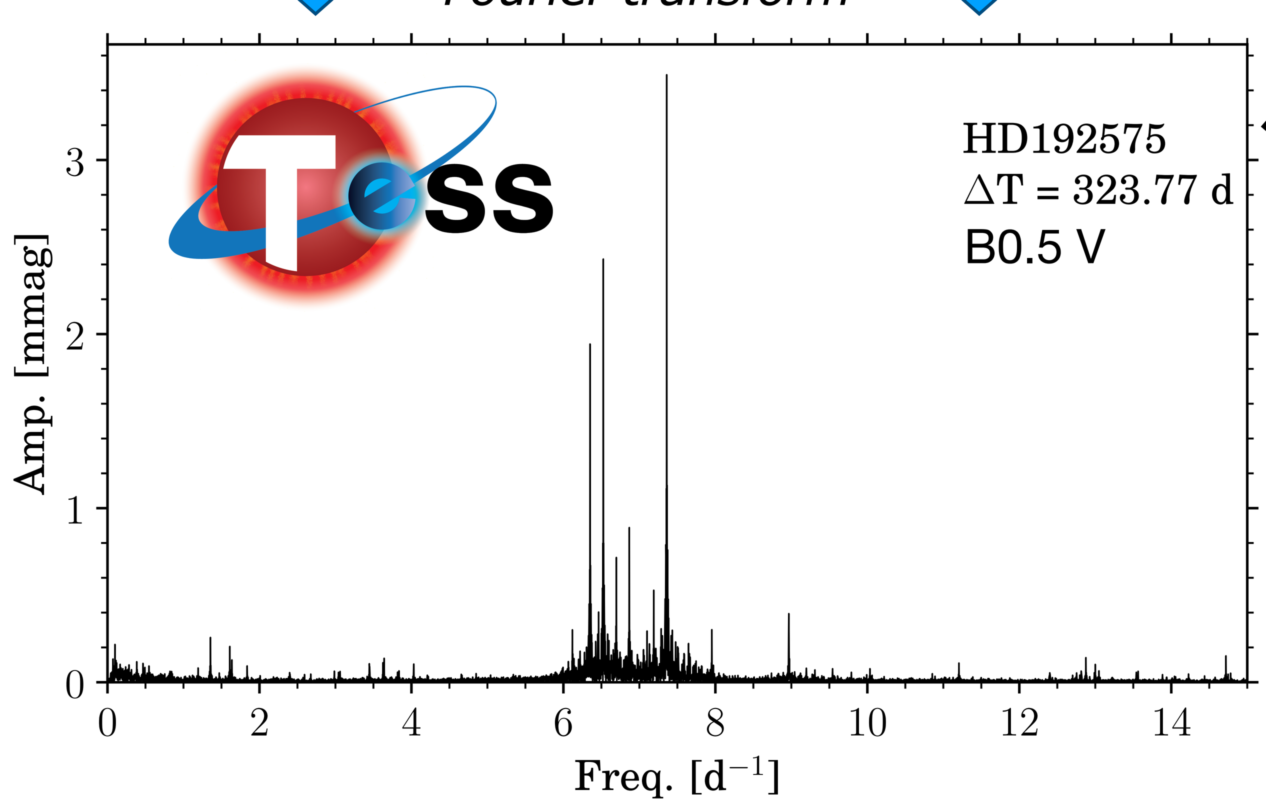
Context: star with convective core



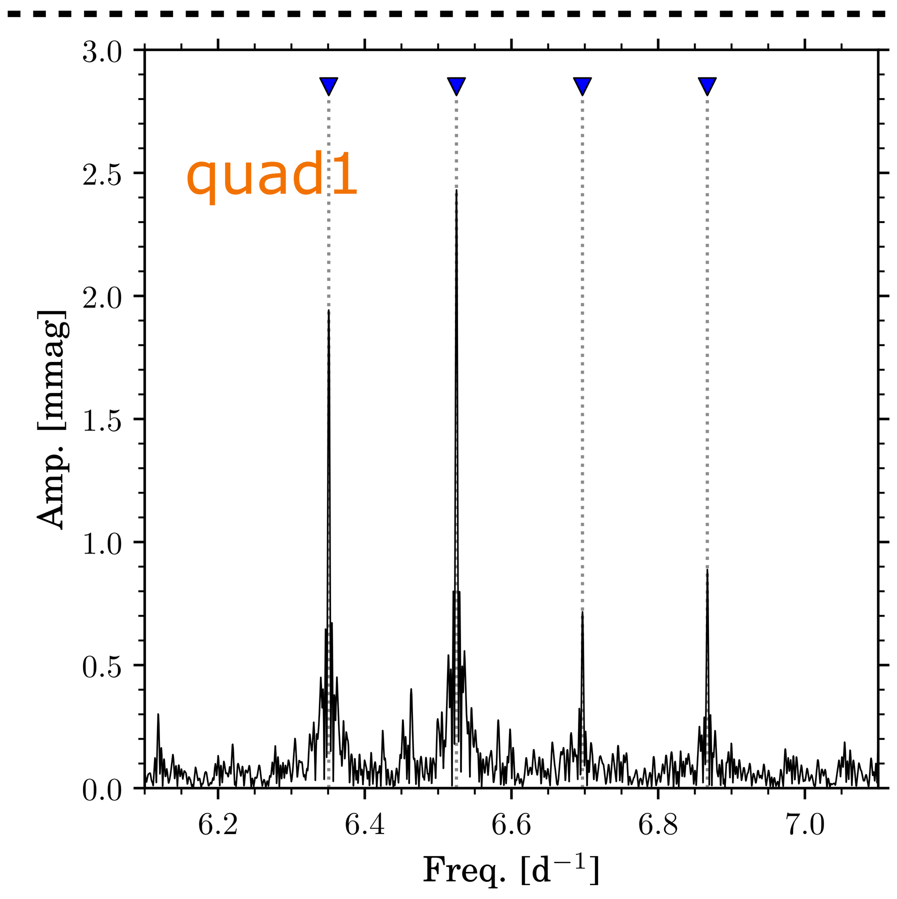
: Mass M_{ini} + composition? + Age? X_c + Core overshooting? f_{CBM} + Rotation? $\Omega(r)$ Mixing? $D_{env}(r)$ } Constrain through *seismic modelling* with high precision TESS data for large samples [1]

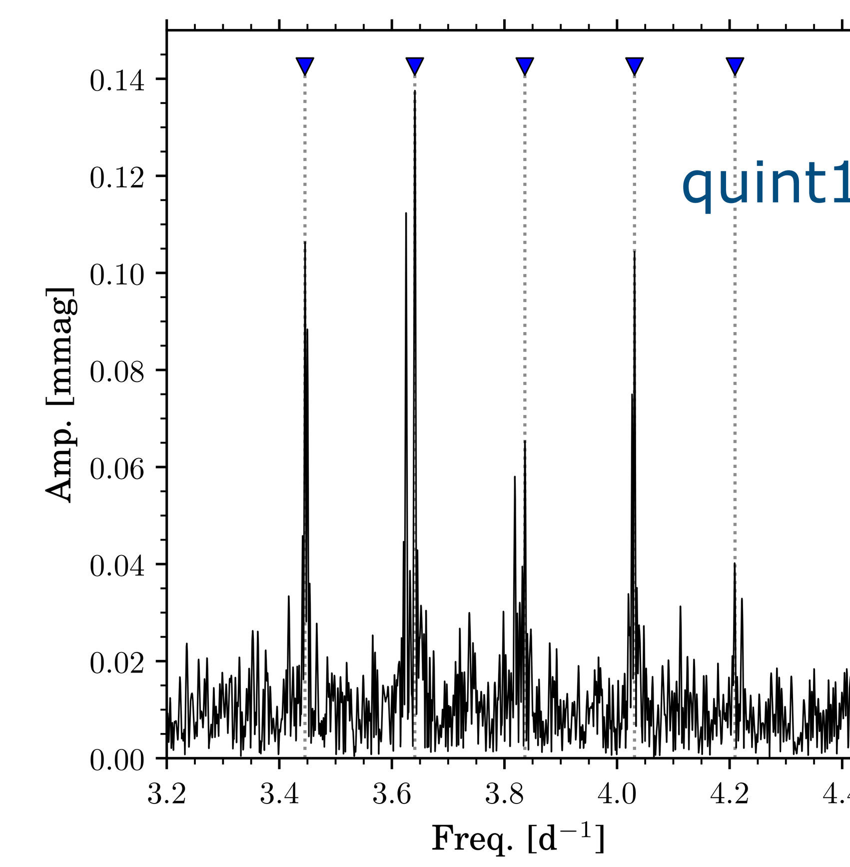


Fourier transform



Frequency analysis!



