Asteroseismology of exoplanet host stars: results from *Kepler* and prospects for *PLATO*

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Asteroseismic KOI ensemble

High-quality solar-like oscillations spectra of *Kepler* Objects of Interest
Kepler
dasteroseismic
solar-type &
red-giant targets

120 seismic KOIs

See also:
Huber et al. (2013)
Chaplin et al. (2011)
Science, 332, 213
Asteroseismic KOI ensemble

Target management

- *Kepler* restriction of $\leq 512$ targets at 1-min short cadence (SC):
  - SC needed to detect oscillations in solar-type stars
  - Around SC 100 slots allocated to seismic KOIs
  - When target acquires KOI status, estimate probability of asteroseismic detection

Asteroseismic KOI ensemble

Distribution in apparent magnitude: 120 KOIs
Asteroseismic KOI ensemble

Improved stellar properties


Asteroseismic KOI ensemble

Asteroseismic vs. transit lightcurve densities

Huber et al., 2013
Prospects for PLATO

- Noise performance:
  - The same as *Kepler* at same apparent magnitude

- No restrictions re: target management:
  - All observations at required rapid cadence for seismic detections in solar-type stars
Prospects for PLATO

- Compared to *Kepler*, PLATO will:
  - Observe much brighter targets
  - Observe many more targets
    (> factor 10 down to $v \sim 13$)

- Complementary data…
  - Radial-velocity follow-up
  - Parallaxes, spectroscopic parameters, interferometric radii etc.
Prospects for PLATO

- From 2-yr long pointing phase:
  - Potential for a few thousand asteroseismic exoplanet host stars
  - Mid to late K dwarfs will have detectable oscillations if very bright
Asteroseismology of solar-type stars:
- Detection limit around $v \approx 7$
- Expect detections in approximately 3000 stars (assuming at least 1 month of data)
- Compares with approximately 600 stars from KASC asteroseismic survey ($v \approx 7$ to 11; 1 month of data per star)
Kepler-10: G-type dwarf

Kepler’s first rocky planet

Kepler-21: F-type subgiant

Was for a while the brightest KOI

Kepler-68: G-type dwarf

Combining RVs and asteroseismology

Kepler-36: G-type subgiant
Combining TTVs and asteroseismology

Carter et al. (2012), Science, 337, 556
Transit Timing Variations (TTVs)

Combining TTVs and asteroseismology

Carter et al. (2012), Science, 337, 556
Accurate and precise masses
Combining TTVs and asteroseismology

Carter et al. (2012), Science, 337, 556
Kepler-37

Small star hosting three planets, one smaller than Mercury

Barclay et al., 2013, Nature, 494, 452
Spin-orbit alignment

- Information on history and dynamics of systems
- Asteroseismology to determine stellar angle of inclination:
  - Useful diagnostic in systems with transiting exoplanets
  - Independent of planet properties: ideal for multi-systems with small planets
Inference on stellar inclination

Example: dipole oscillation mode

Kepler-50 and Kepler-65

Two stars with multiple small planets

Kepler-50 and Kepler-65

Two stars with multiple small planets

End