Red Giants in Eclipsing Binaries

Exploring Non-Oscillators and Testing Asteroseismic Scalings

Meredith L. Rawls @merrdiff

New Mexico State University
University of Washington/LSST (Fall 2016)

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In collaboration with P. Gaulme, J. McKeever, J. Jackiewicz, et al.

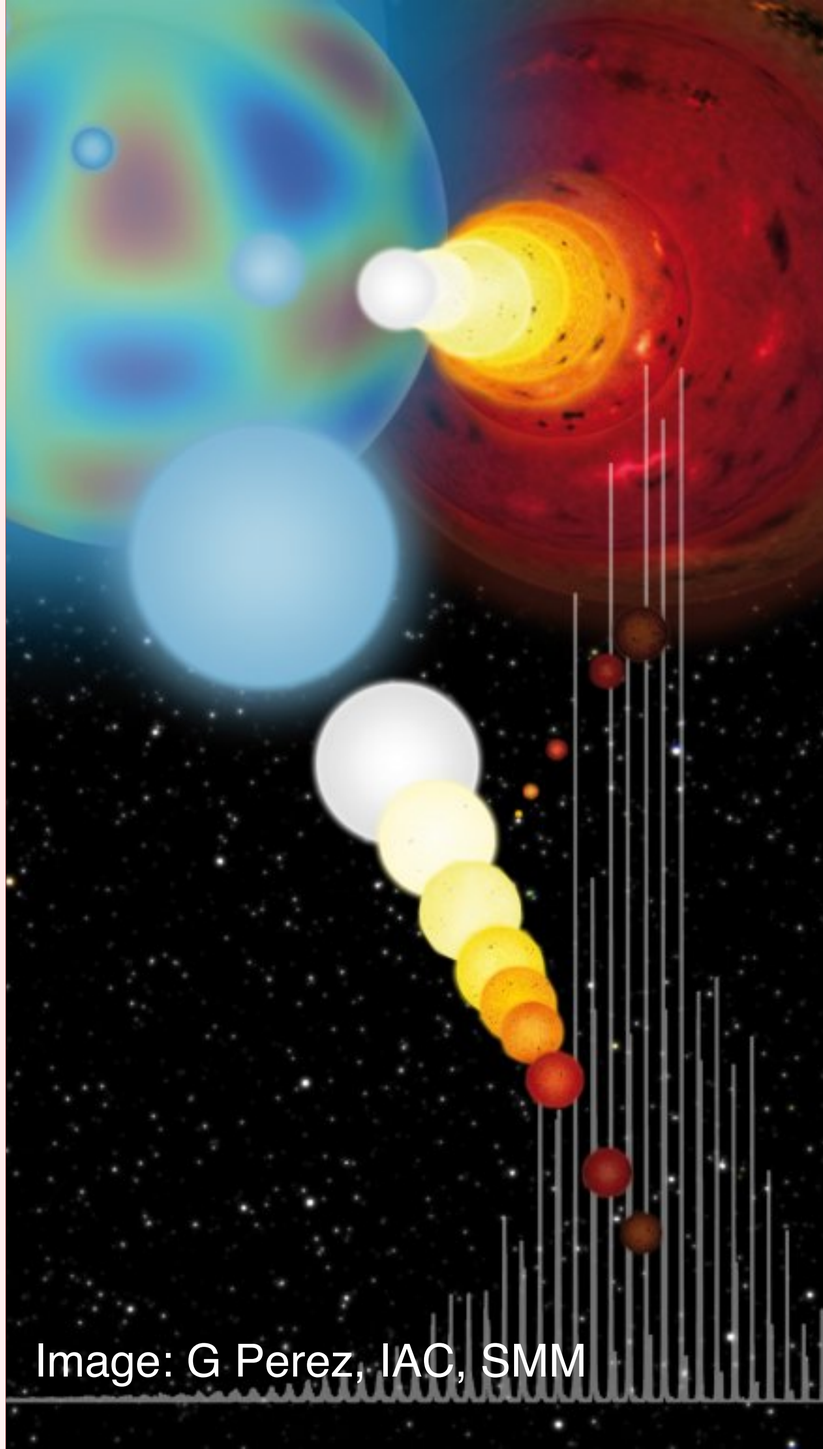
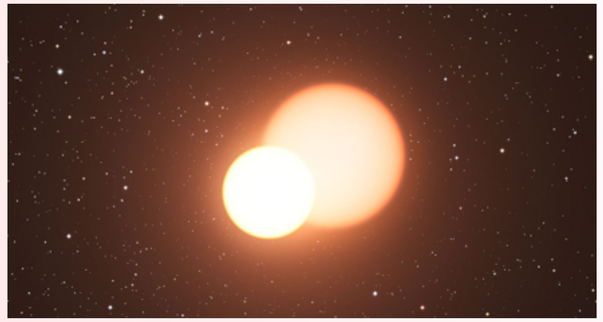
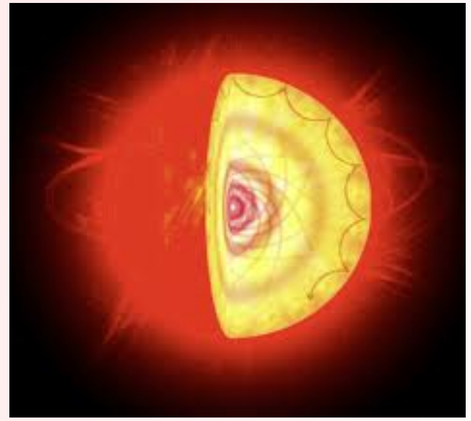


