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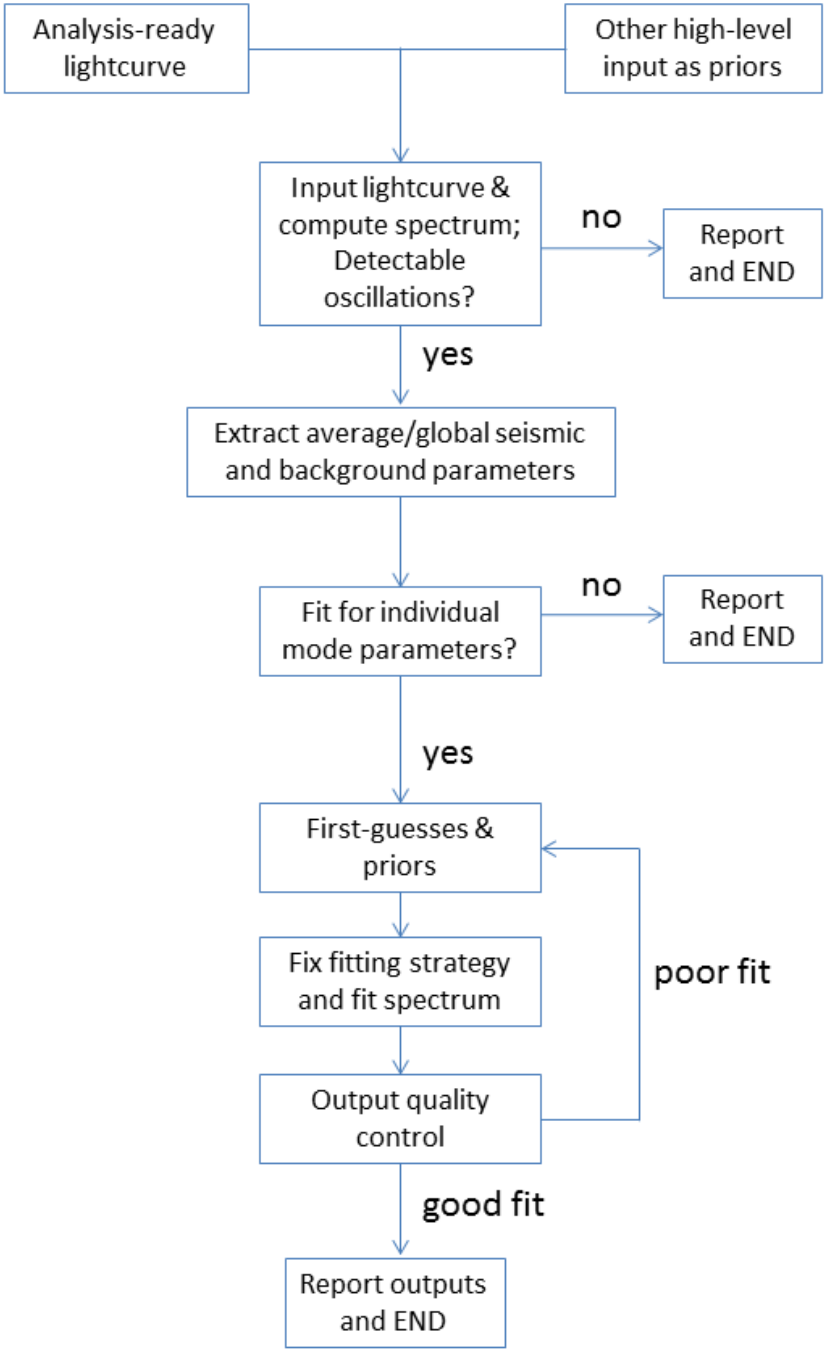
WG5 Summary: Seismic Data Analysis (WP128)

PLATO PSPM WP120 meeting

Paris 10 April 2015

Asteroseismic mode parameters (WP128)

Product	Designation	Level
Calibrated lightcurves and centroid curves	DP1	L1
Planet candidate transits and parameters	DP2	L2
Asteroseismic mode parameters	**DP3**	**L2**
Stellar rotation and activity	DP4	L2
Stellar masses and ages	DP5	L2
Confirmed planet systems and their characteristics	DP6	L2



- Firm foundations to build on: coordinated activities for CoRoT and *Kepler*
- Development of analysis methodologies and pipelines
- Challenges and work to be done are "known unknowns"

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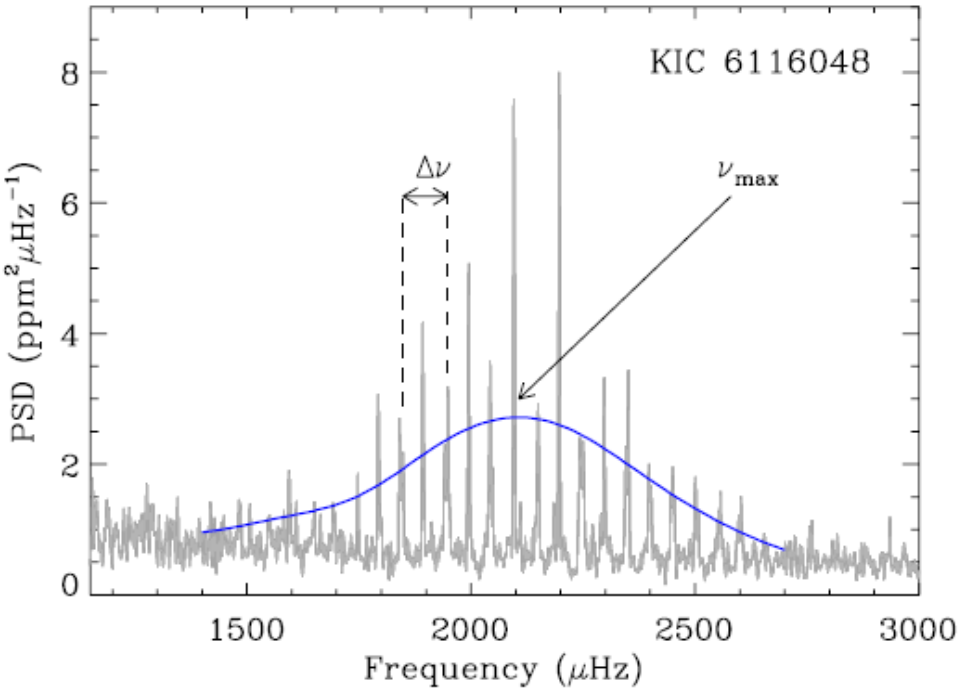
Outputs

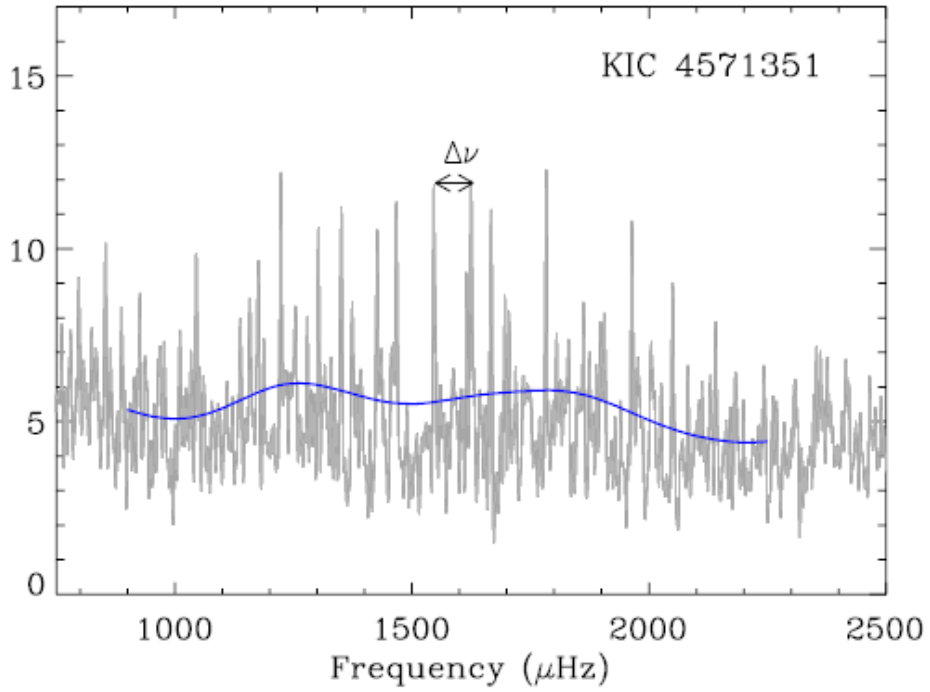
- Asteroseismic parameters:
  - Average or global parameters
  - Individual mode parameters + additional outputs (e.g. stellar angle of inclination)
- Granulation parameters:
  - Characteristic amplitudes and timescales
- PDFs of, and correlations between, parameters

