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STELLAR ASTROPHYSICS CENTRE

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

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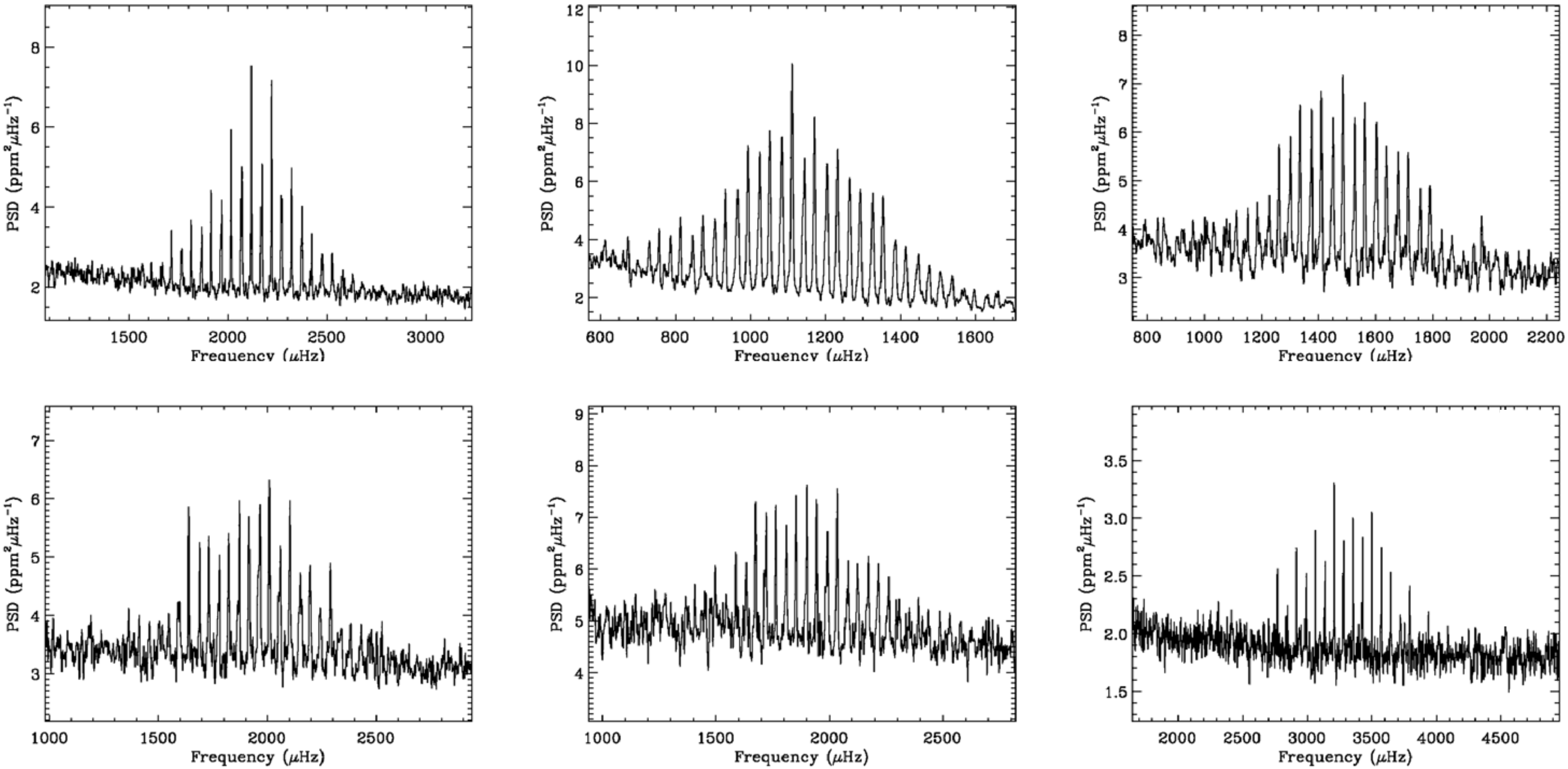
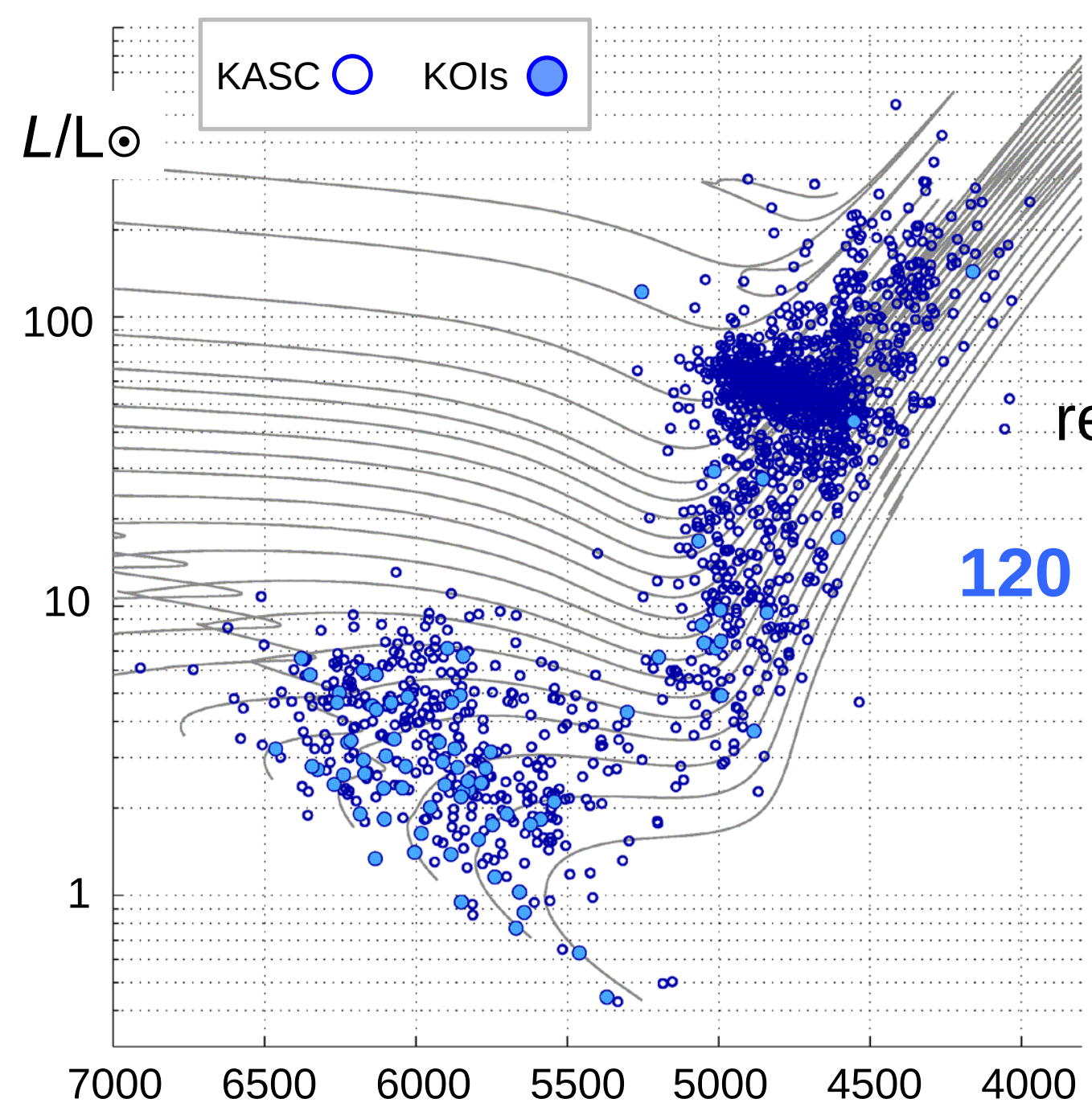
University of Birmingham + KASOC team

