TESS Asteroseismology: New Detections from Subgiant to Cool Main Sequence Stars.

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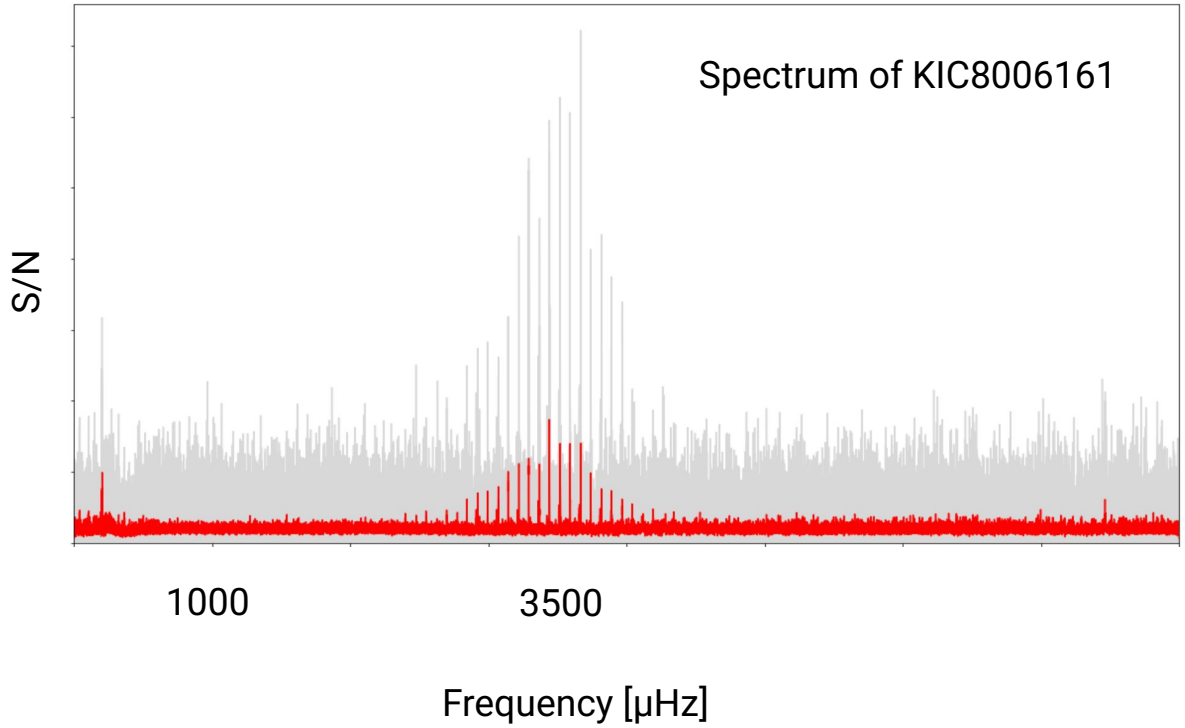
Asteroseismology with TESS

TASC - TESS Asteroseismic Science Consortium

- δ Scuti
- γ Doradus
- RR Lyrae + Cepheids
- Compact pulsators
- A and F type oscillators
- **Solar type oscillators**