Image: G Perez, IAC, SMM

How to measure stellar properties?

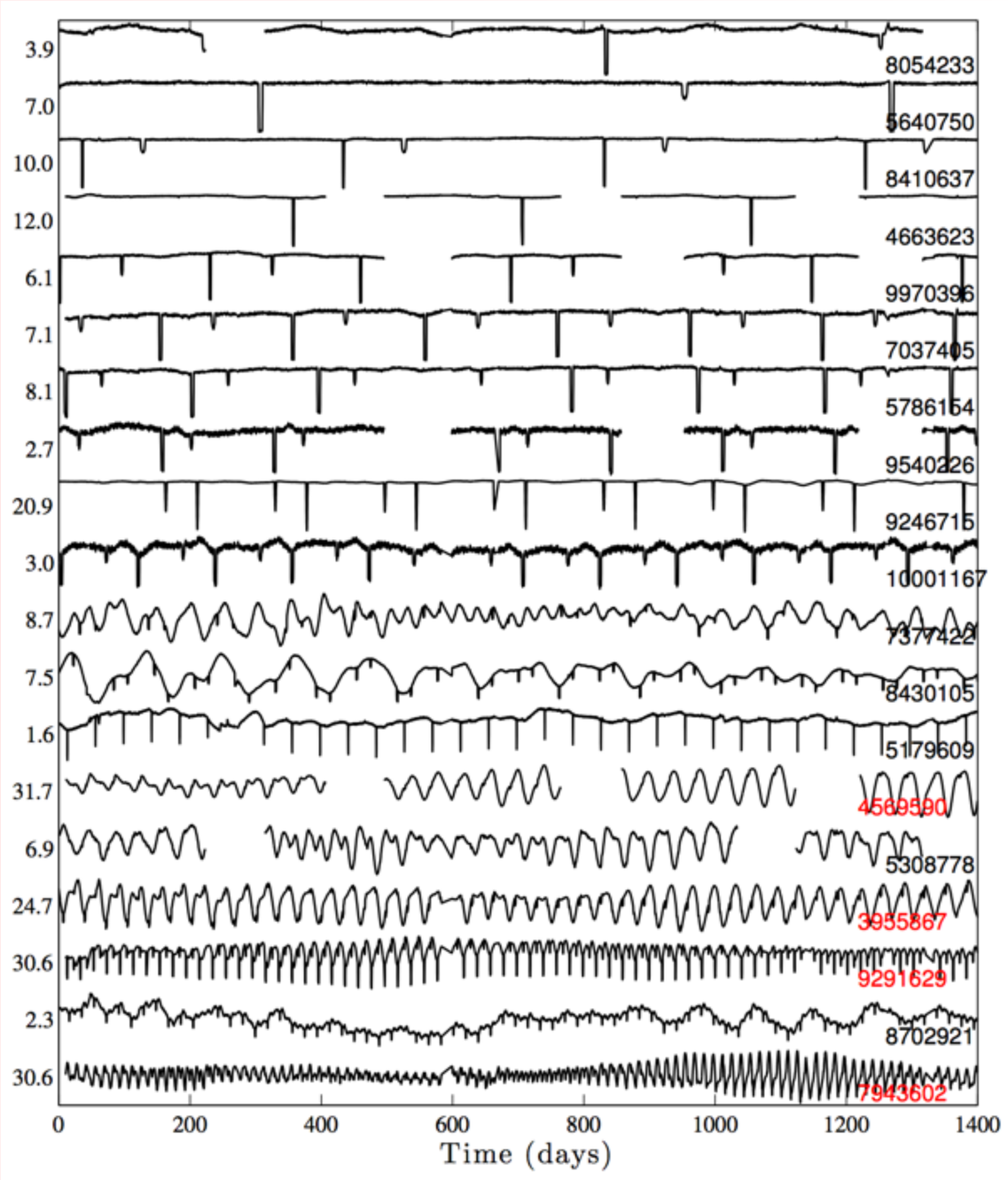
- Eclipsing binaries with light curves and radial velocities let us **directly** measure *M*, *R*
- Asteroseismology is a powerful tool to characterize lots of stars **quickly**, using light curves alone
- We can study oscillating stars in eclipsing binaries from two **independent** perspectives
- A set of well-characterized binaries lets us explore why some don't oscillate when we think they should