PLATO Workshop, ESTEC, Noordwijk, 2013 July 30

Asteroseismic KOI ensemble

High-quality solar-like oscillations spectra of *Kepler* Objects of Interest





Kepler

asteroseismic
solar-type &
red-giant targets

120 seismic KOIs

See also:
Huber et al. (2013)
ApJ, 767, 127

Chaplin et al. (2011)
Science, 332, 213

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Asteroseismic KOI ensemble

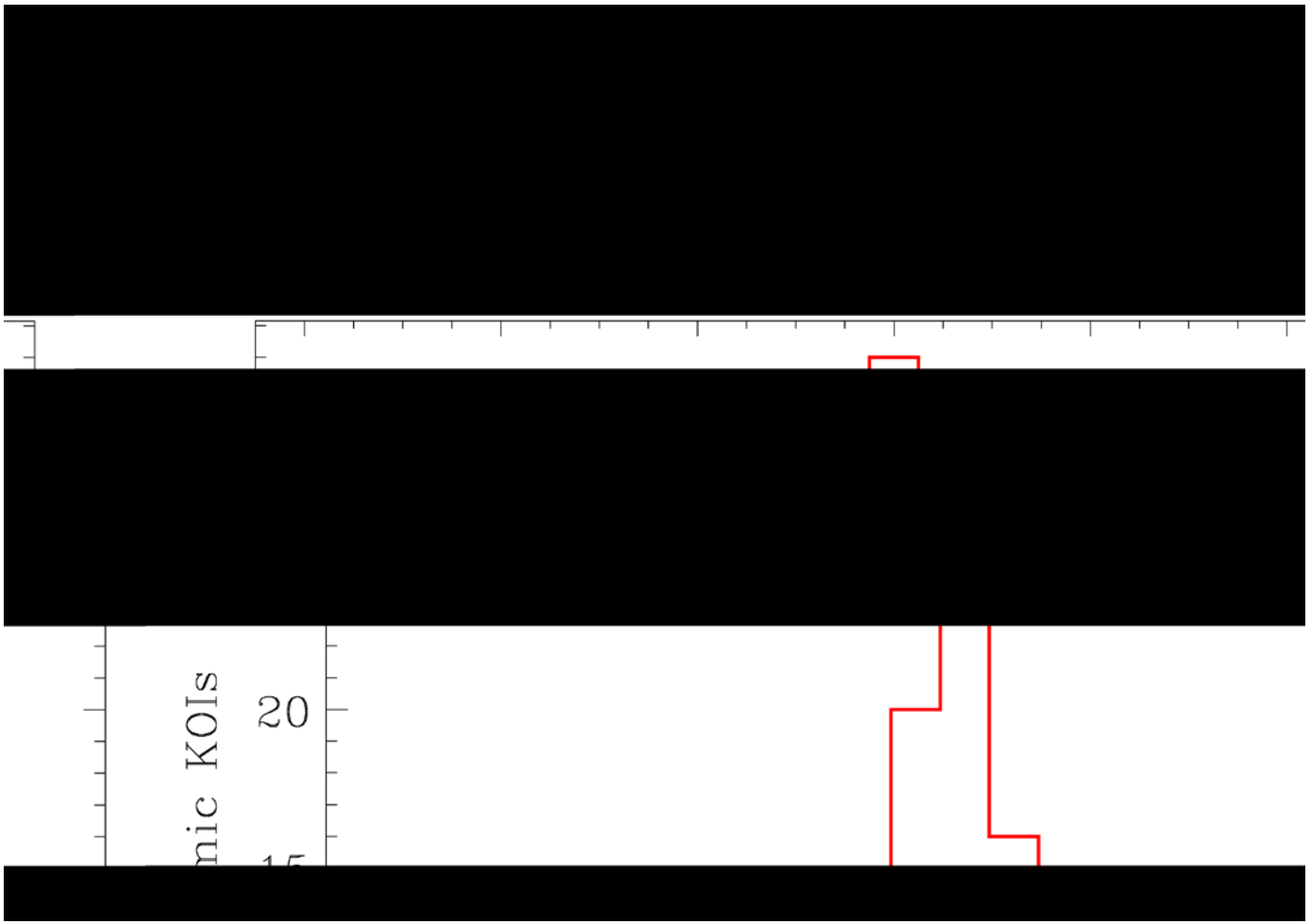
Target management

- *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

    As per: Chaplin et al. (2011), ApJ, 732, 54

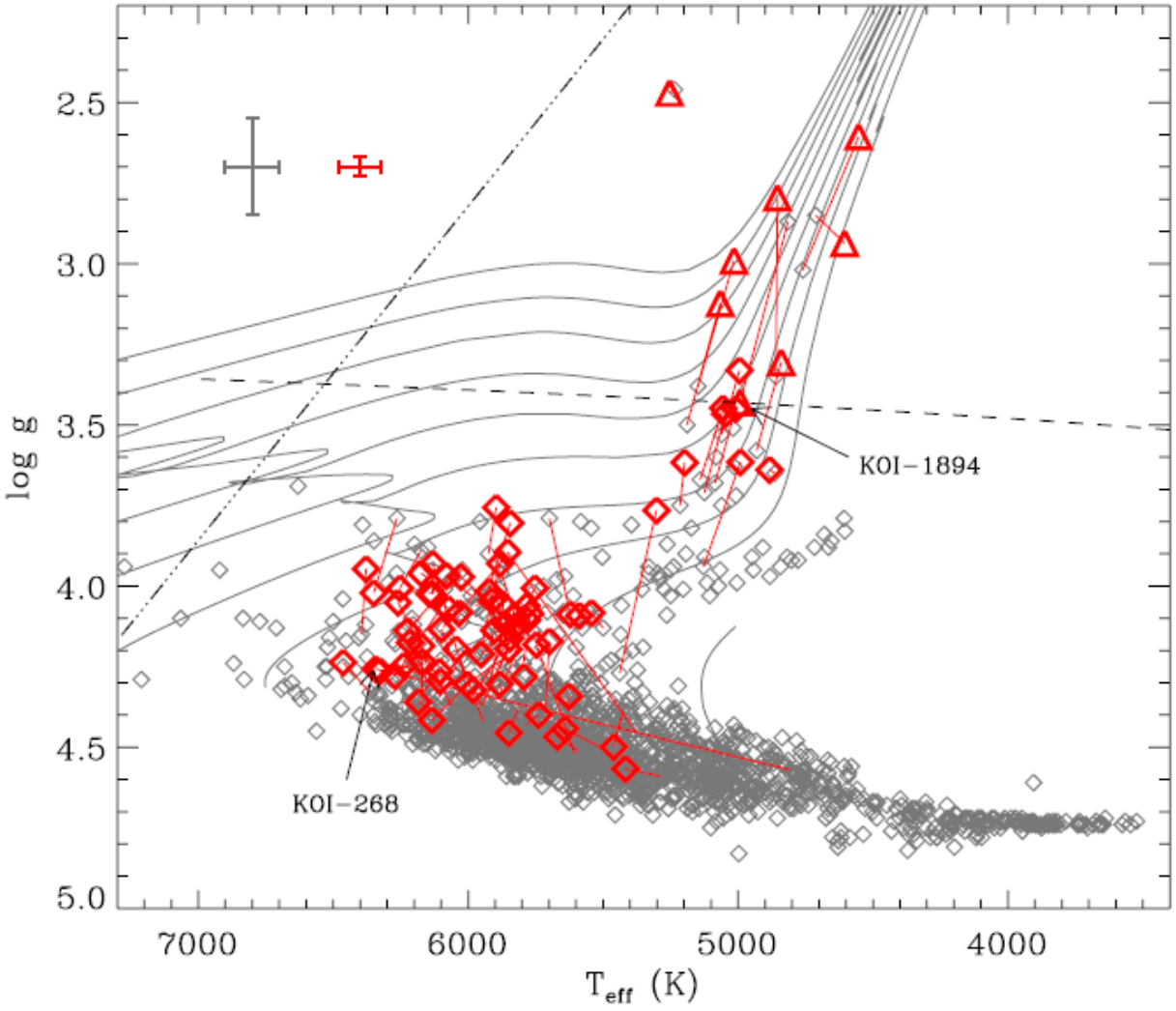
Asteroseismic KOI ensemble

Distribution in apparent magnitude: 120 KOIs



Asteroseismic KOI ensemble

Improved stellar properties



See also: Verner et al. (2011), ApJ, 738, L28

Huber et al. (2013), ApJ, 767, 127