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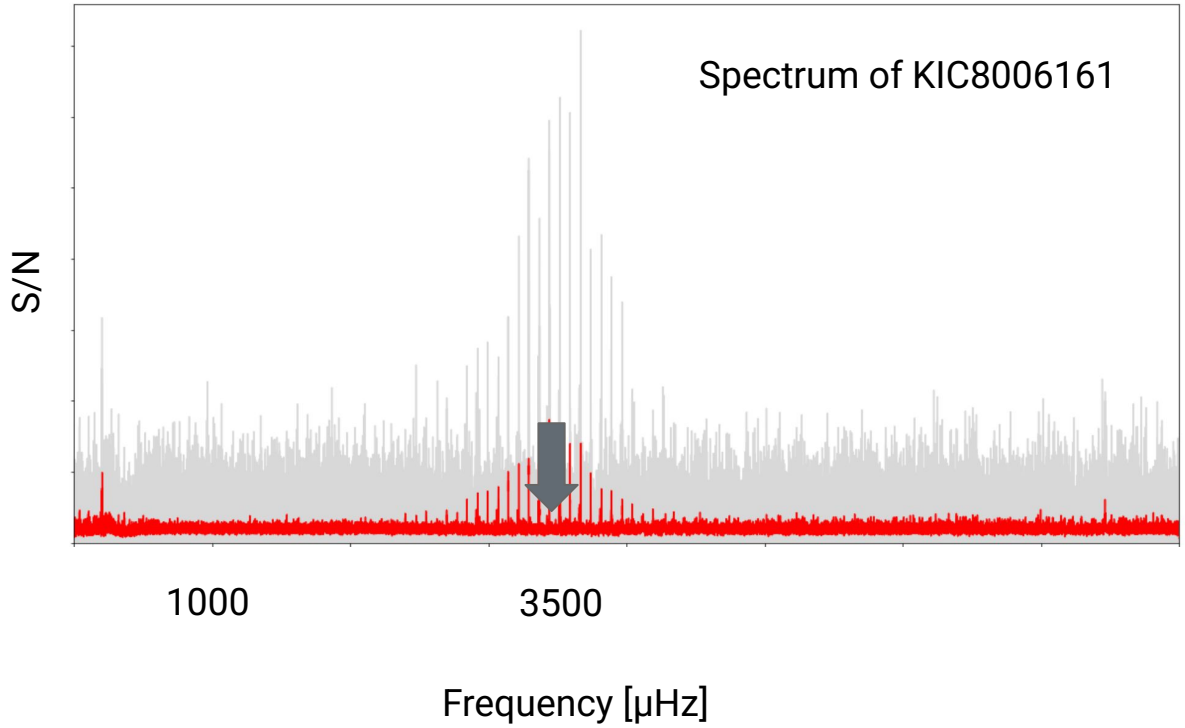


Kepler vs TESS

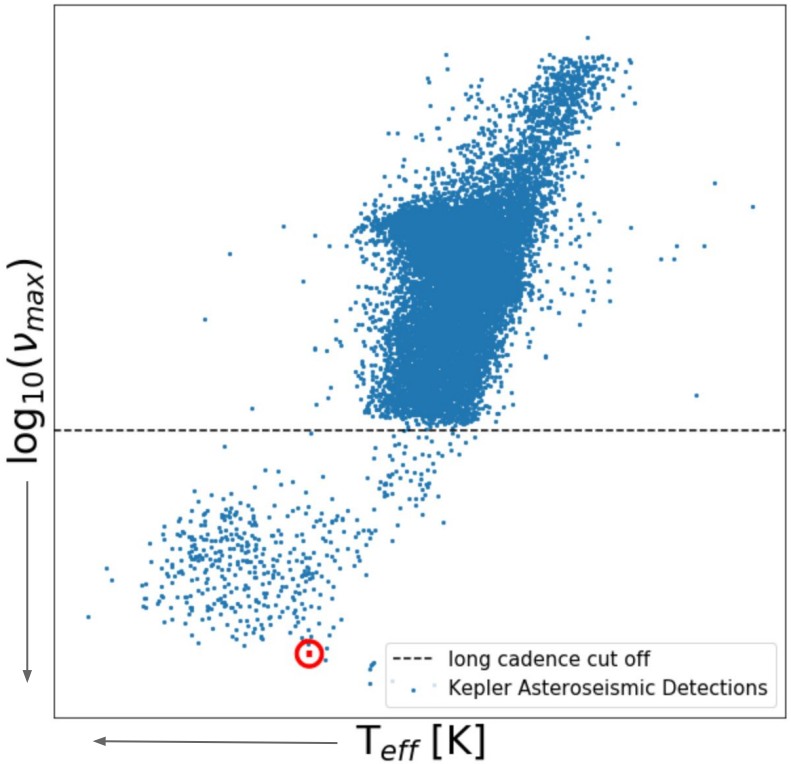
Kepler:

- Long cadence:
  - Integration times: 30 minutes
- Short cadence:
  - Integration times: 1 minute

TESS:

- Long cadence (FFIs):
  - Integration time: 30 minutes
- Short cadence:
  - Integration time: 2 minutes
- Super short cadence:
  - Integration time: 20 seconds