Inputs

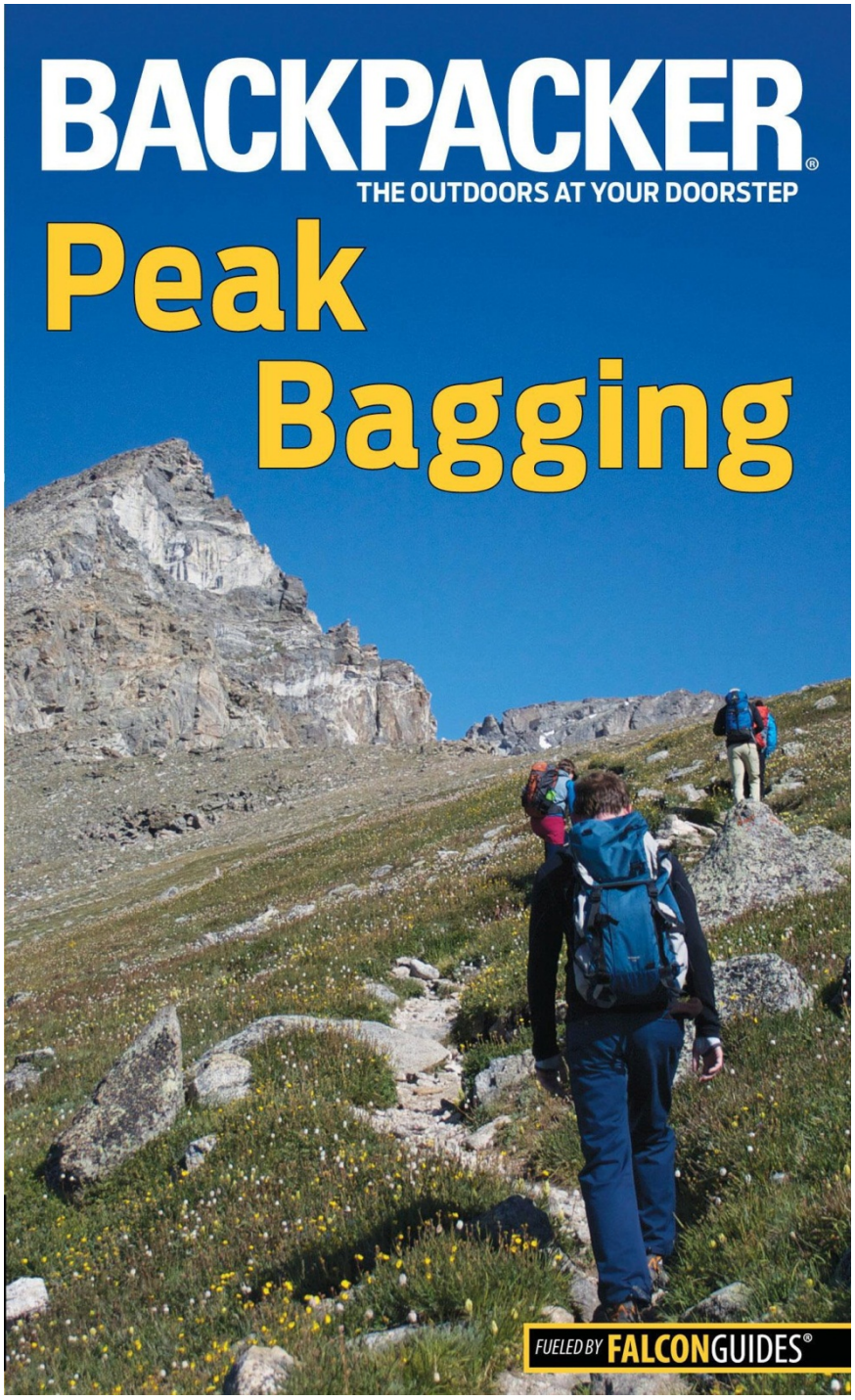
- Parameters extracted from frequency spectrum of *analysis-ready lightcurve*
- Lightcurve must be cleaned/filtered:
  - Transits and eclipses
  - Strong rotational modulation of stellar activity
- Also use spectroscopic & photometric information (priors)

Detection of oscillations, extraction of average parameters + first-guess information for detailed *peak bagging*





Chaplin et al. 2014, ApJS, 210, 1



the peak bagging app

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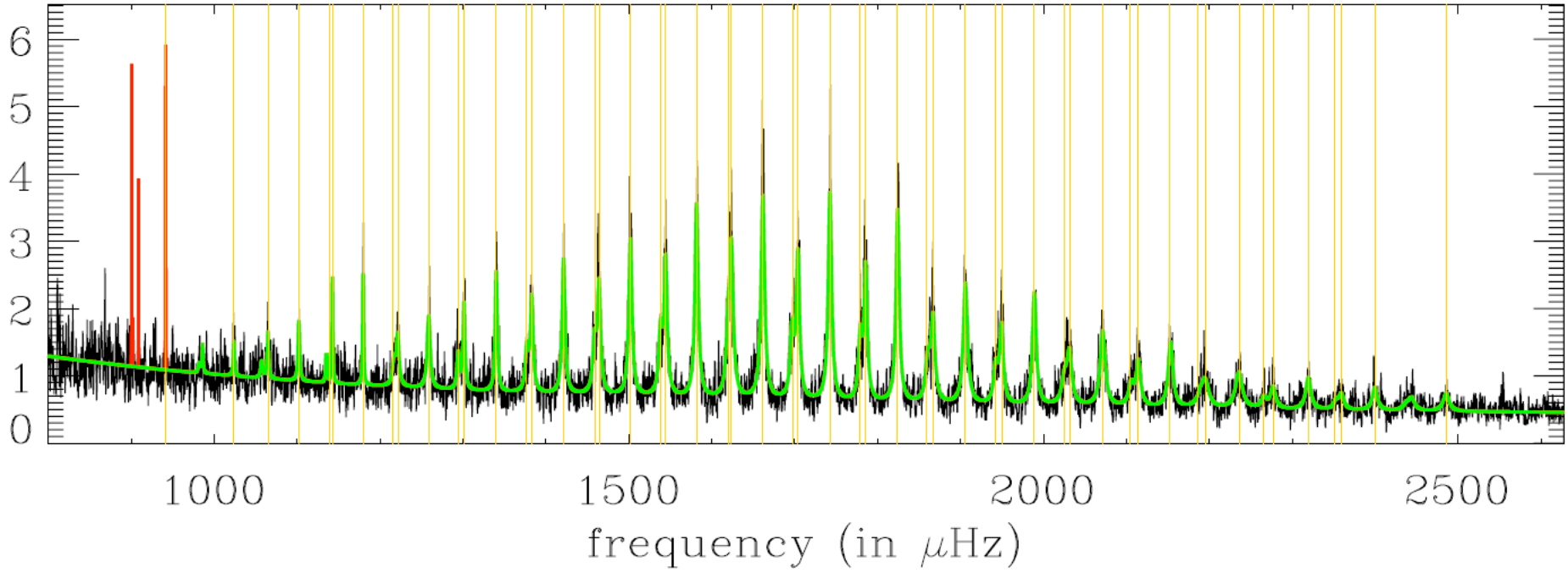
Peak-Bagging App

The peak bagging app project is an initiative conceived by some outdoor enthusiasts/computer nerds who longed for a better way to track and plan their peak bagging, climbing and mountaineering adventures.