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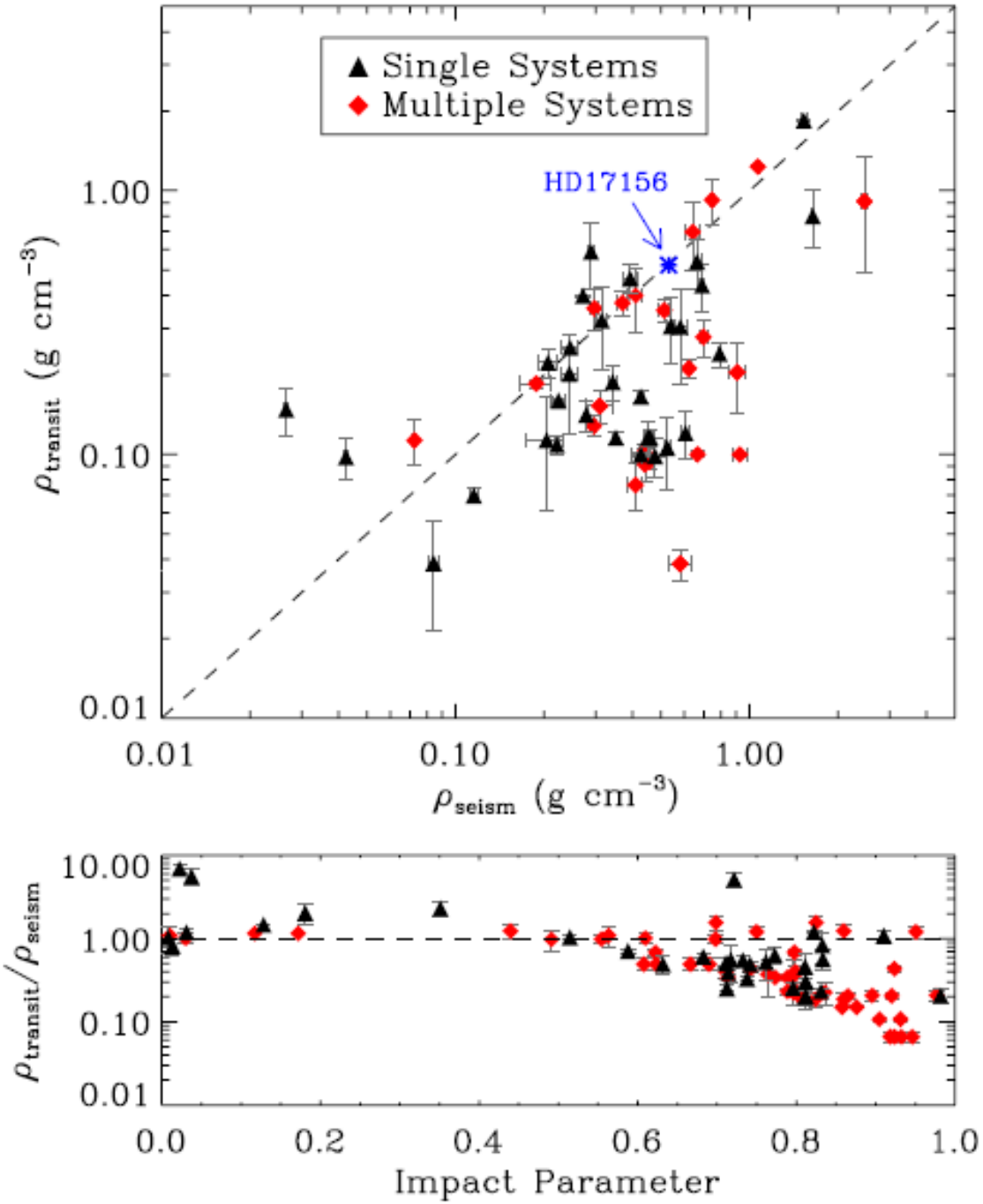

Asteroseismic KOI ensemble

Asteroseismic vs. transit lightcurve densities

Huber et al., 2013
ApJ, 767, 127

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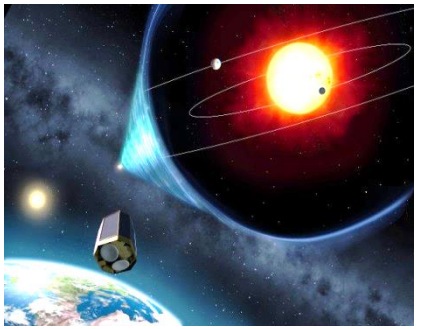
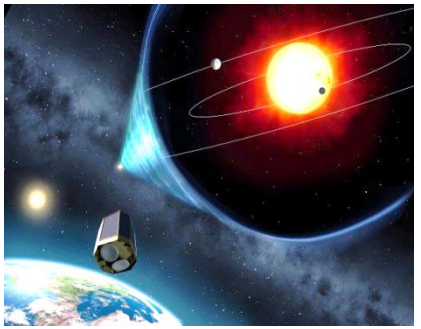
Prospects for PLATO



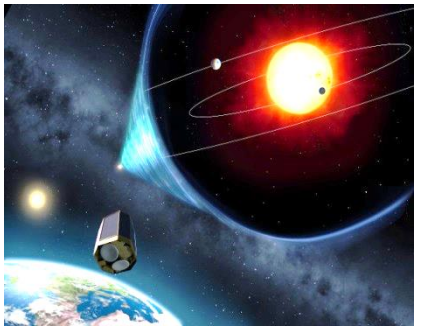
- Noise performance:
  - The same as *Kepler* at same apparent magnitude
- No restrictions re: target management:
  - All observations at required rapid cadence for seismic detections in solar-type stars

Prospects for PLATO



- Compared to *Kepler*, PLATO will:
  - Observe much brighter targets
  - Observe many more targets (> factor 10 down to v~13)
- Complementary data…
  - Radial-velocity follow-up
  - Parallaxes, spectroscopic parameters, interferometric radii etc.