Searching for red giants in eclipsing binary systems

- *Kepler* red giant catalog: ~14,000
- *Kepler* eclipsing binary catalog: 2,500+
- After cross-correlating: 19
- Most systems are SB2, but 4 are SB1
- Most are oscillators, but 4 are not



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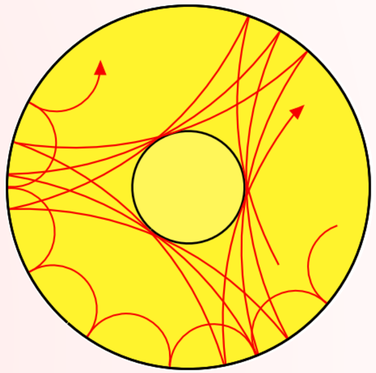
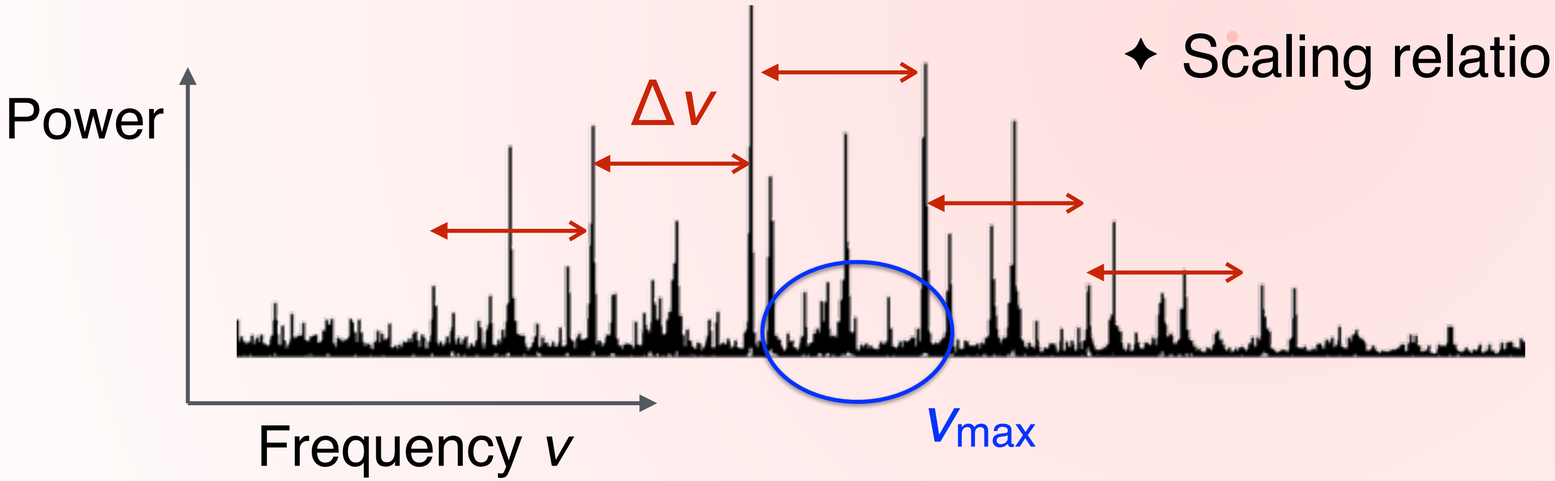
Gaulme et al. 2013 & 2014

Characterizing a star: asteroseismology

- Acoustic **pressure** modes
- Buoyant **gravity** modes
- Evolutionary state
- Scaling relations