Peak-Bagging App

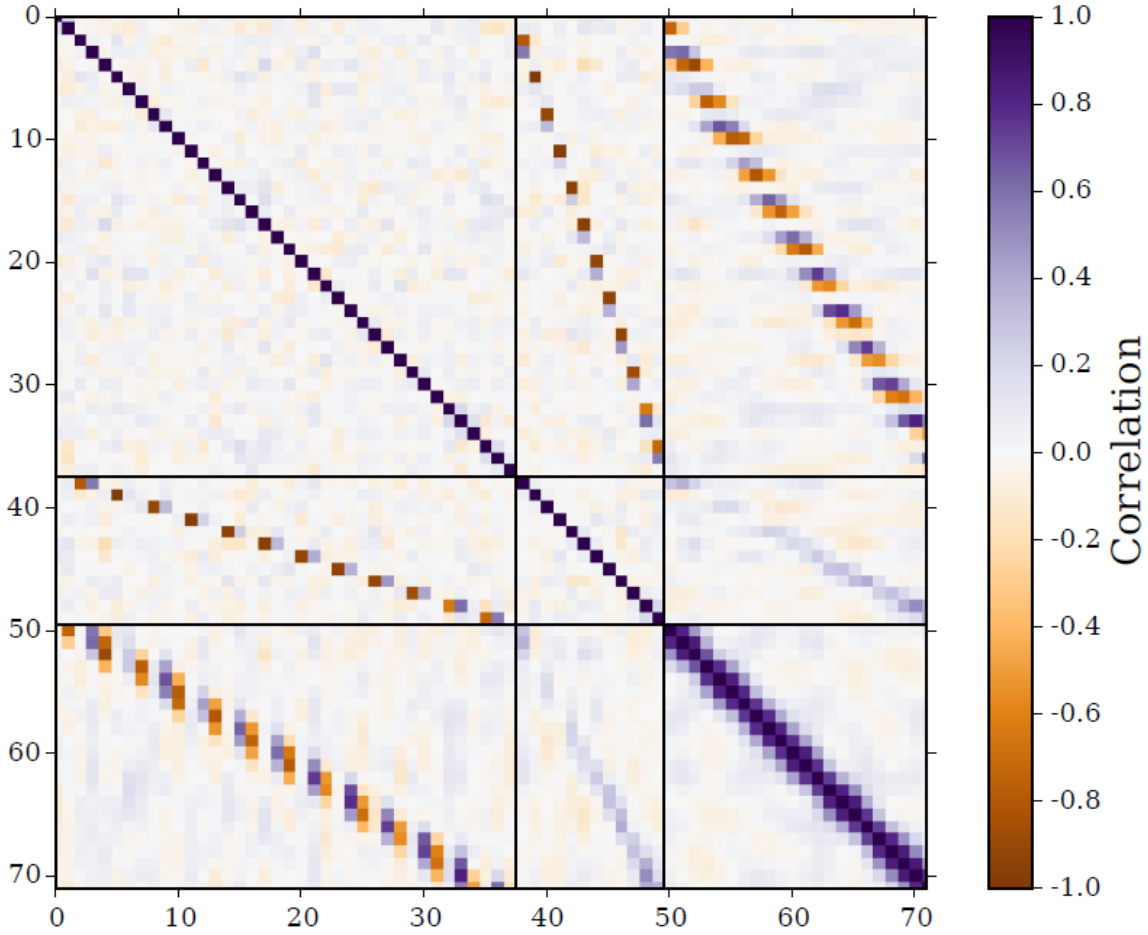
The PLATO peak bagging app project is an initiative conceived by some asteroseismologists/computer nerds who longed for a way to fit, in an automated manner, oscillation spectra of thousands of solar-type stars observed by PLATO

Peak-bagging asteroseismic data



Appourchaux et al., 2012, A&A, 543, A54

Correlation matrices of fitting parameters

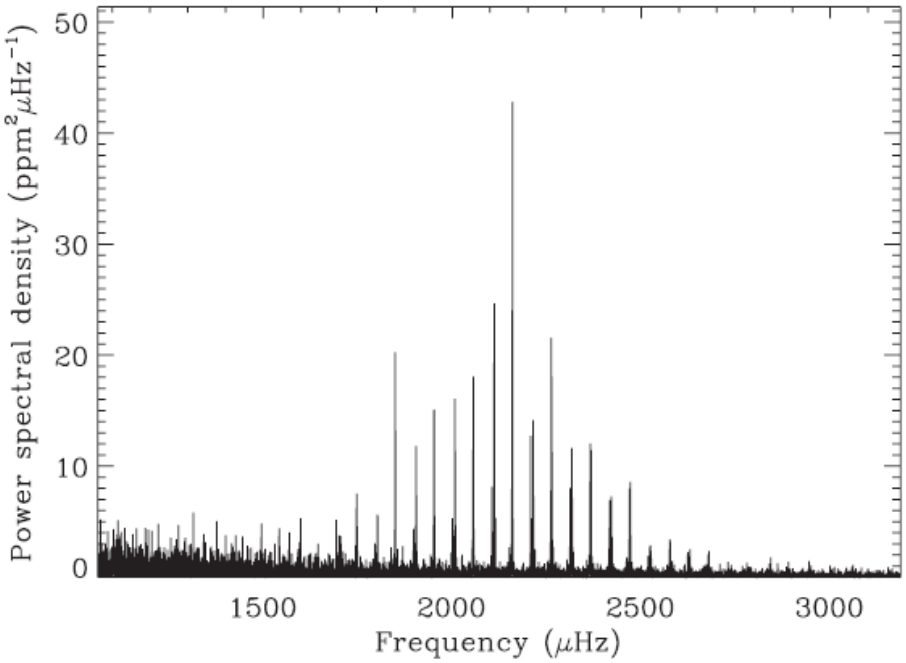


Davies et al., in preparation

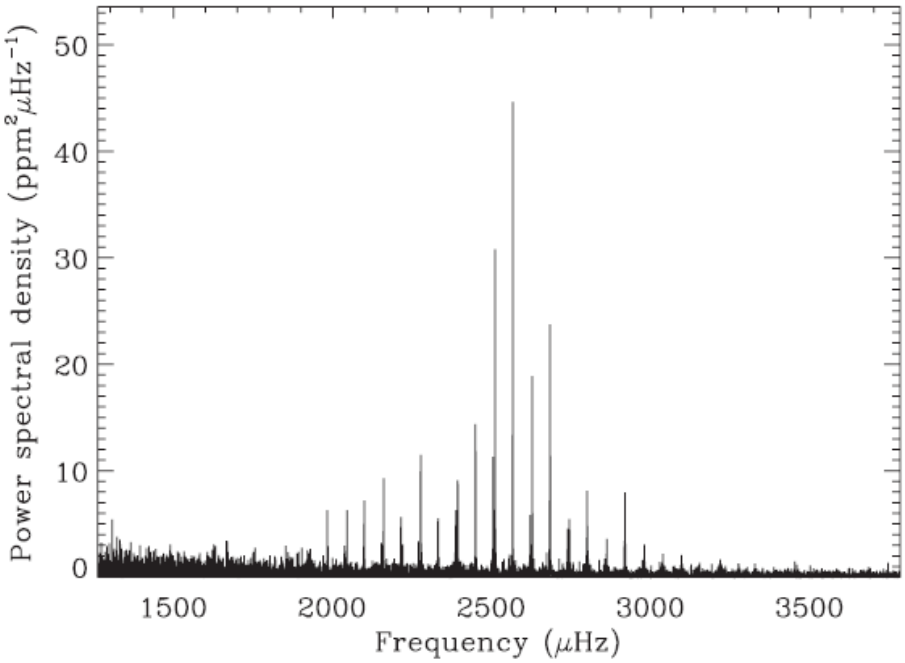
Kepler's "best in class"

Solar-type binary 16 Cyg (age 6.8 Gyr)

16 Cyg A $M = 1.11 M_{\odot}$



16 Cyg B $M = 1.07 M_{\odot}$



Metcalfe et al., 2012, ApJ, 748, L10

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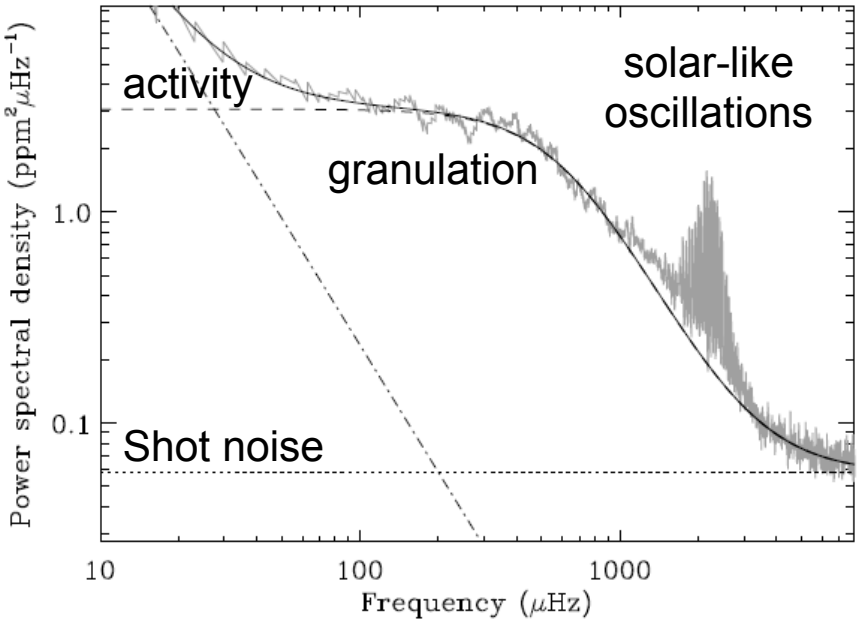