Prospects for PLATO

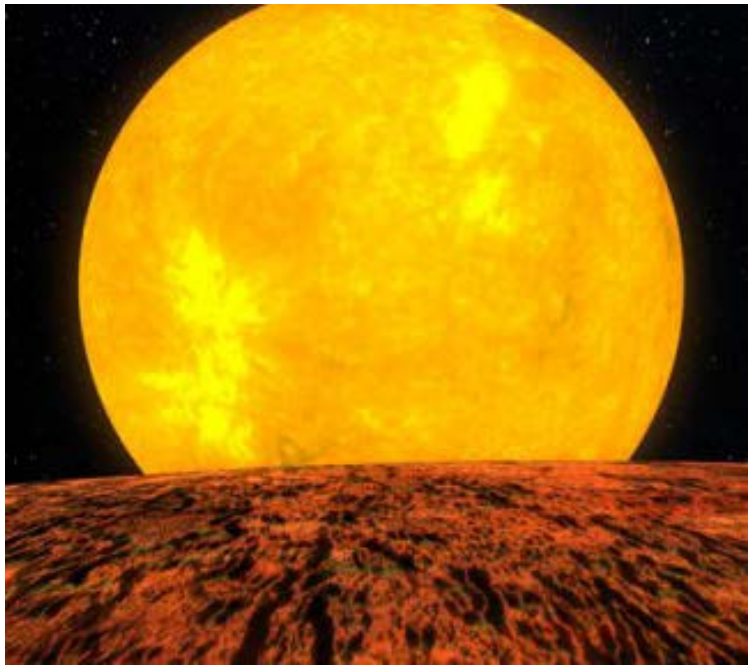


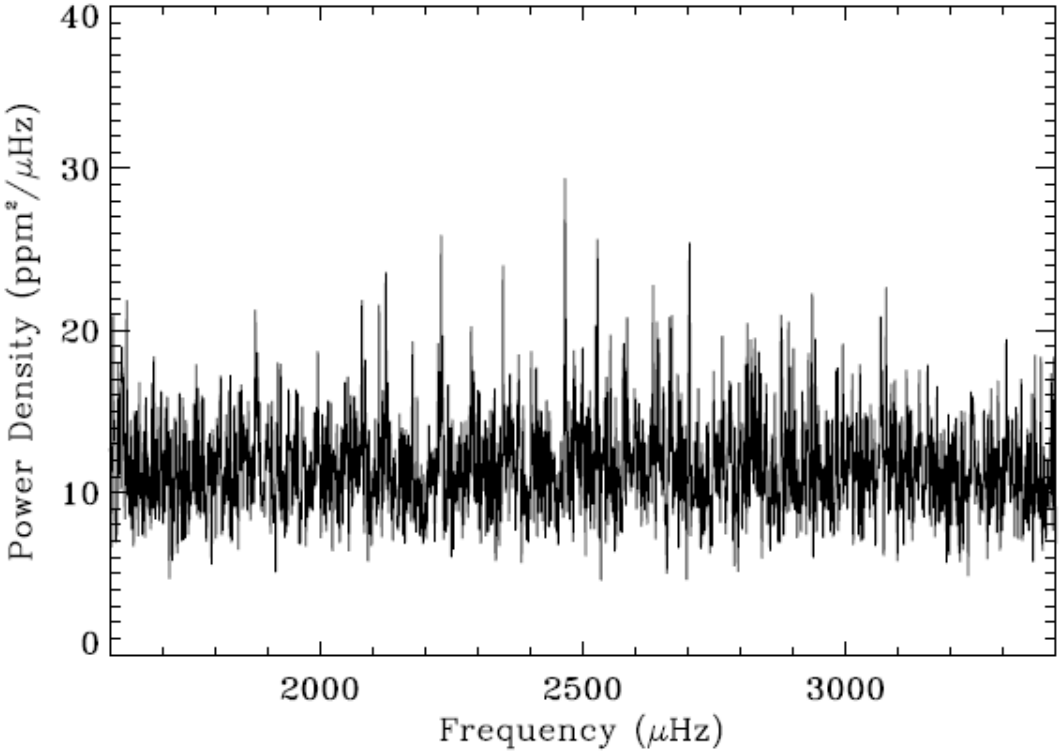
- From 2-yr long pointing phase:
  - Potential for a *few thousand* asteroseismic exoplanet host stars
  - Mid to late K dwarfs will have detectable oscillations if very bright

- Asteroseismology of solar-type stars:
  - Detection limit around v ≈ 7
  - Expect detections in approximately 3000 stars (assuming at least 1 month of data)
  - Compares with approximately 600 stars from KASC asteroseismic survey (v ≈ 7 to 11; 1 month of data per star)