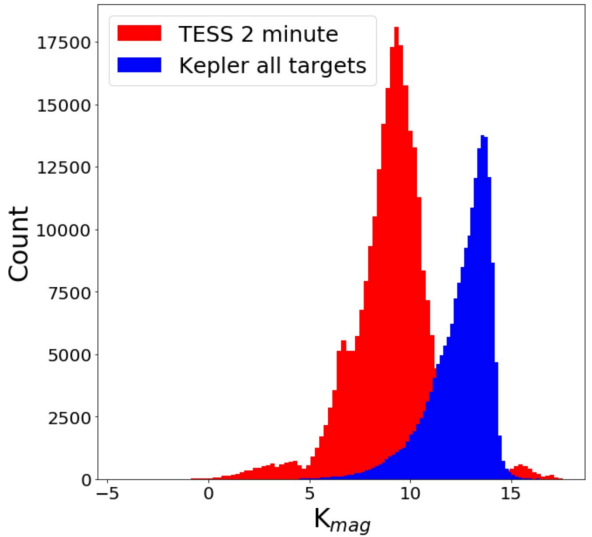
Yu et al. 2018, Lund et al. 2016, Serenelli et al. 2017

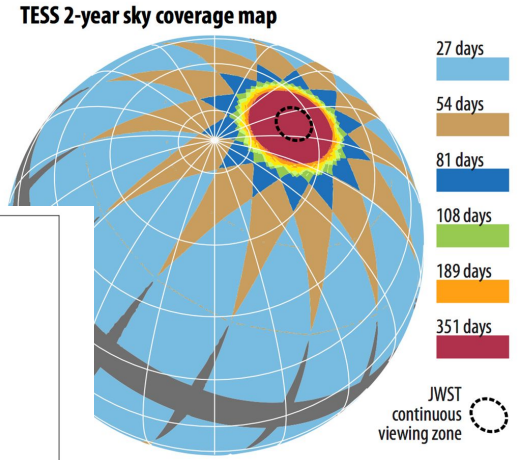


Kepler vs TESS

Baseline (days)	Sky coverage (%)
0	14.6
27.4	63.0
54.8	15.2
82.2	3.0
109.6	0.56
everything from 137.0 to 301.4	1.4 total
328.8	0.52
356.2	1.7

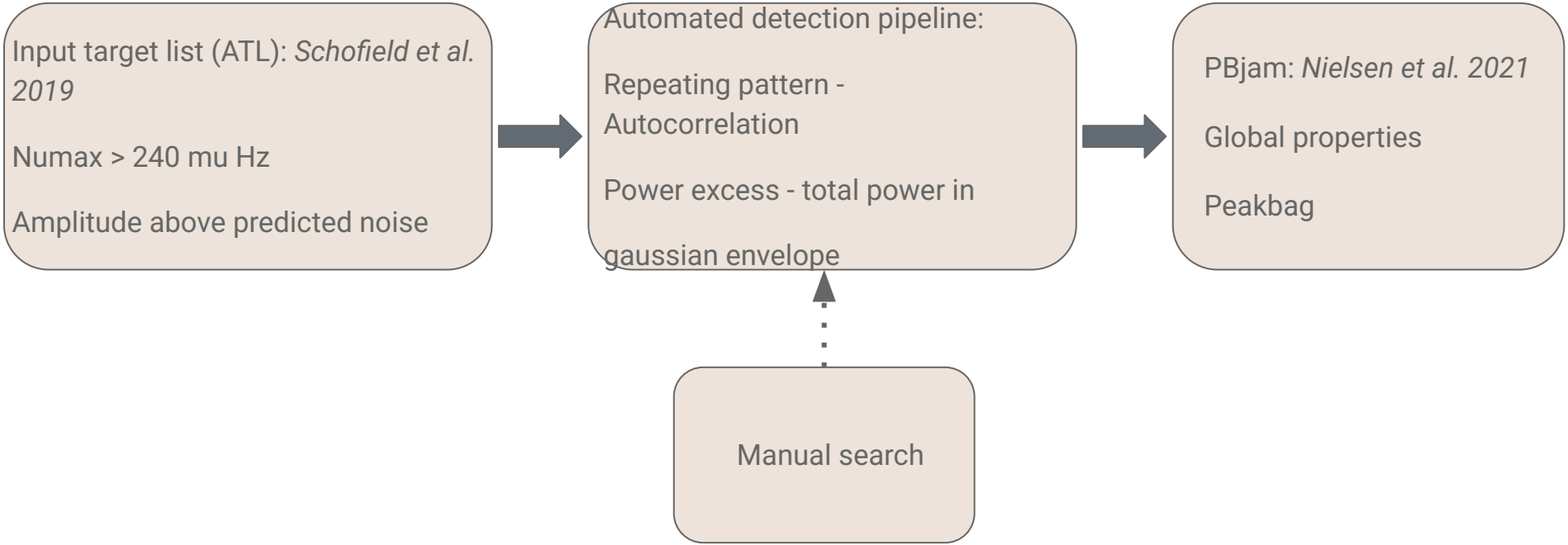
(https://tess.mit.edu/science/data/)