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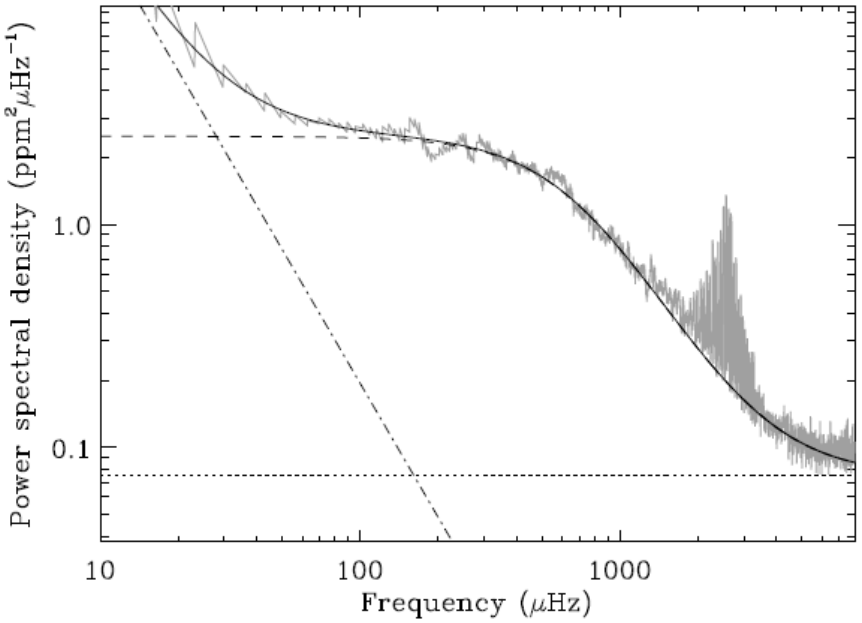

Metcalfe et al., 2012, ApJ, 748, L10

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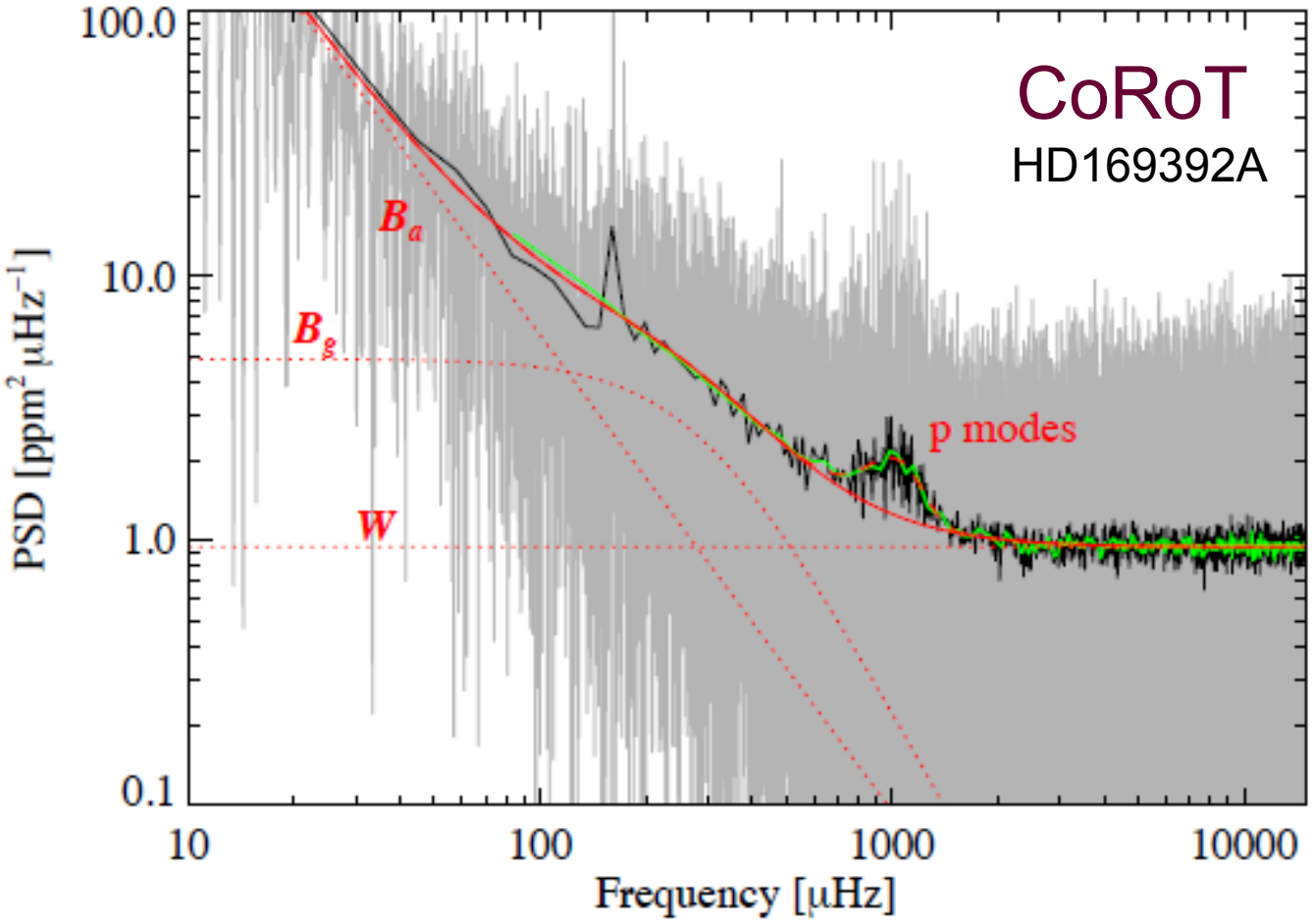
Modelling background power