Kepler-10: G-type dwarf

Kepler's first rocky planet

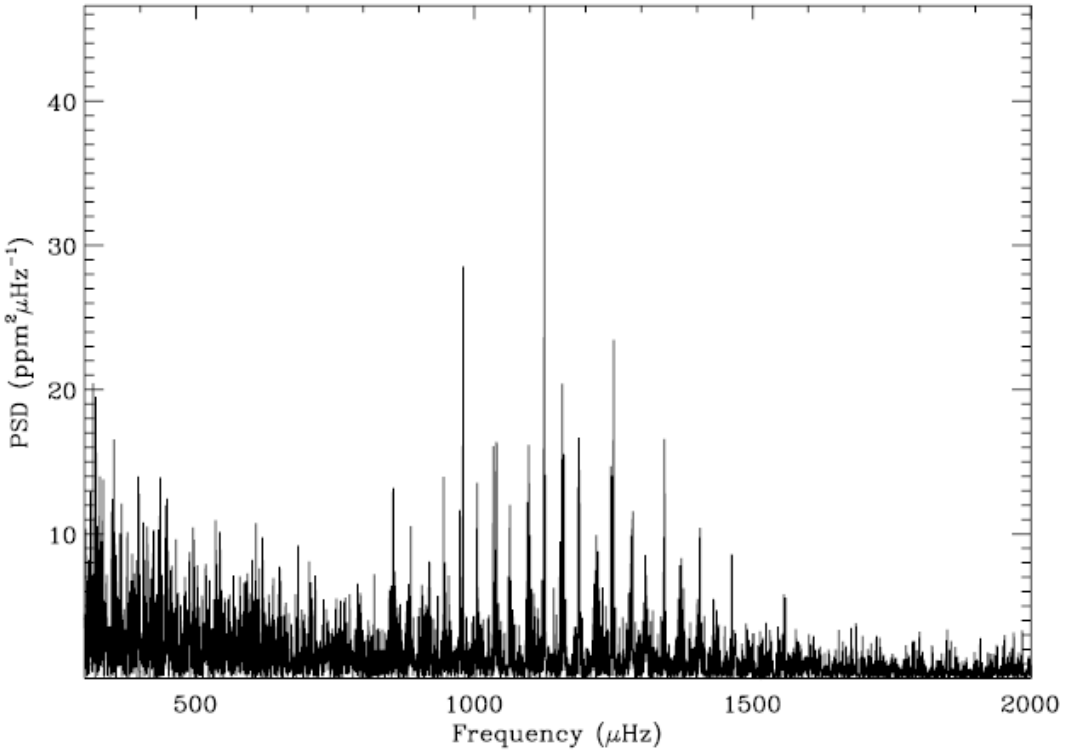




Batalha et al. (2011), ApJ, 729, 27

Kepler-21: F-type subgiant

Was for a while the brightest KOI



Howell et al. (2012), ApJ, 746, 123

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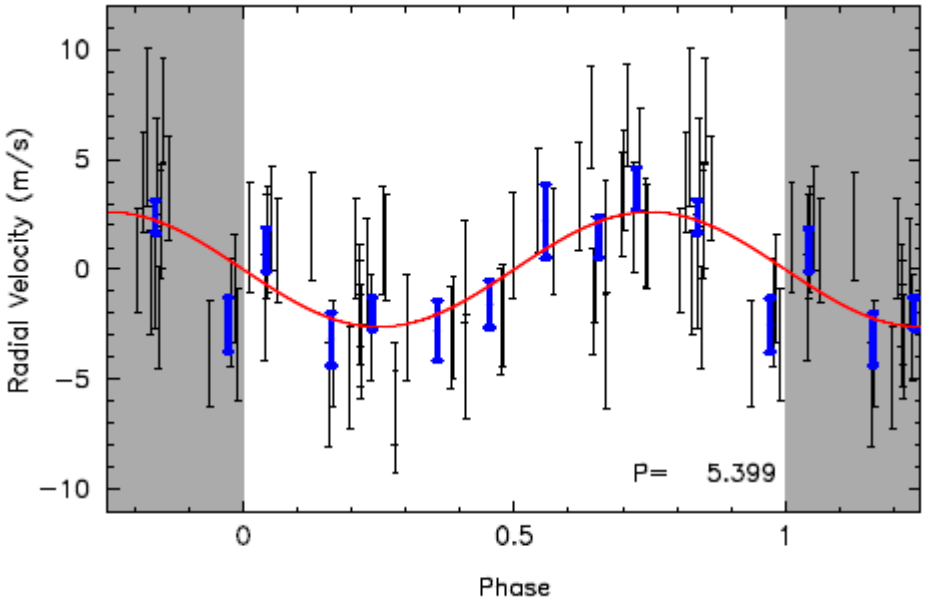
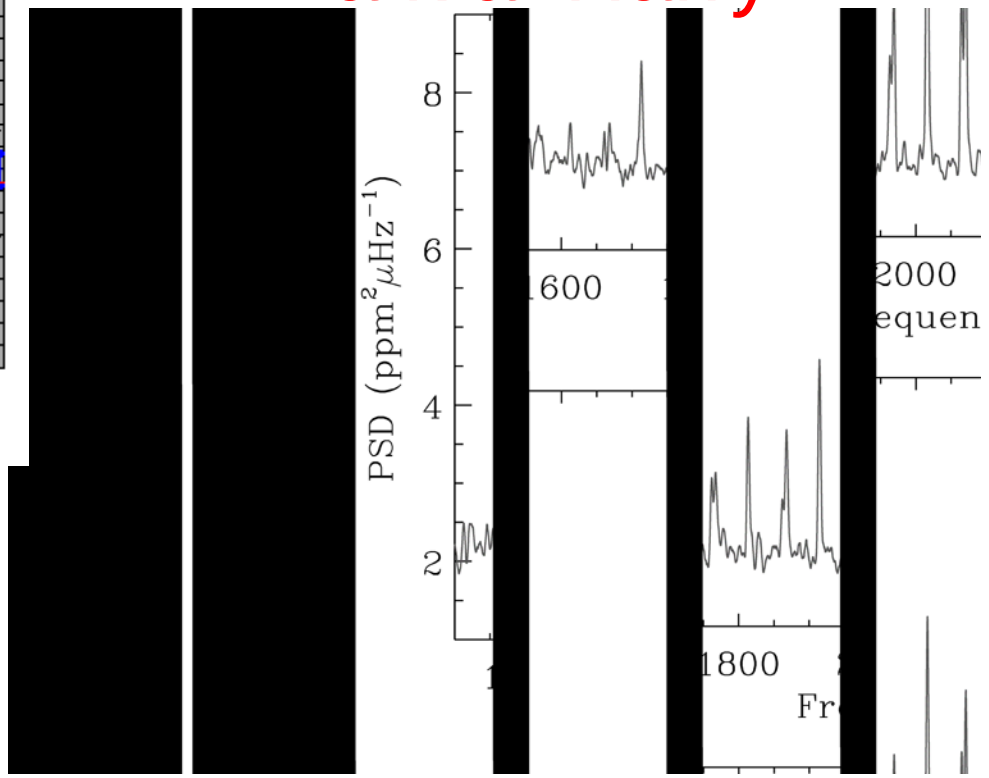
Kepler-68: G-type dwarf

Combining RVs and asteroseismology



a.k.a. Harry



Gilliland et al., 2013, ApJ, 766, 40

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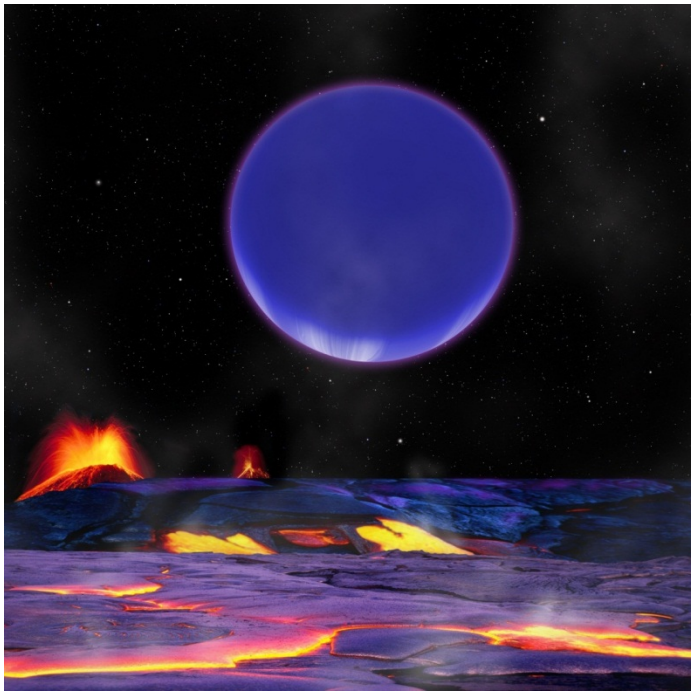
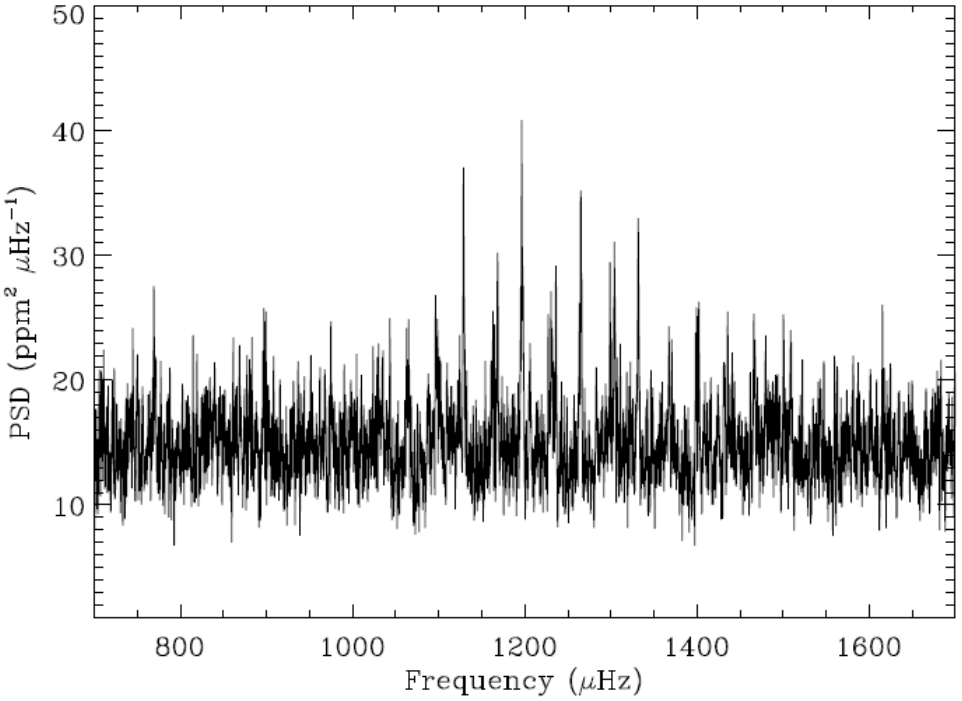
Kepler-36: G-type subgiant