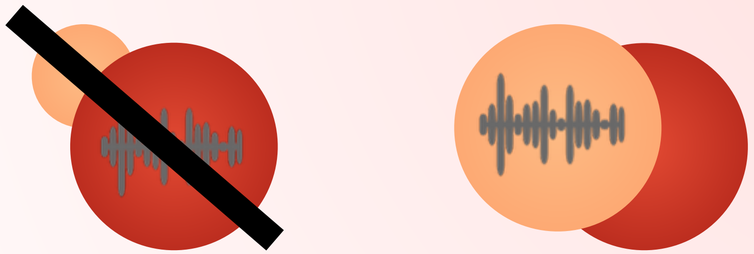


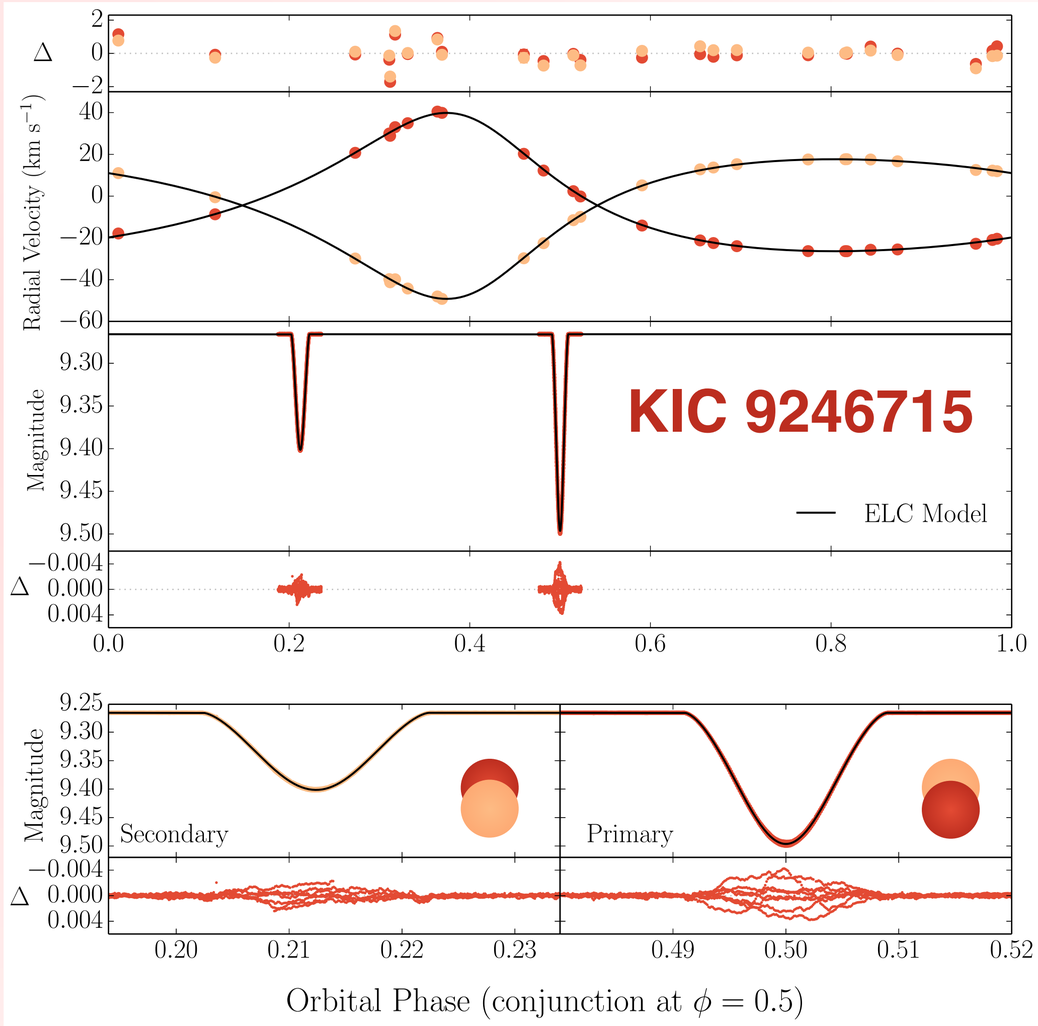
$$\nu_{\rm max} \propto g\ T_{\rm eff}^{-1/2}$$

$$\Delta\nu \propto \rho^{1/2}$$

Characterizing a star: binary modeling

- Double red giant **KIC 9246715**
- Stars are nearly twins
- Simultaneously fit radial velocities and light curve