Granulation, activity, shot noise, instrumental



Mathur et al., 2013, A&A, 549, 12

Modelling background power

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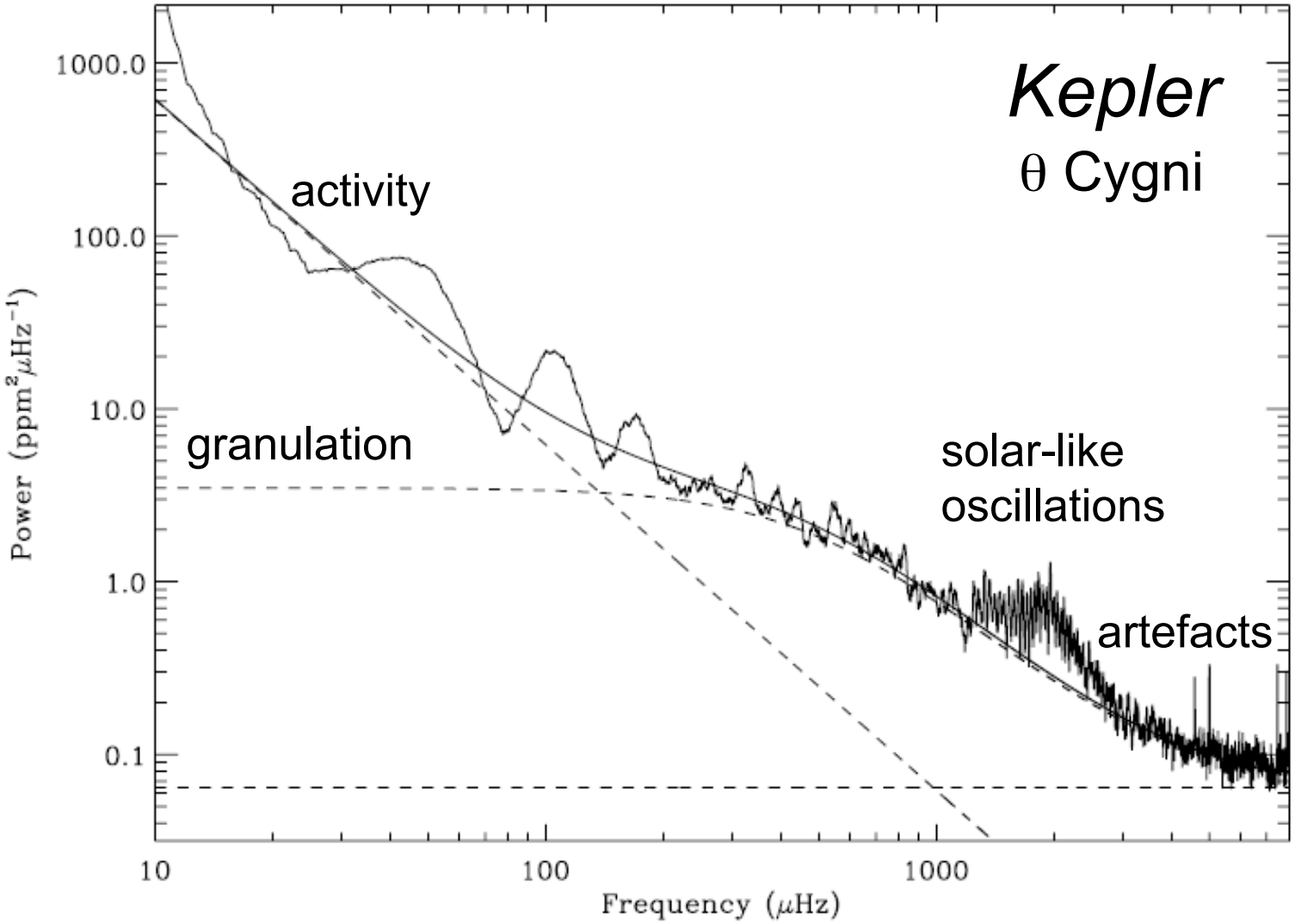
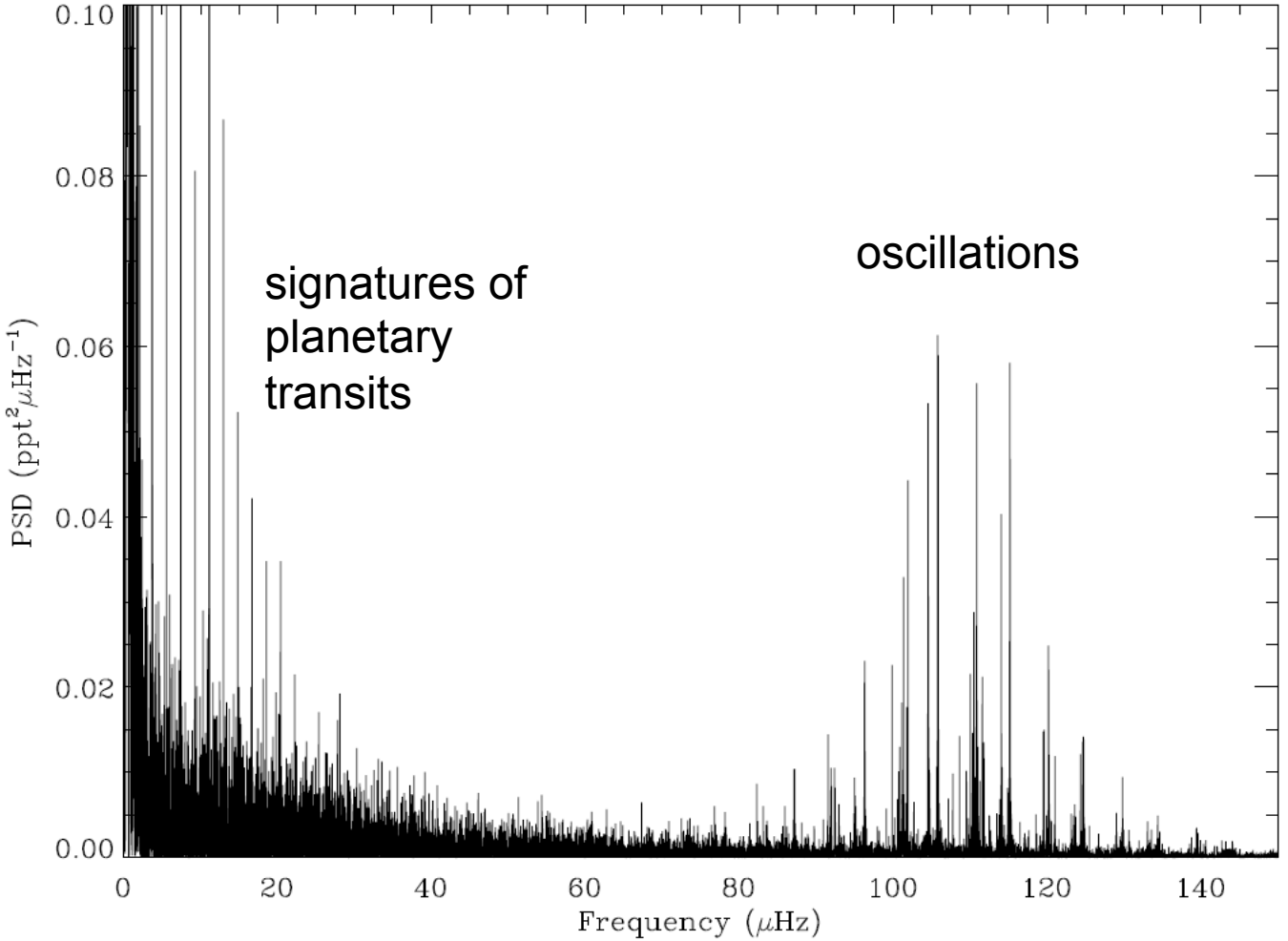
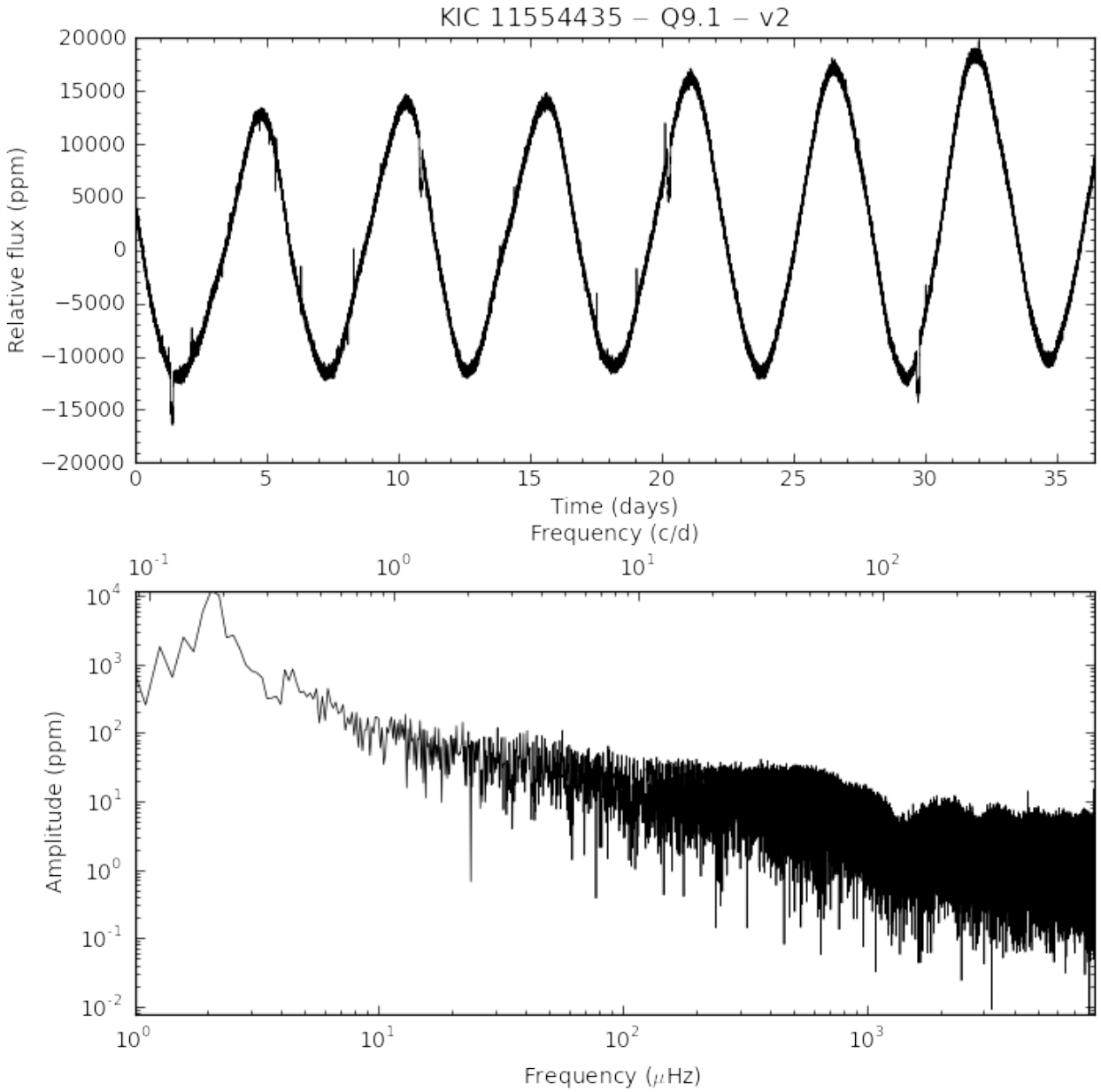