Combining TTVs and asteroseismology

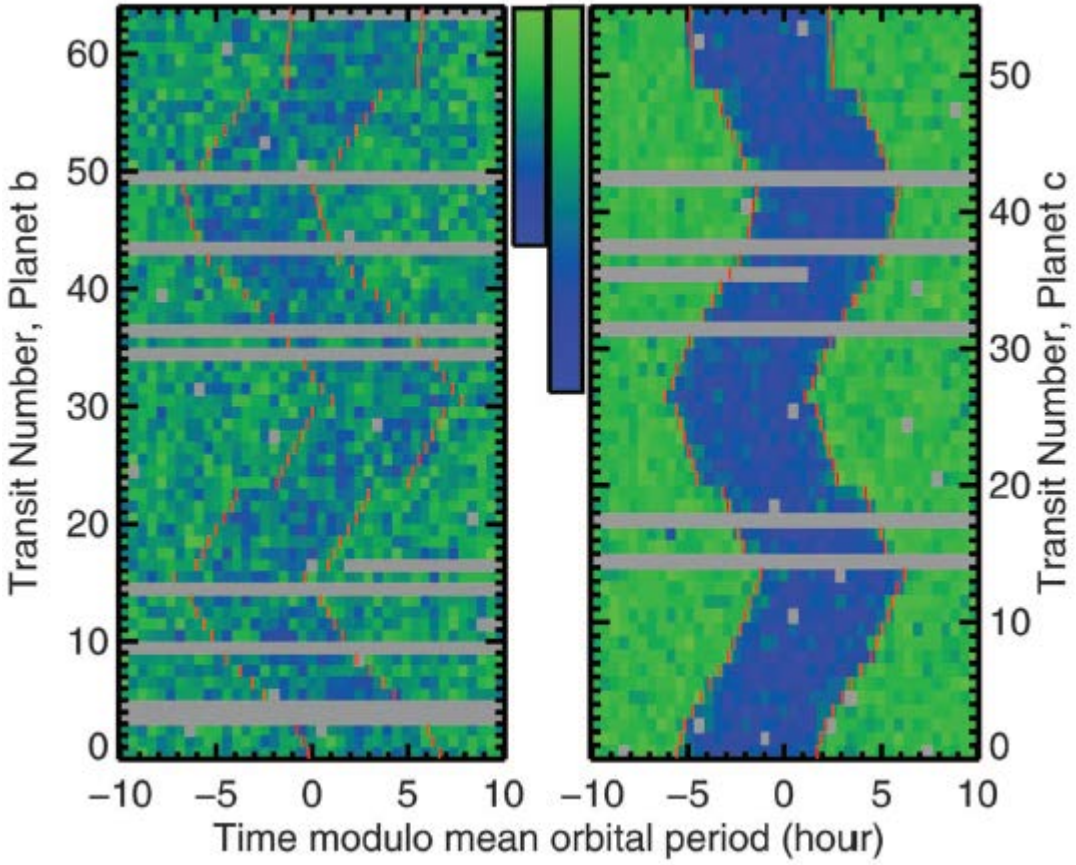




Carter et al. (2012), Science, 337, 556

Transit Timing Variations (TTVs)

Combining TTVs and asteroseismology



Carter et al. (2012), Science, 337, 556

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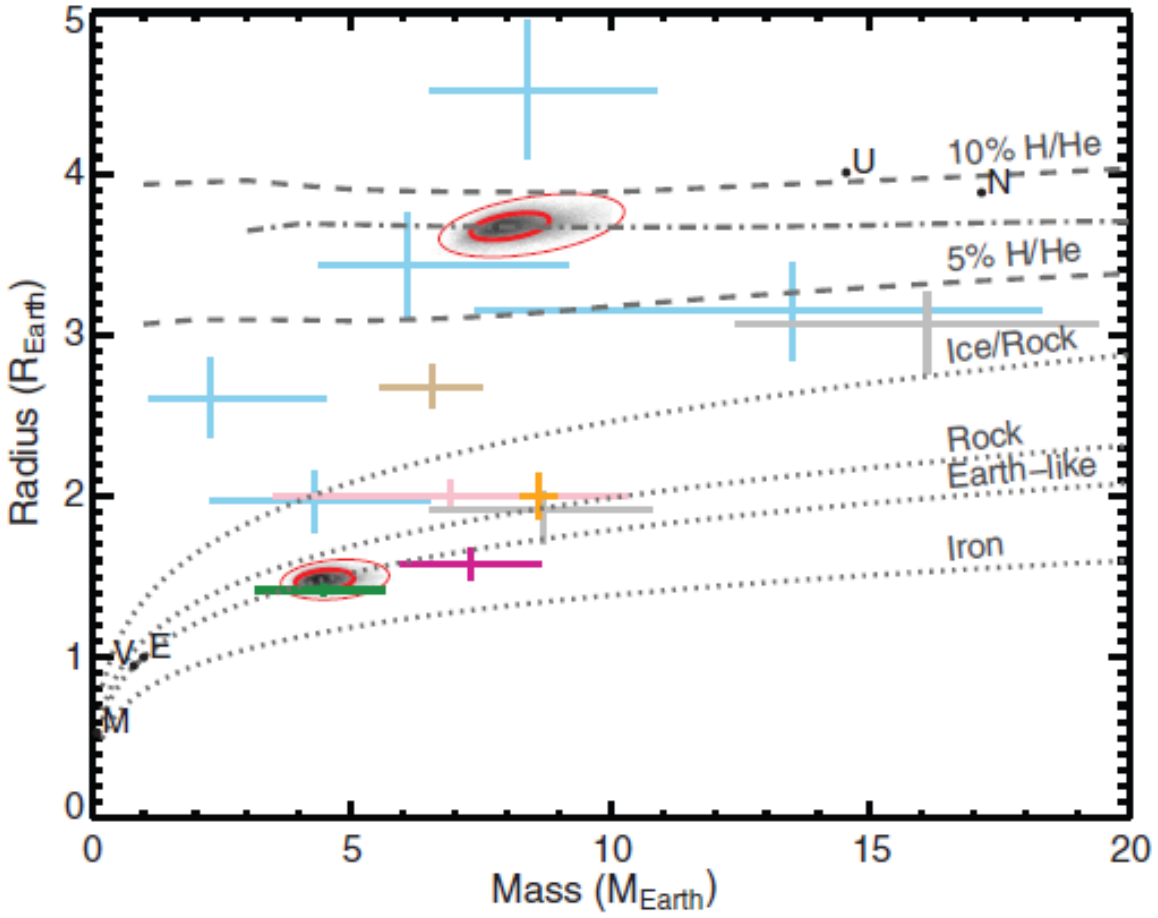
Accurate and precise masses