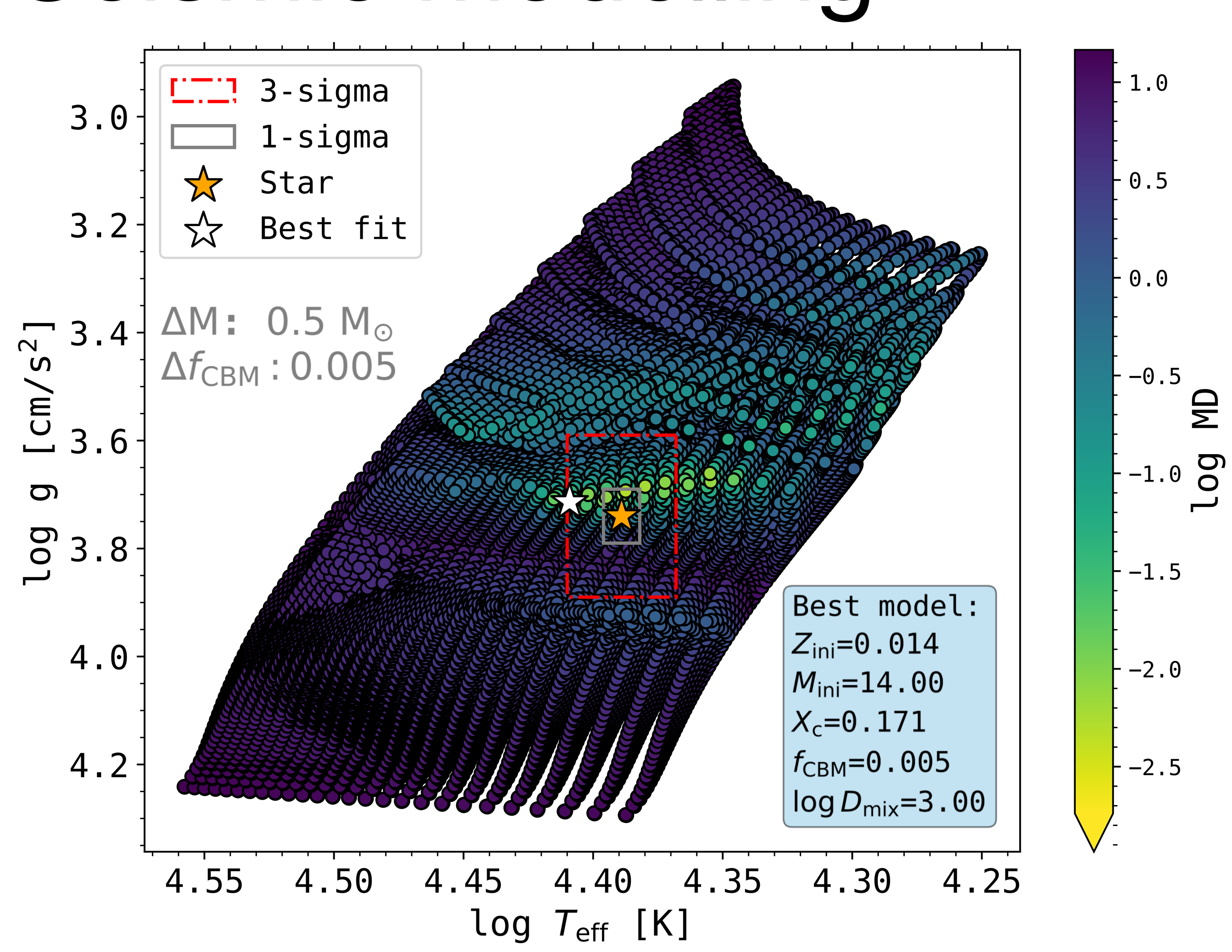


Pulsation modes are characterised by wave numbers ℓ, m, n_{pg}. In case of *slow and rigid rotation* modes of same (ℓ, n_{pg}) but different m split up into multiplets with frequency splittings:

$$\Delta f = m\beta_{nl} f_{rot} \quad \text{(Eq.1)}$$

Where f_{rot} is the rotation frequency and β_{nl} is a mode (and model) dependent constant. **Splittings like quad1 and quint1 yield mode identification (needed for modelling) and a measure of interior rotation (once β_{nl} from model found)!**