Kepler-91


signatures of planetary transits
oscillations
PSD (ppt^2 μHz^{-1})
0.10
0.08
0.06
0.04
0.02
0.00
0
20
40
60
80
100
120
140
Frequency (μHz)

Kepler-63

Very active planet host



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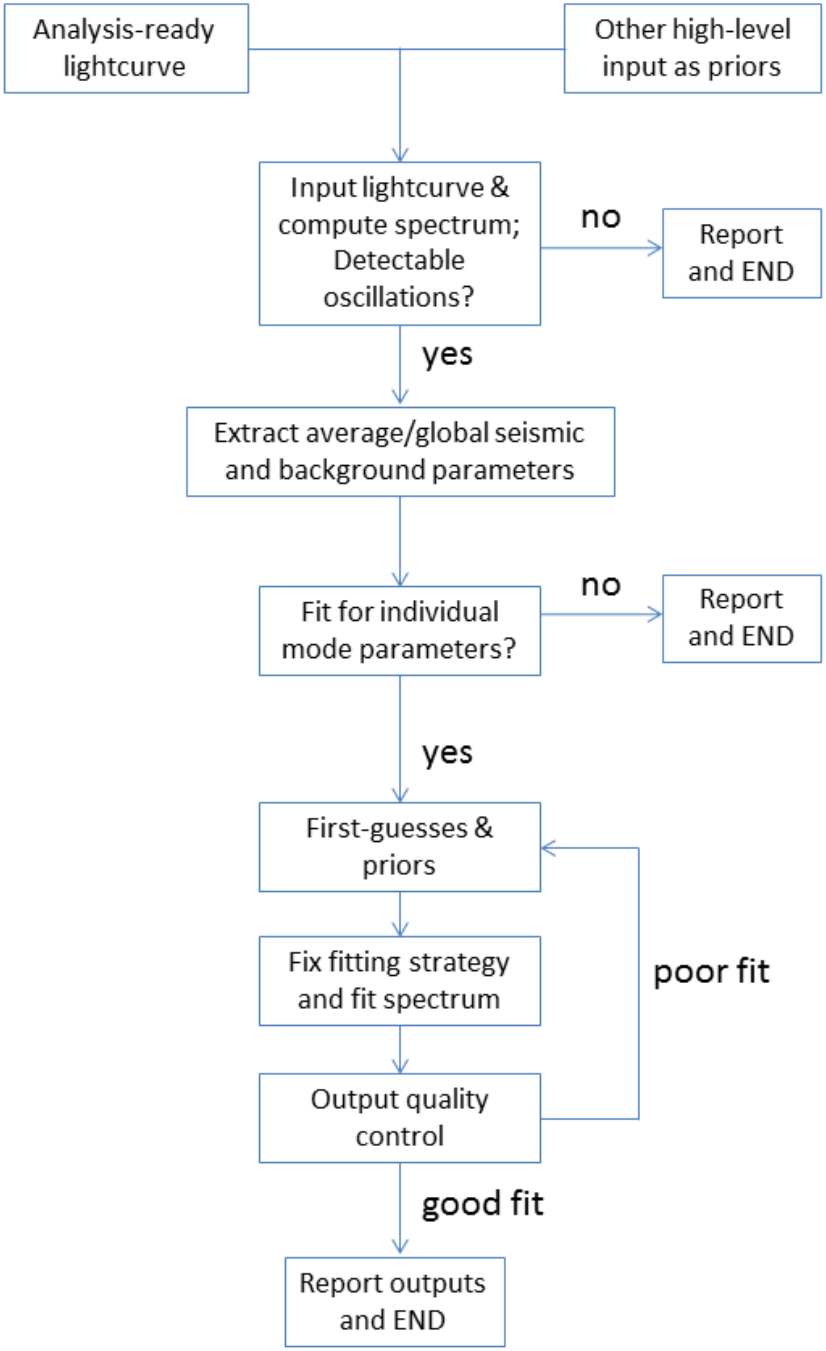
Inputs

- Lightcurves:
  - Transits removed from L1 lightcurves by PDC workpackage 375000 (Alonso, IAC)
  - For seismology also need correction for rotational signatures of activity, other narrow-band artefacts
  - So have set of lightcurves for rotational/ activity analysis (DP4) *and* another set for asteroseismic analysis (DP3)



Scheme

Firm foundations to build on (CoRoT, *Kepler*)

Several complementary approaches to each part; redundancy

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Challenges

- Front-to-end automation for large number of stars
- Dealing with a range of intrinsic stellar (hence seismic) properties and data quality
- Tensioning complexity of fitting model with data quality
  - Don’t squeeze too much from the data, but don’t sell it short
  - Examples: model for frequency splittings, mode peak asymmetry, peak height ratios…