Radial velocities

Kepler light curve

Eclipse zoom

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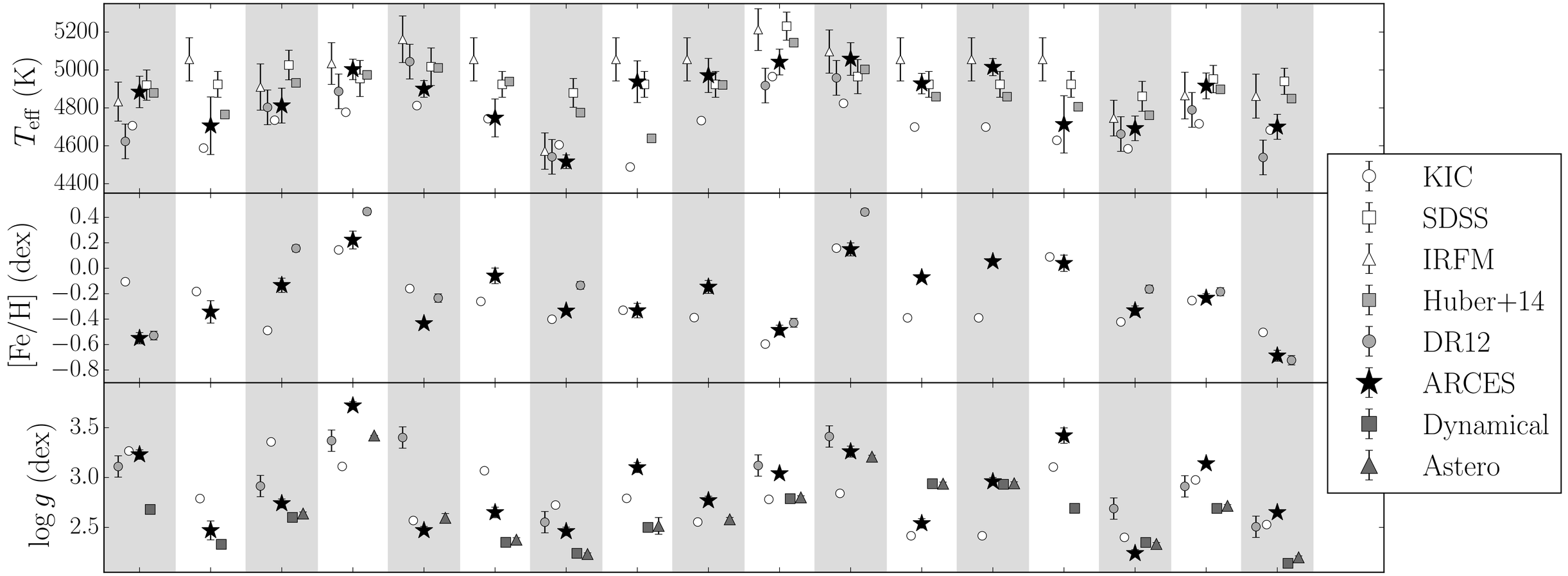
Rawls et al. 2016

Pipeline comparisons: $T_{\rm eff}$, [Fe/H], log g



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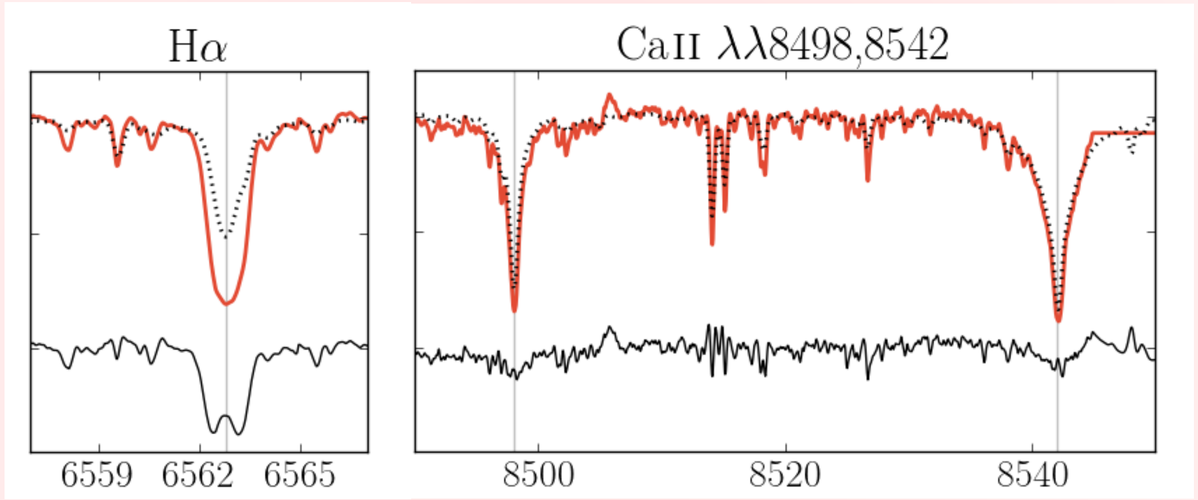
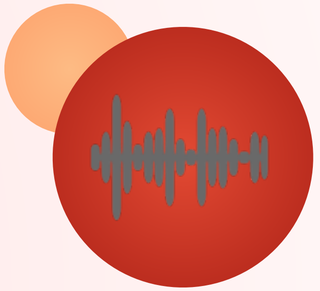
Gaulme et al. submitted