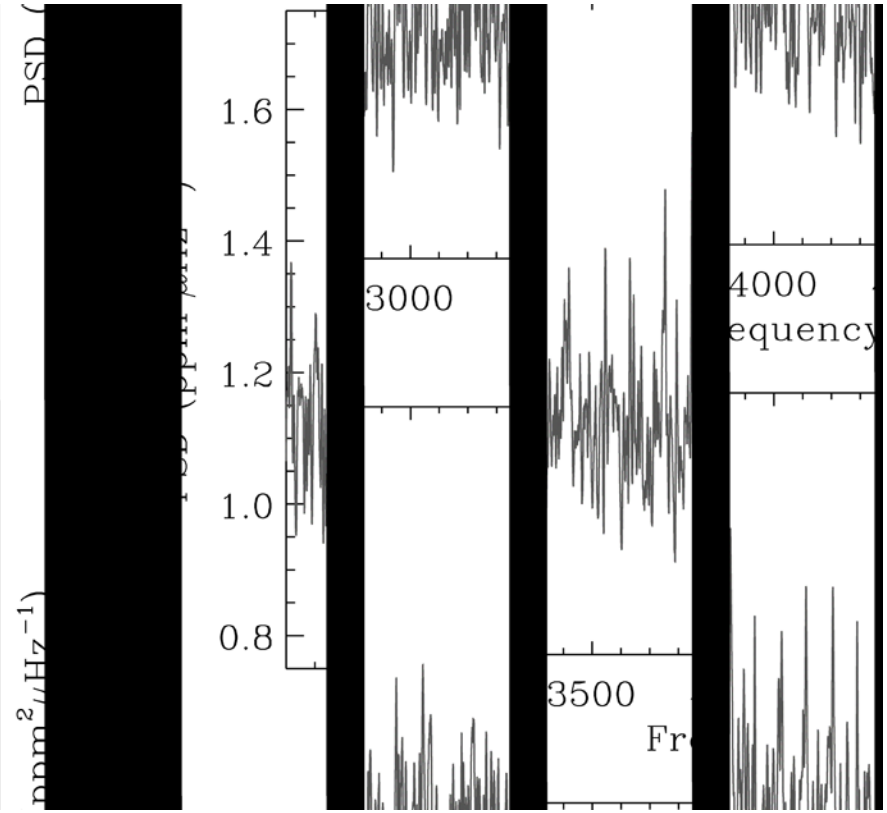
Combining TTVs and asteroseismology



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

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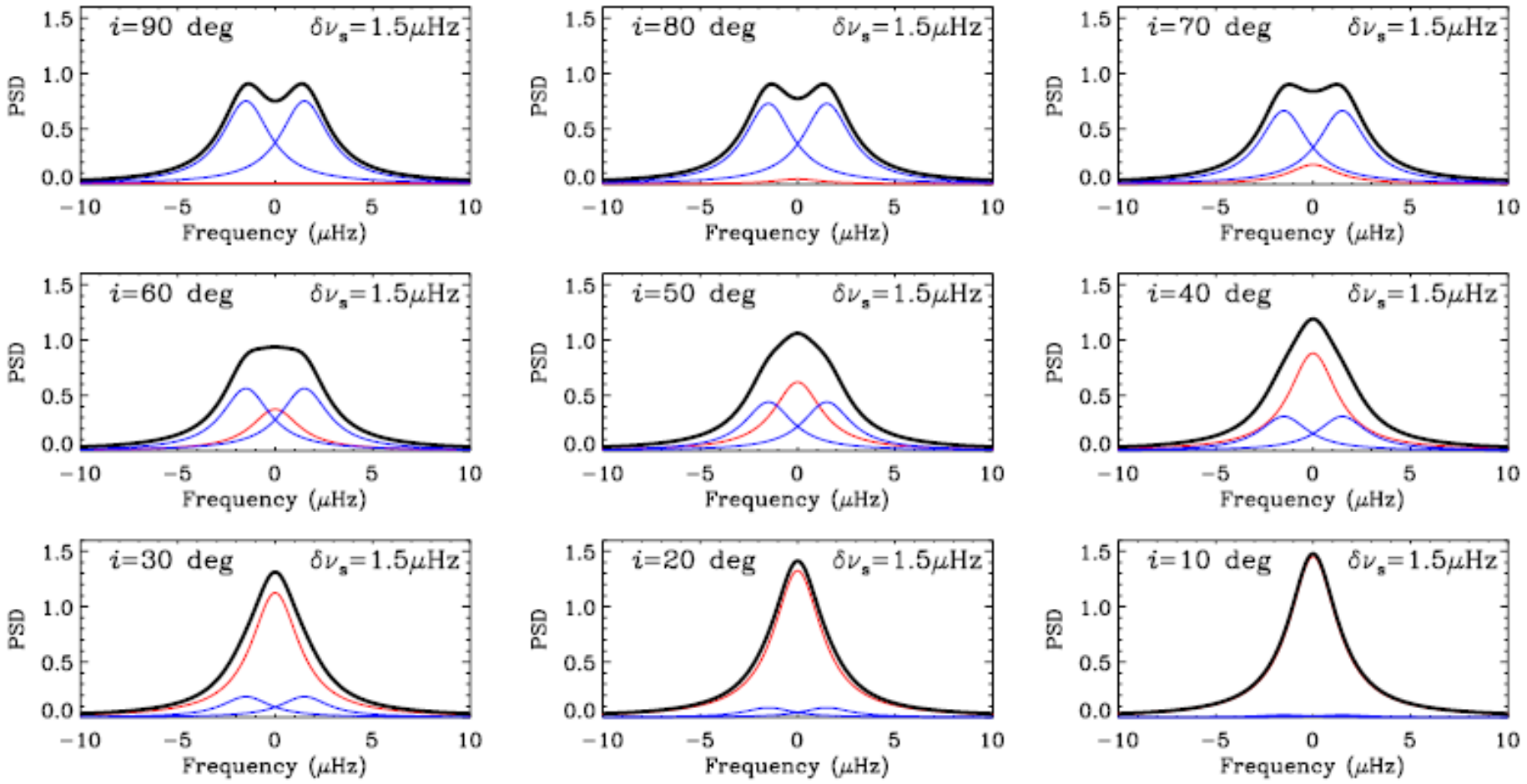
Spin-orbit alignment

