Tests of Convective Zone Radial Differential Rotation In Intermediate Mass Core Helium Burning Stars with PEPSI

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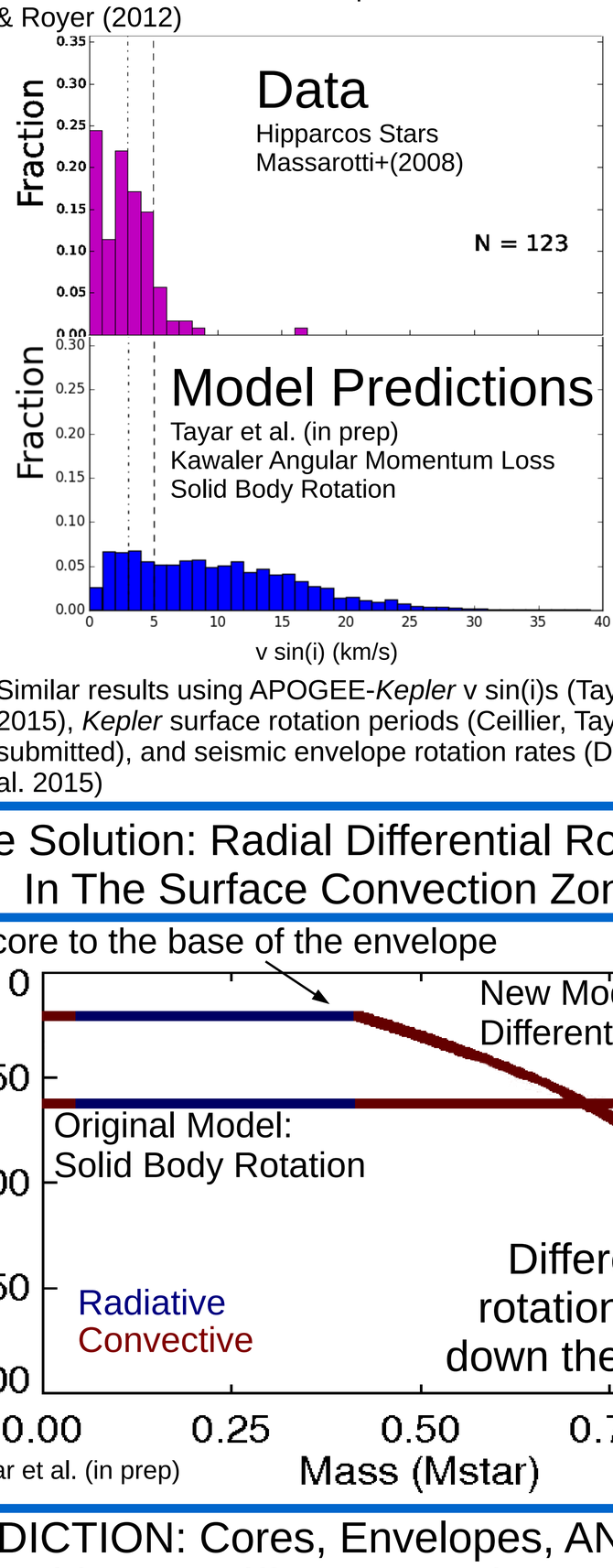
The PROBLEM: Surface Rotation Rates of Secondary Clump Stars are MUCH Slower Than Models Predict

- Masses between 2.0 and 3.0 M_o, log(g) between 3.1 and 2.0
- Forward model from main sequence rotation distribution of Zorec & Royer (2012)



- Similar results using APOGEE-*Kepler* v sin(i)s (Tayar et al. 2015), *Kepler* surface rotation periods (Ceillier, Tayar, et al. submitted), and seismic envelope rotation rates (Deheuvels et al. 2015)

One Solution: Radial Differential Rotation In The Surface Convection Zone

The PREDICTION: Cores, Envelopes, AND Surfaces Should Have Different Rotation Periods

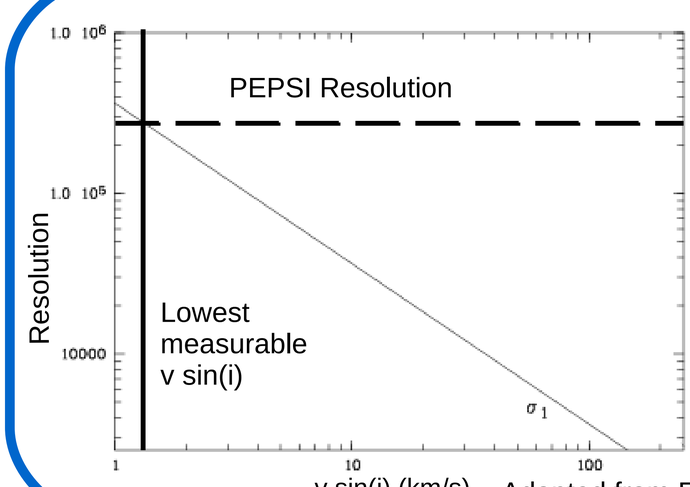
KIC ID	P_{core}	P_{env}	P_{surf}	(Days)
3744681	60	184		
4659821	70	147		
5184199	58	184		
7467630	96	121		
7581399	69	138	151	
8962923	84	147		
9346602	71	218		

Core and Envelope Periods from Deheuvels et al. (2015)

Surface period from Ceillier, Tayar et al. (submitted)