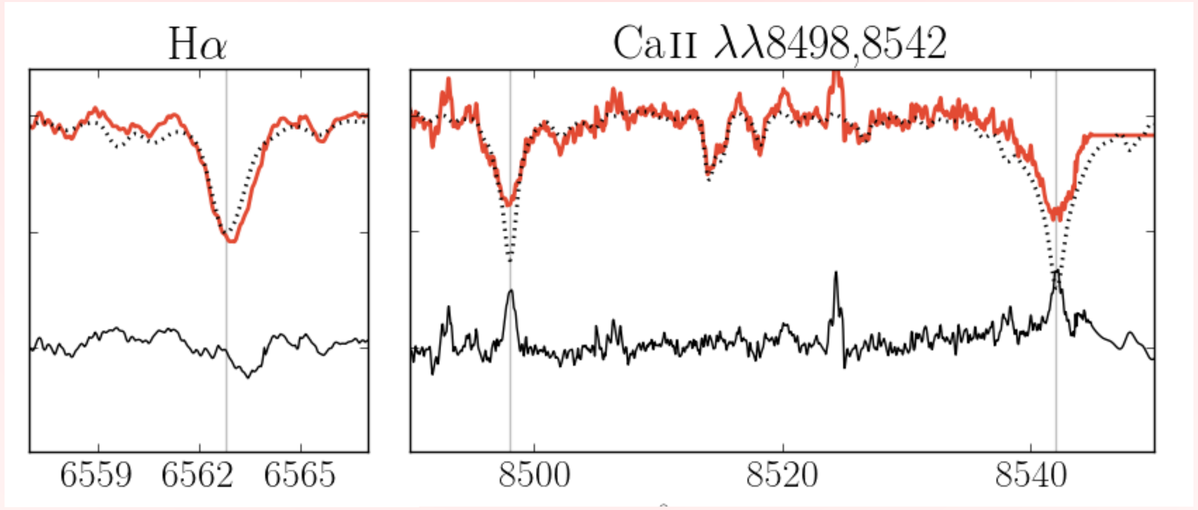
Tides and magnetism affect oscillations

P = 207 d
e = 0.23
oscillator





P = 20 d
$e \sim 0$
non-oscillator



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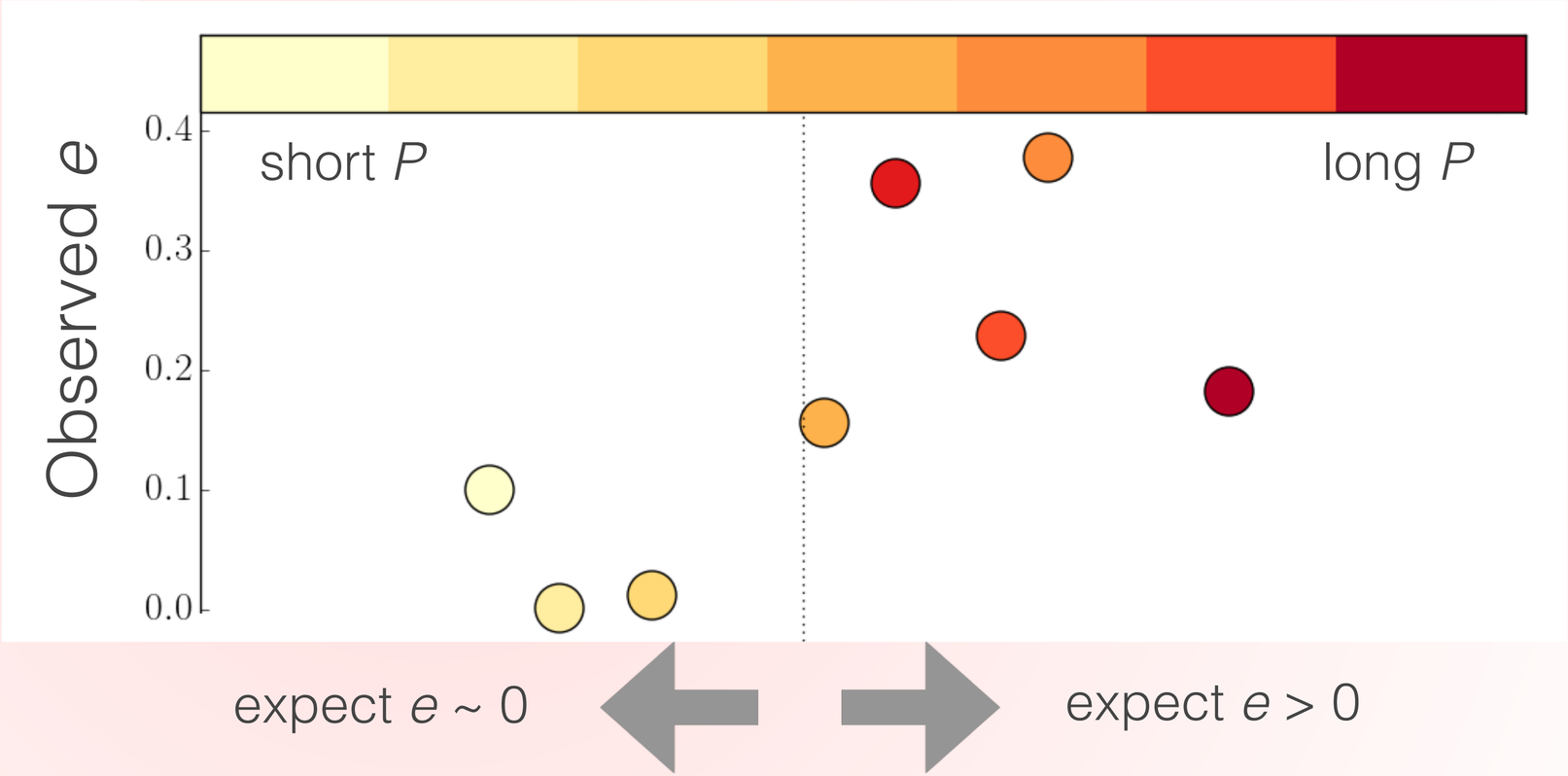
Rawls et al. in prep

Tides and magnetism affect oscillations

- Predicted change in eccentricity from stellar evolution modeling
- Non-oscillators have short *P*, circularized orbits, and spots