- 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

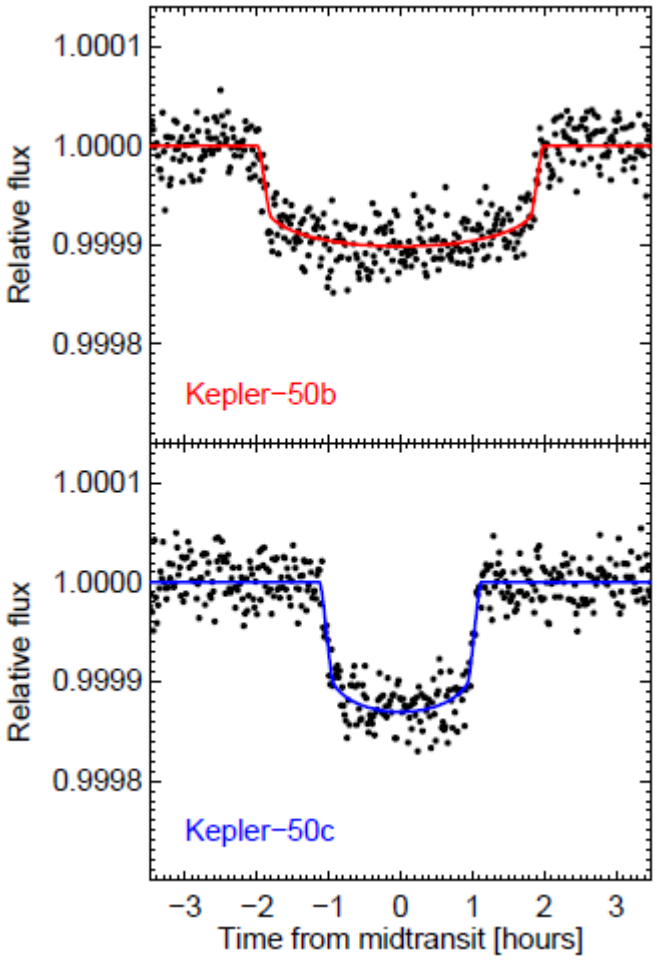
Example: dipole oscillation mode

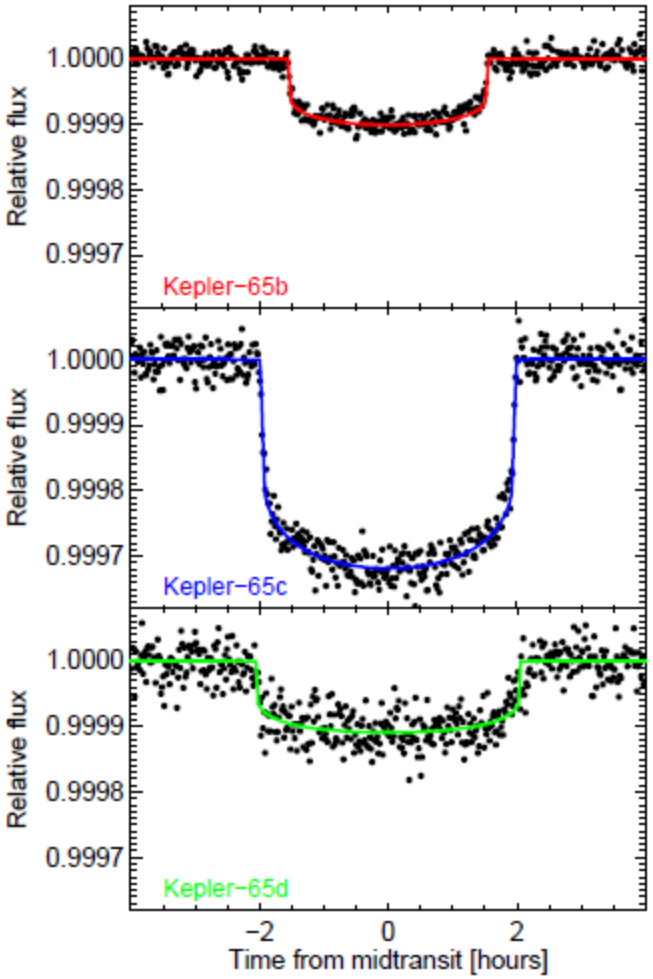


Chaplin et al., 2013, ApJ, 766, 101

Kepler-50 and *Kepler*-65

Two stars with multiple small planets





Chaplin et al., 2013, ApJ, 766, 101

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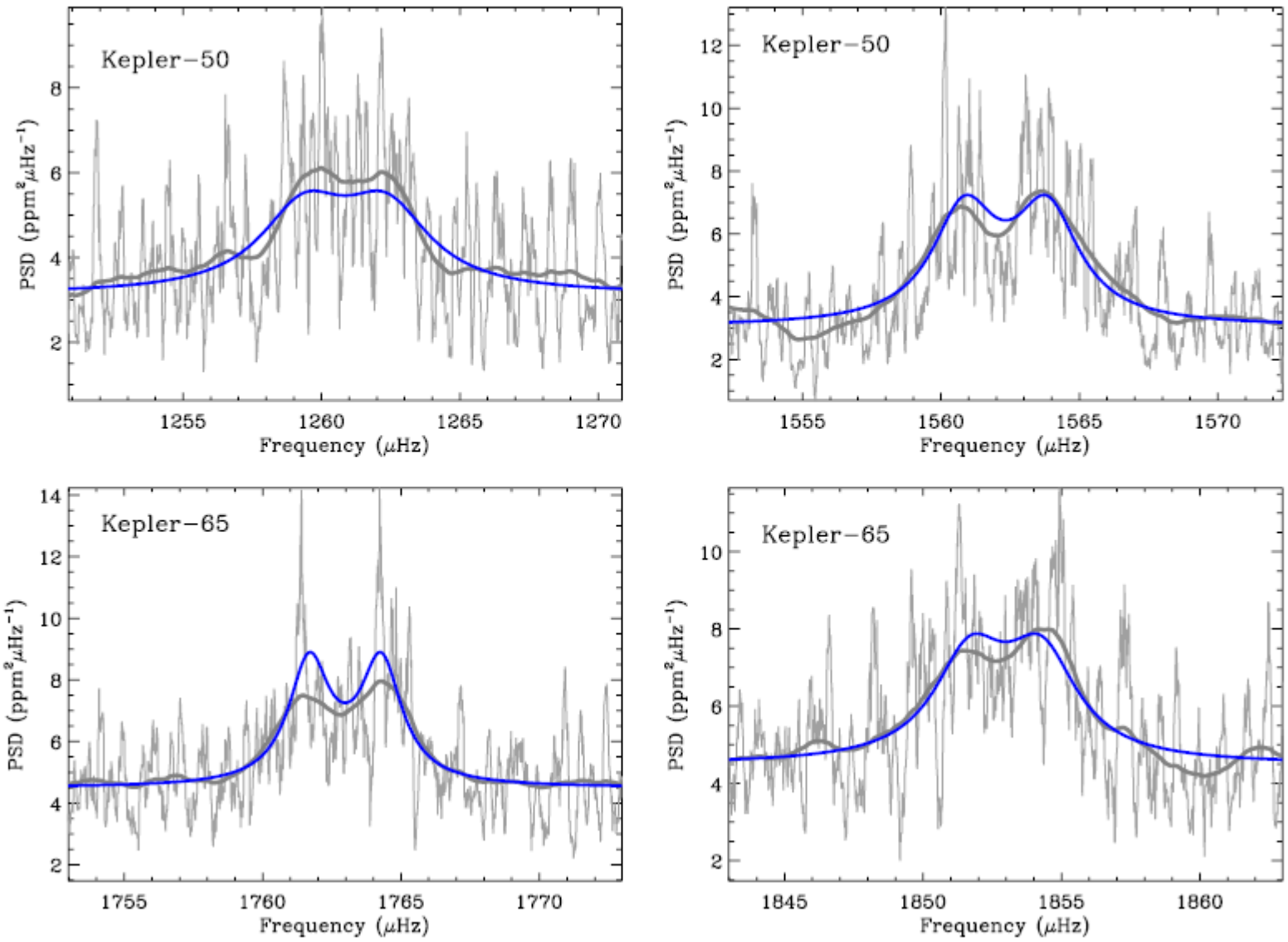

Chaplin et al., 2013, ApJ, 766, 101

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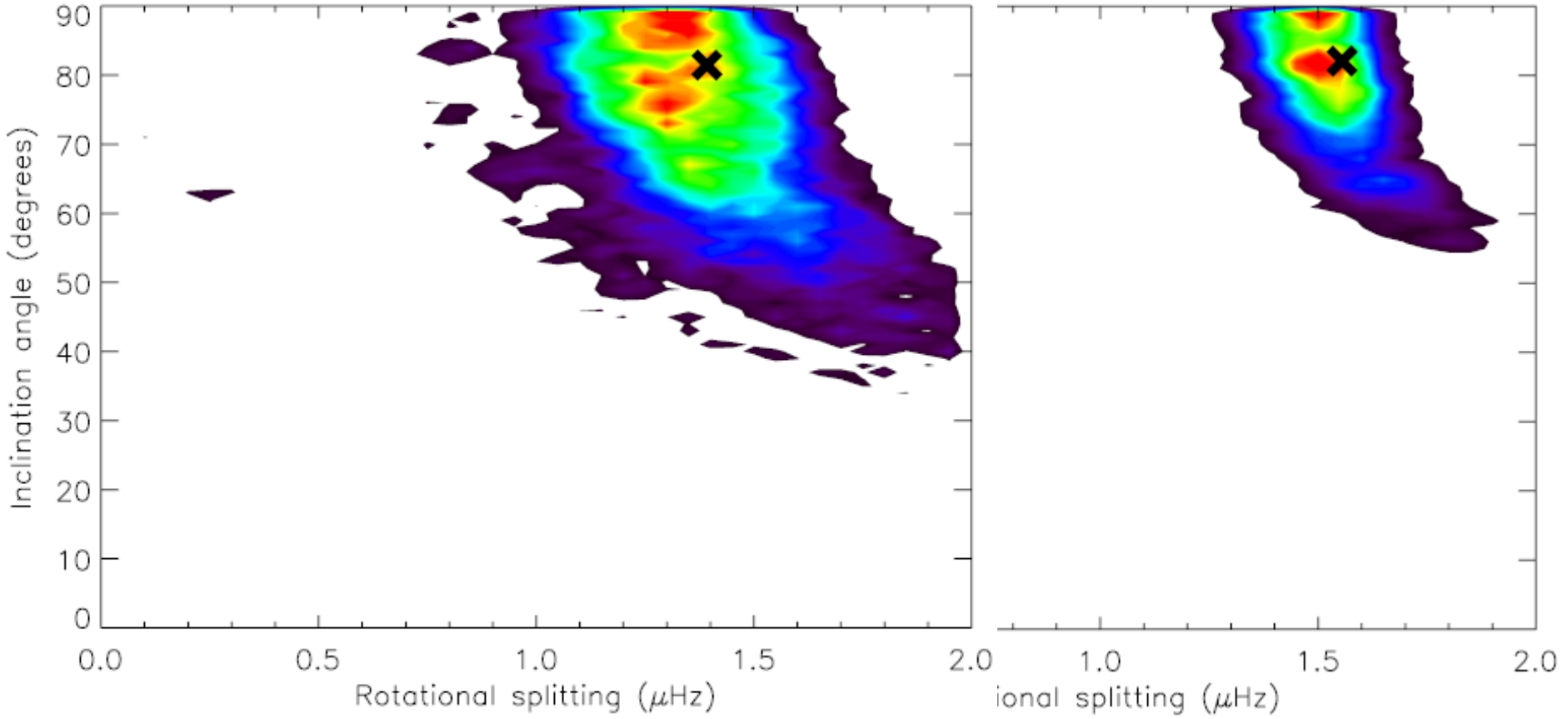

Chaplin et al., 2013, ApJ, 766, 101

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