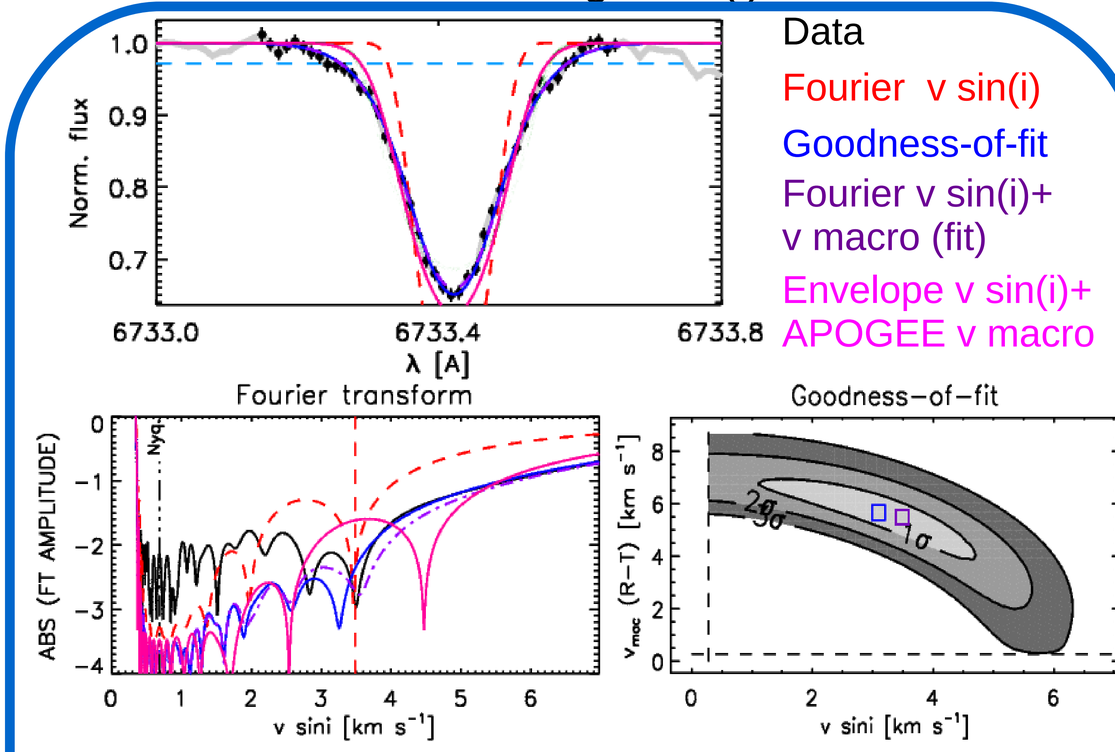
- Core and envelope rotation periods are different
- Only one star in the sample has a measured surface period from spots
- Without surface periods, we can't tell whether the differential rotation is in the surface convective zone

Why We Needed PEPSI



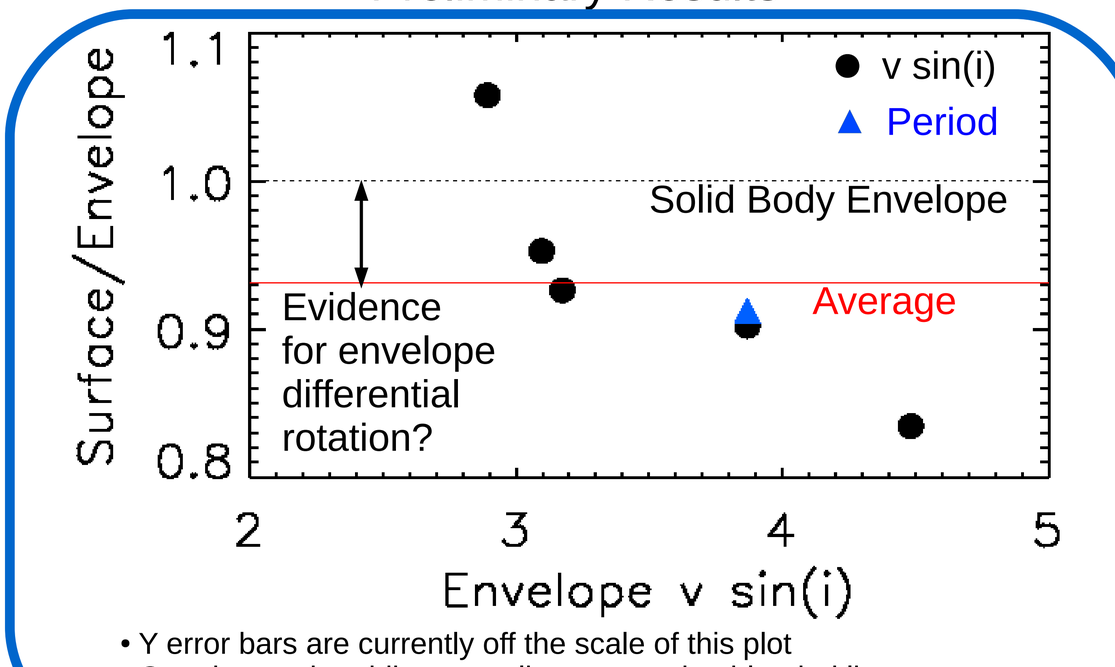
- R=270,000 allows us to measure v sin(i) down to ~ 1.3 km/s
- Using the seismically measured radius and inclination angles, we can convert from v sin(i) to period
- Envelope rotation periods predict v sin(i) from 2.4-4.4 km/s
- Differential rotation would predict lower v sin (i)

Measuring v sin(i)



- Rotational velocity and macroturbulent velocities are comparable
- Take the Fourier transform of individual lines to separate the two broadening components
- Use the iacob_broad package from Simon-Diaz & Herrero (2014)

Preliminary Results



- Y error bars are currently off the scale of this plot
- Ongoing work: adding more lines, removing blended lines, improving error analysis, checking calibration, validating method

We Have Tentative Evidence of Radial Differential Rotation In The Surface Convection Zone of Intermediate Mass Core Helium Burning Stars