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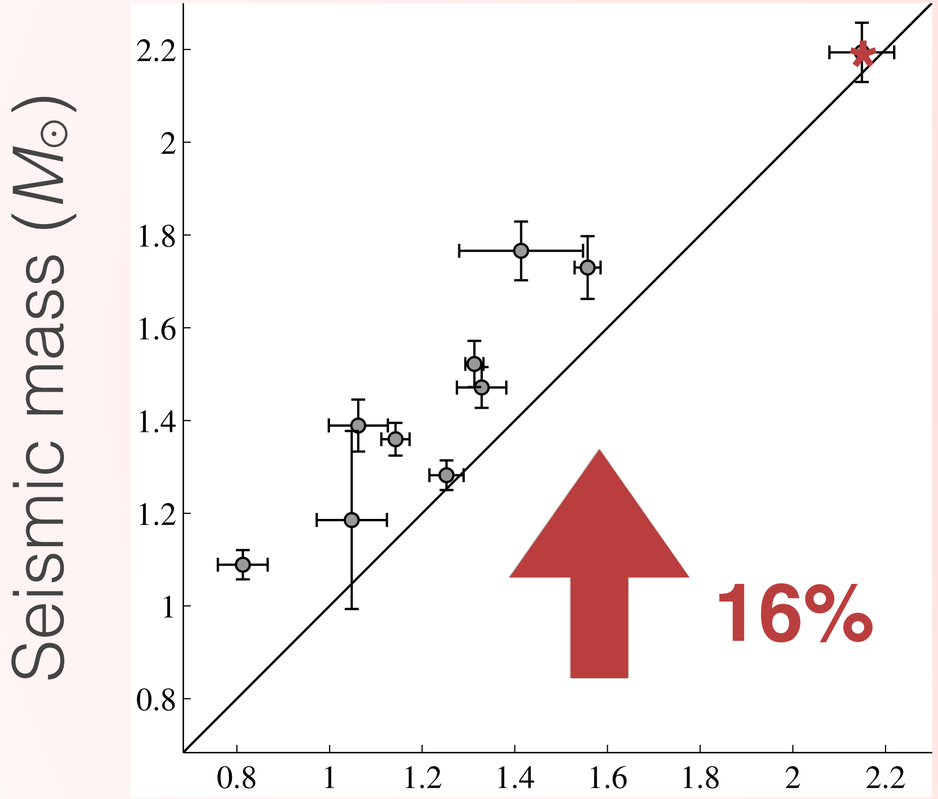
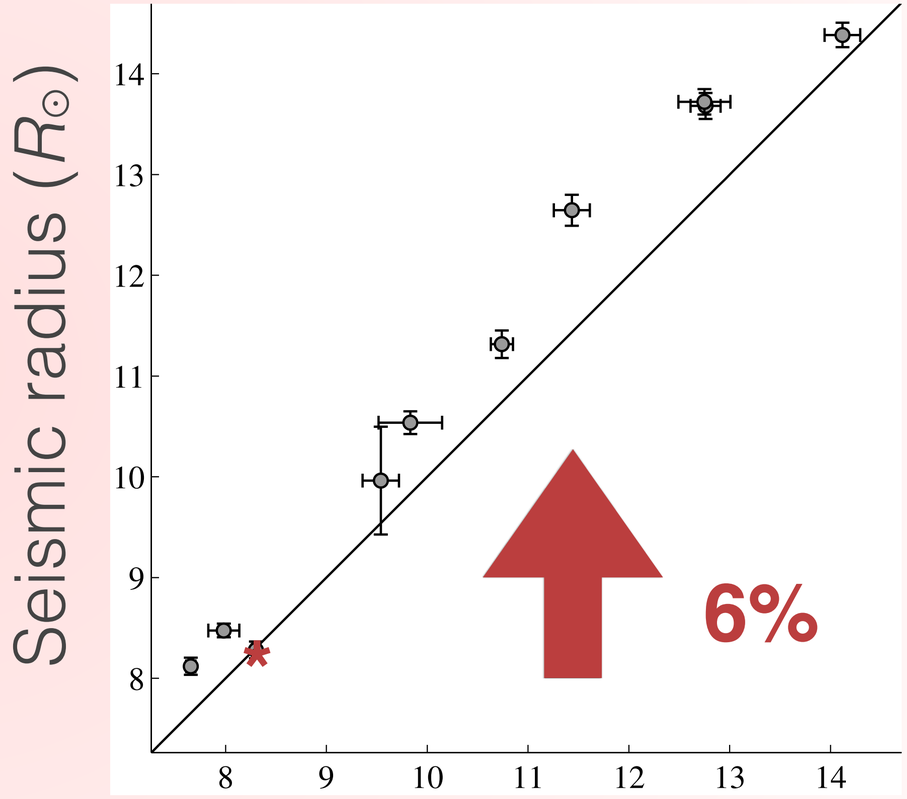
Asteroseismic scalings overestimate *M* and *R*





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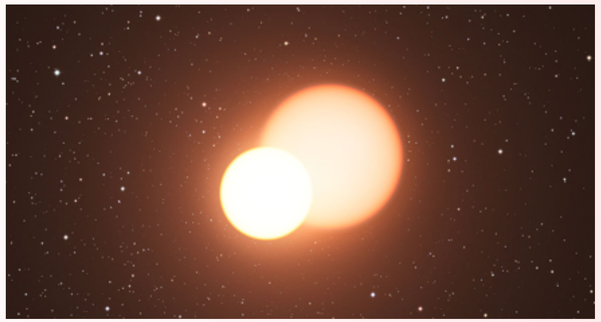
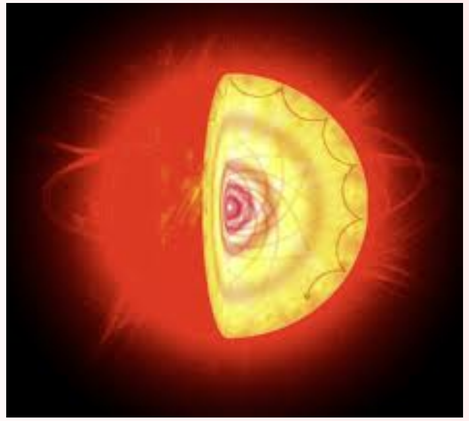
Gaulme et al. submitted

Red giant binaries are powerful benchmarks for asteroseismology





- Solar-like oscillations are **damped** by magnetism & tides, which occur together
- Scaling relations overestimate giant *M*, *R*
- These stars are references for survey pipelines
- Asteroseismic surveys **underestimate ages** and exclude active stars and close binaries

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