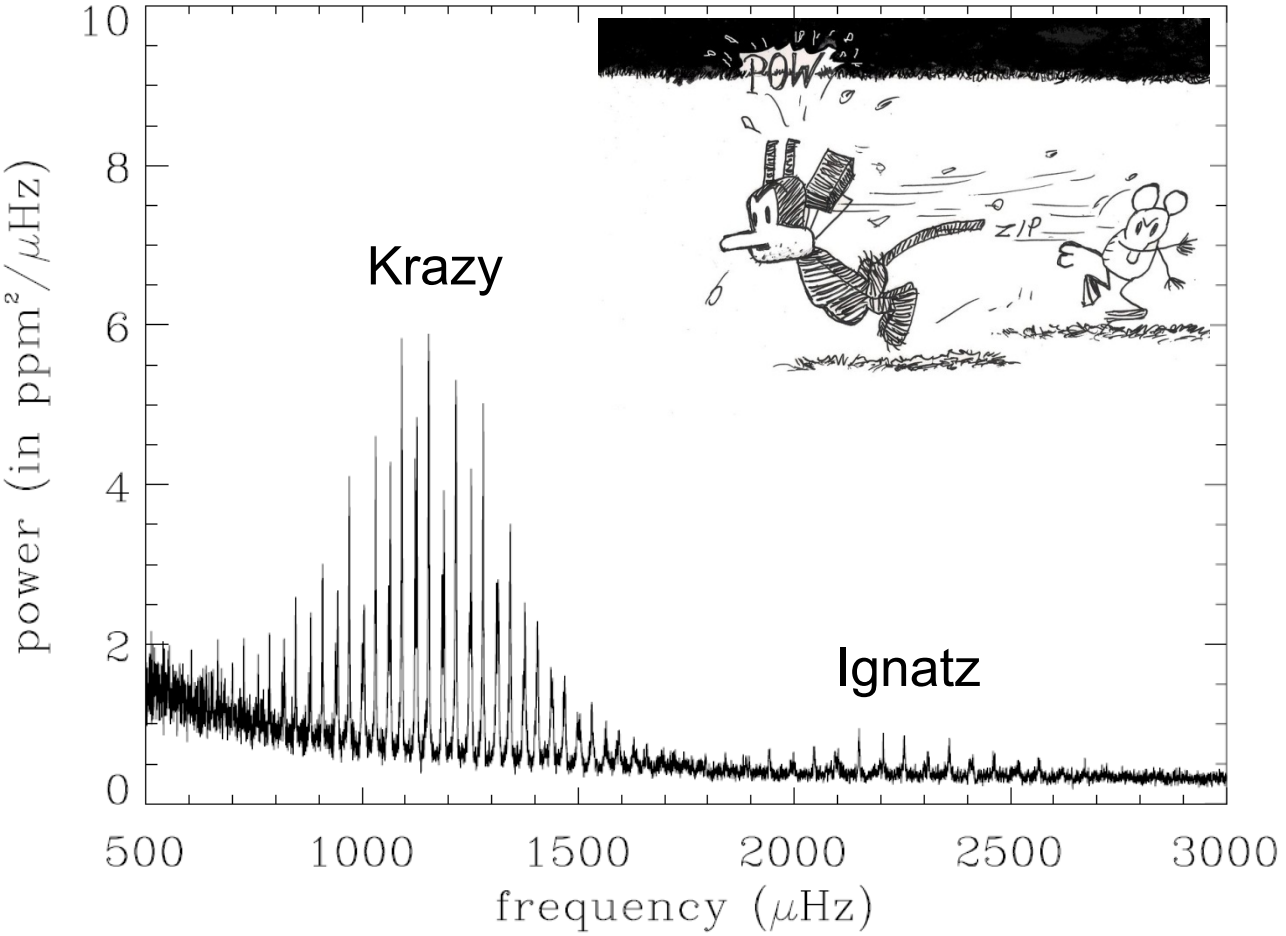
Challenges

- Background fitting
- Validation of uncertainties/confidence intervals
- Specifications for removal/filtering of transits, eclipses and rotational activity signatures
- Tests using:
  - *Kepler* and CoRoT data; degraded SOHO data
  - Artificial data (e.g. PLATO H&H data; asteroFLAG data)

Questions

- 50-second cadence OK for seismology of the core sample:
  - Nyquist frequency is 10 mHz
  - Acoustic cut-off frequency for late-K is around 8 to 8.5 mHz
  - *But* a more rapid cadence of interest for compact pulsators
- Multi-colour photometry:
  - Baseline: merge two colours
  - But do PA/QA on the two individually

Seismic signatures of two or more stars in one lightcurve



Appourchaux et al., in preparation; Miglio et al. 2014, ApJ, 784, 3L

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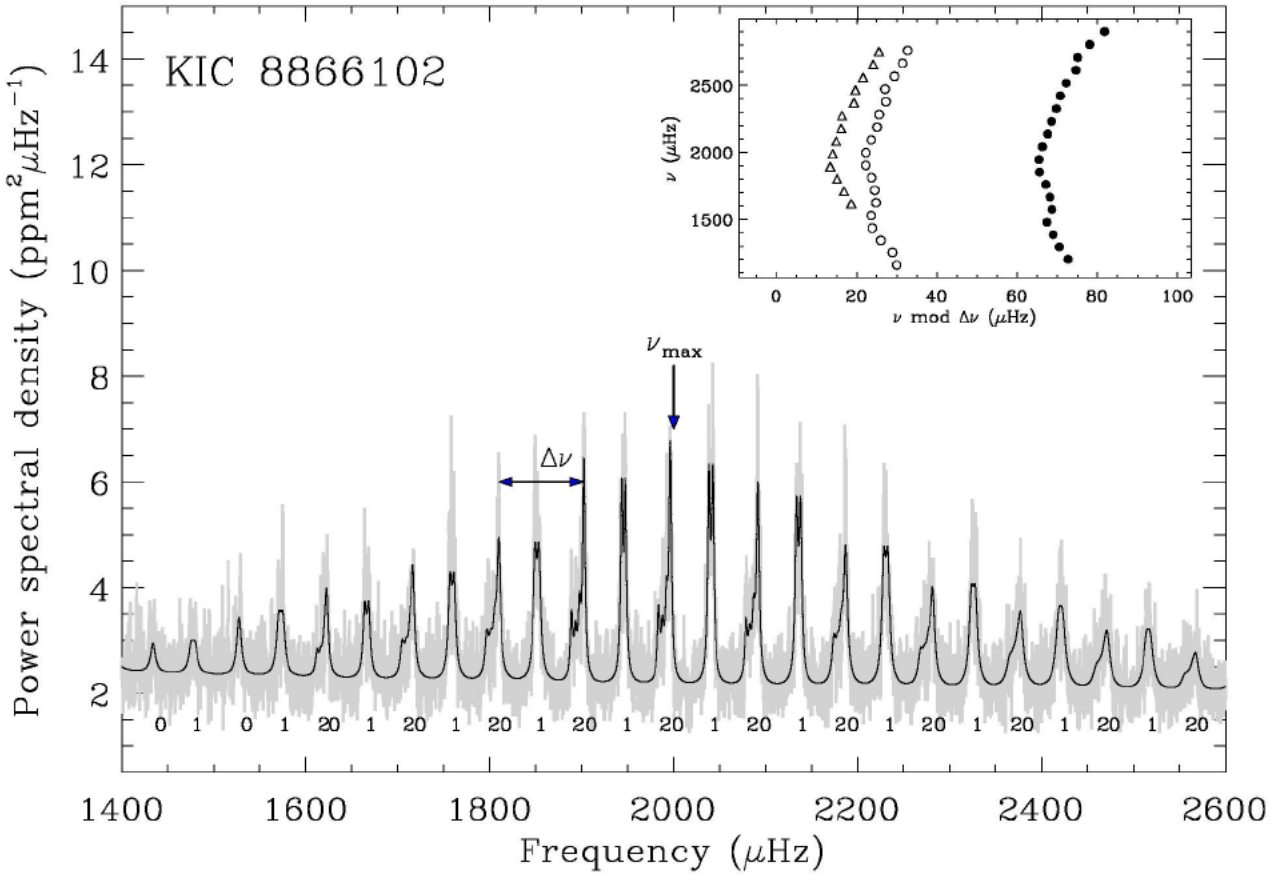
Assess quality for extraction of individual mode parameters



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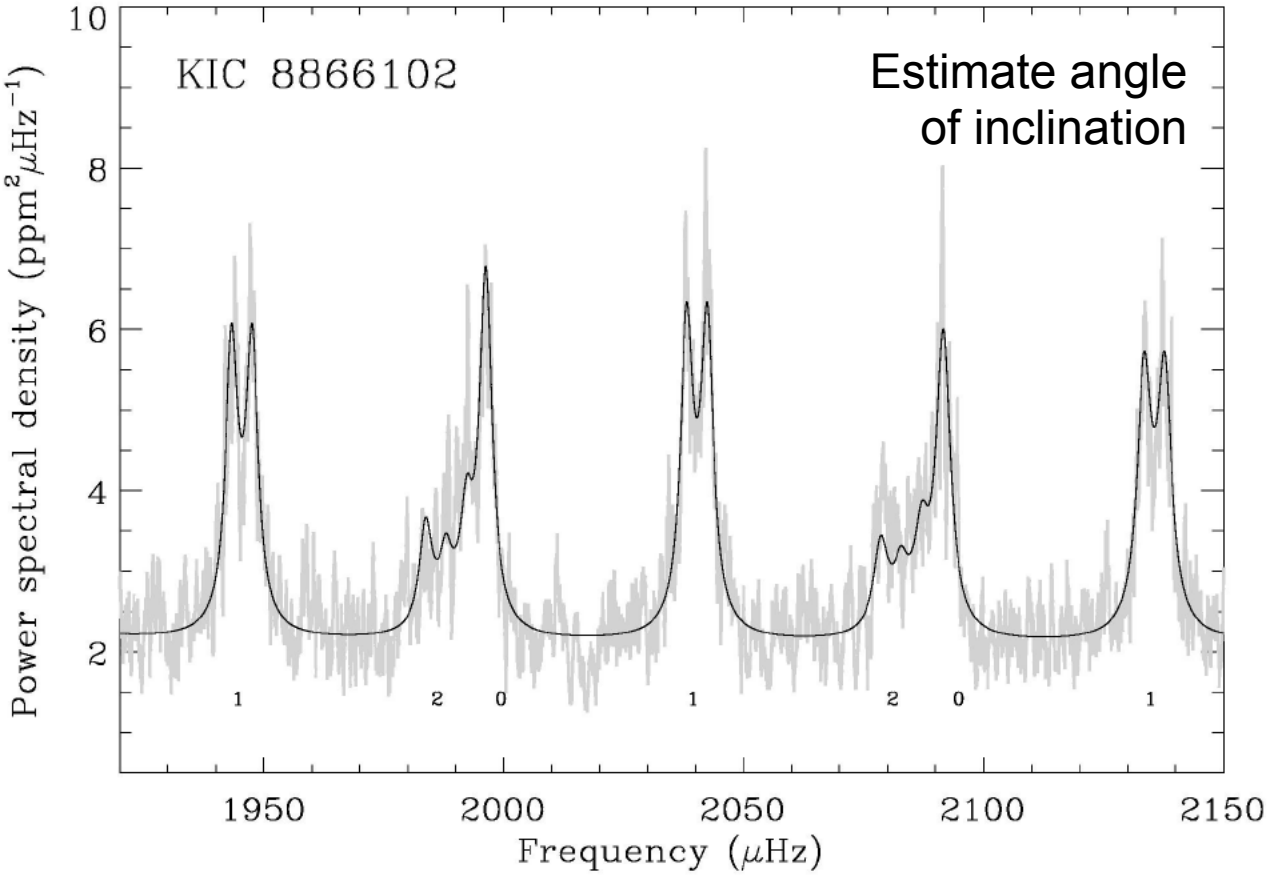