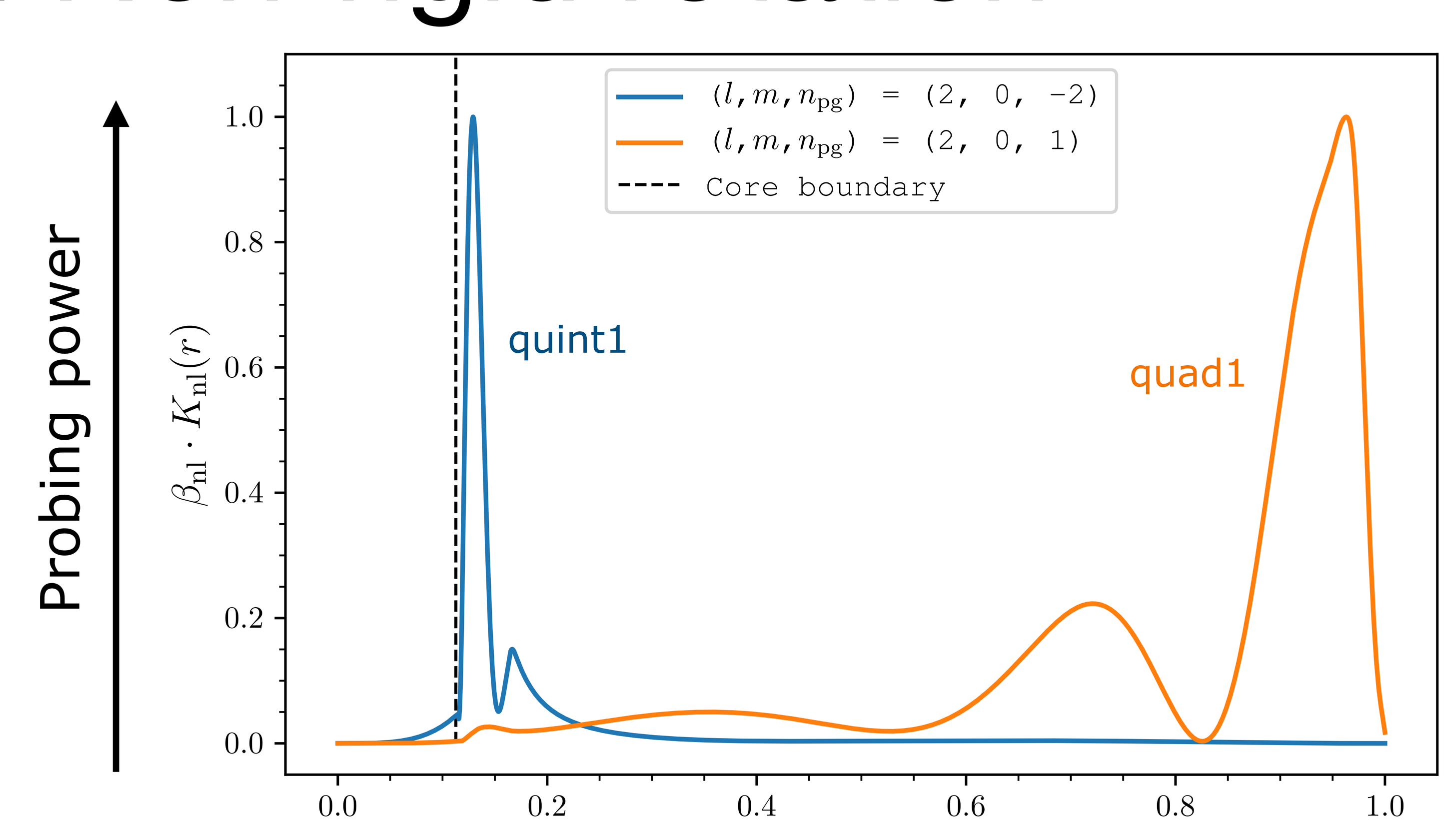
2. Seismic modelling



Observed multiplets allow for direct comparison to stellar and pulsation models computed using MESA [2] and GYRE [3]. This allows us constrain stellar parameters using forward seismic modelling [4, 5].

Combined power of spectroscopy and TESS photometry allows for accurate solution region yielding precise estimates of stellar parameters.

3. Non-rigid rotation



By using (Eq.1) with β_{nl} from best model we derive *different* $f_{rot}(r)$ from multiplets quint1 and quad1: incentive to abandon rigid rotation hypothesis! Δf depends on kernel $\beta_{nl}K_{nl}(r)$ which has radial dependence for each mode:

$$\Delta f = m\beta_{nl}\int_0^R K_{nl}(r)\Omega(r)dr \quad \text{(Eq.2)}$$

Probing power reaches maximum in different regions so higher splitting in quint1 relative to quad1 implies higher rotation frequency in near-core region: **Differential rotation!**

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4. Conclusion

High precision TESS data allowed for confident detection of frequency multiplets in HD192575 which were used for **mode identification** and **forward seismic modelling**. The multiplets further uncover **signatures of differential rotation.**

References

1. Burssens et al. 2020, A&A, 639, A81
2. Paxton et al. 2019, ApJS, 243, 10
3. Townsend et al. 2018, MNRAS, 475, p.879-893
4. Aerts et al. 2018, ApJS, 237, 15
5. Michielsen et al. 2021, A&A, 650, A175