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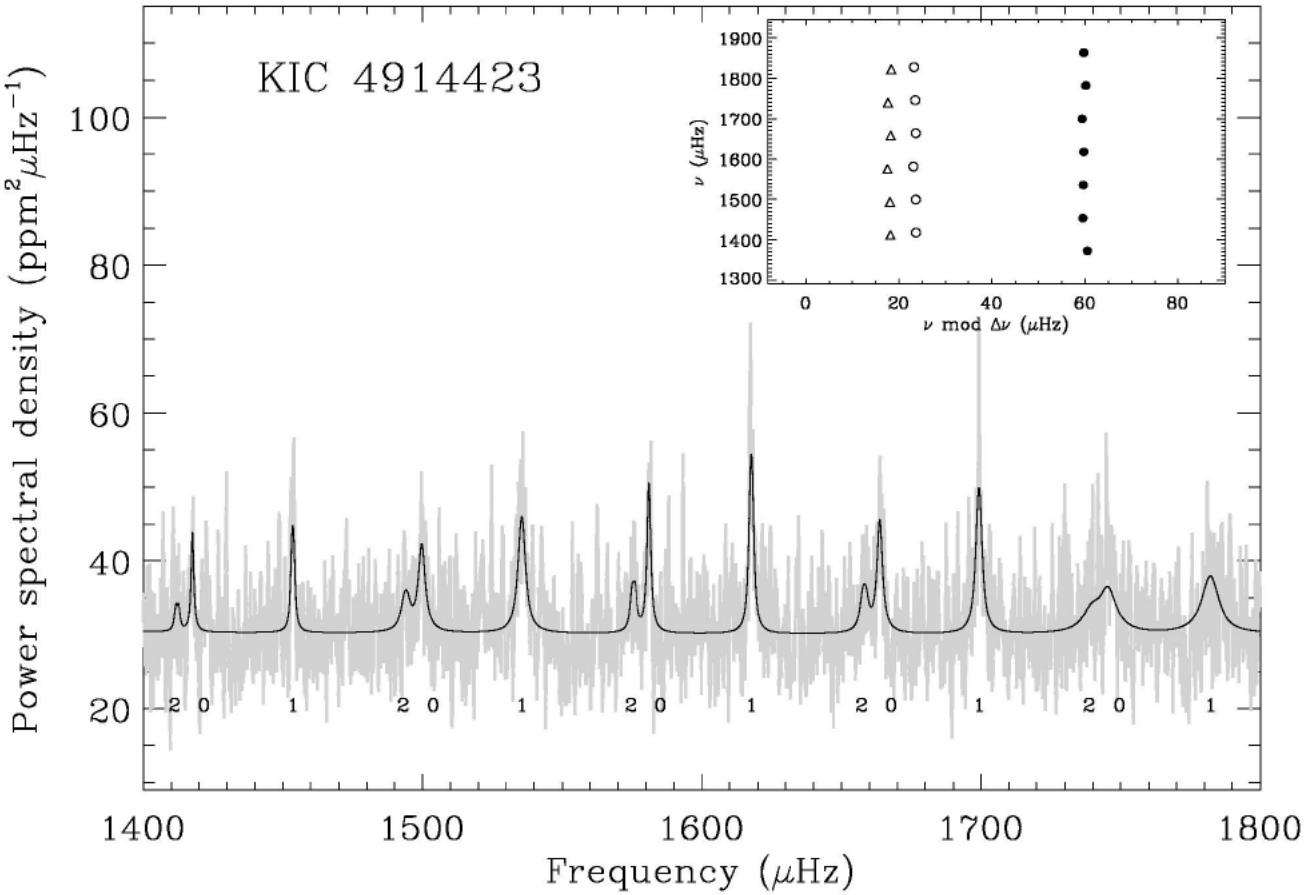

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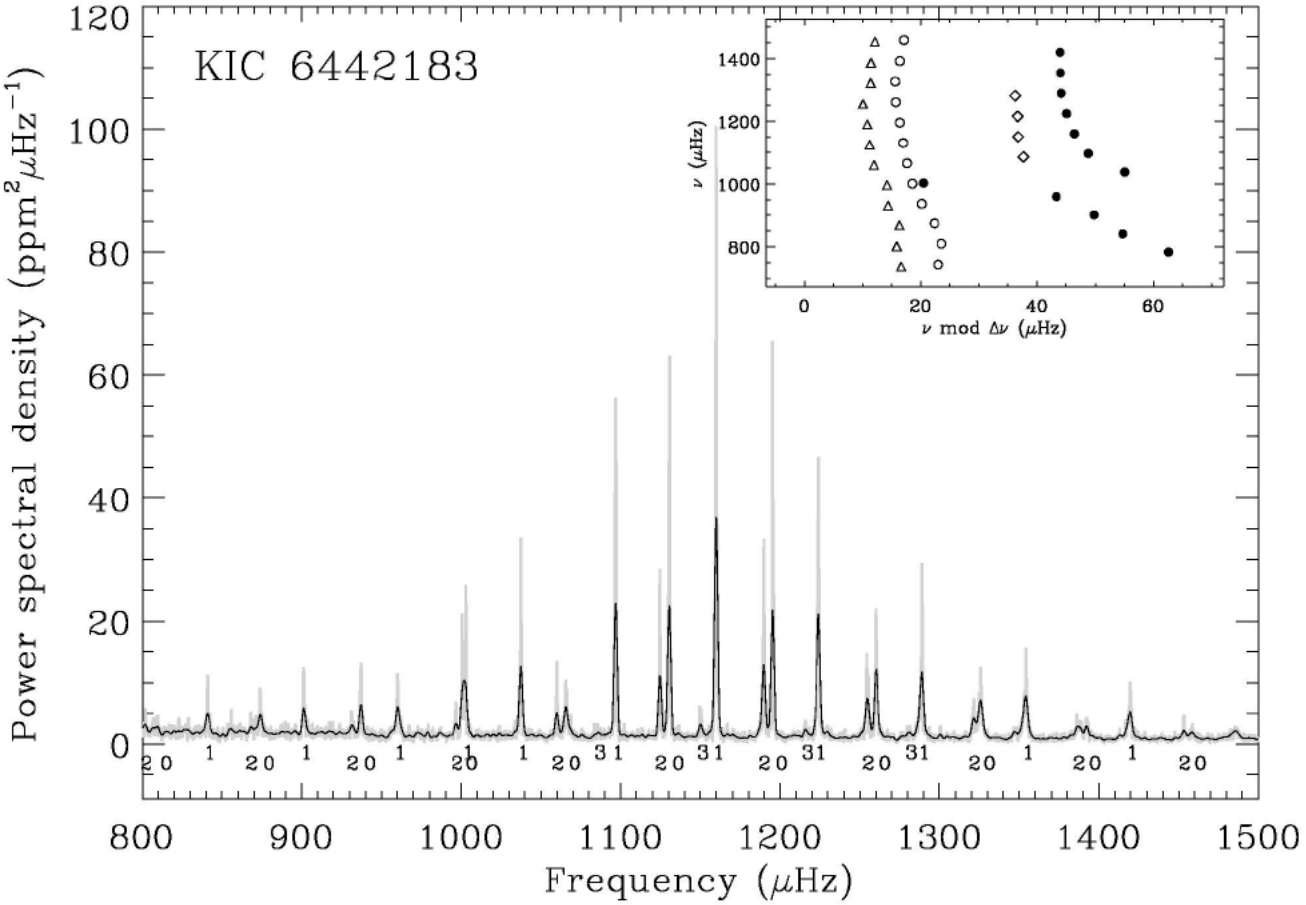
Mixed modes in evolved stars



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