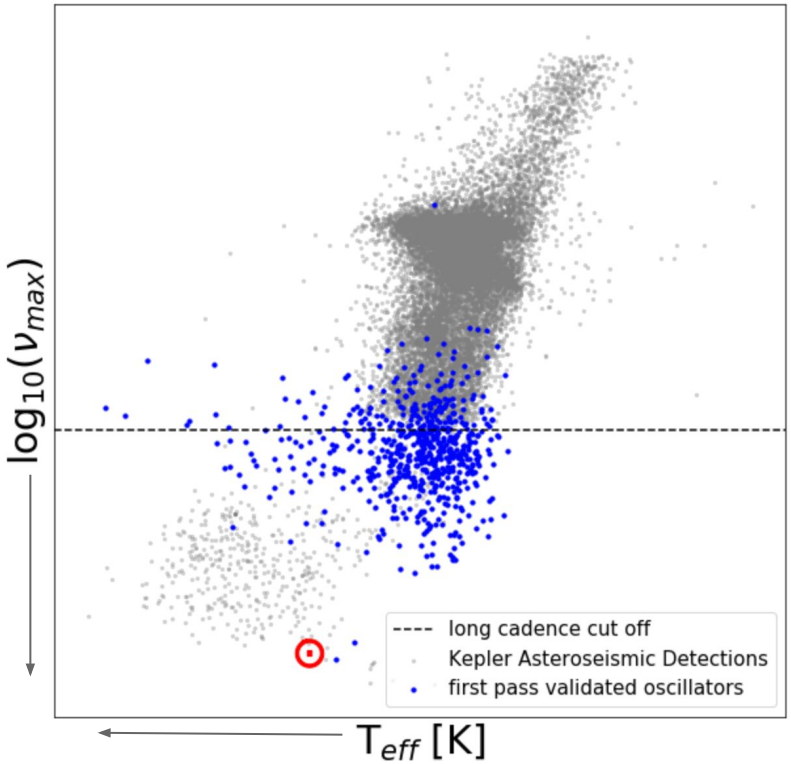


NB: aperture size

A short cadence catalogue



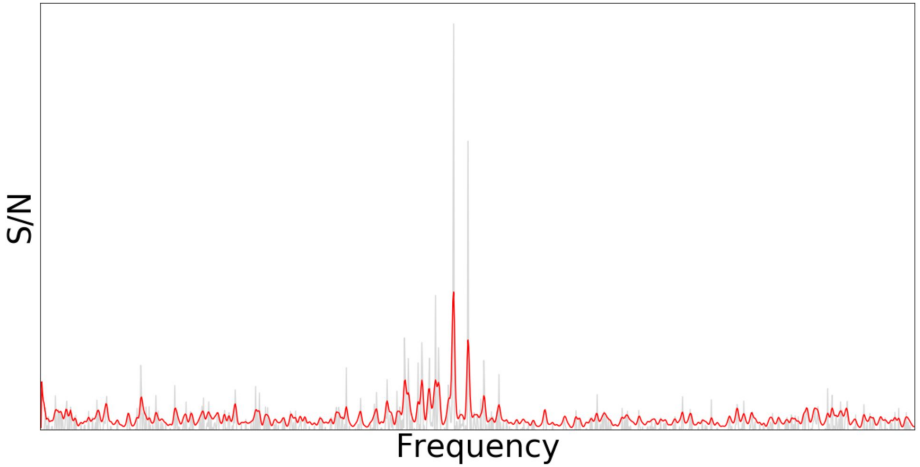
A short cadence catalogue



Representative error

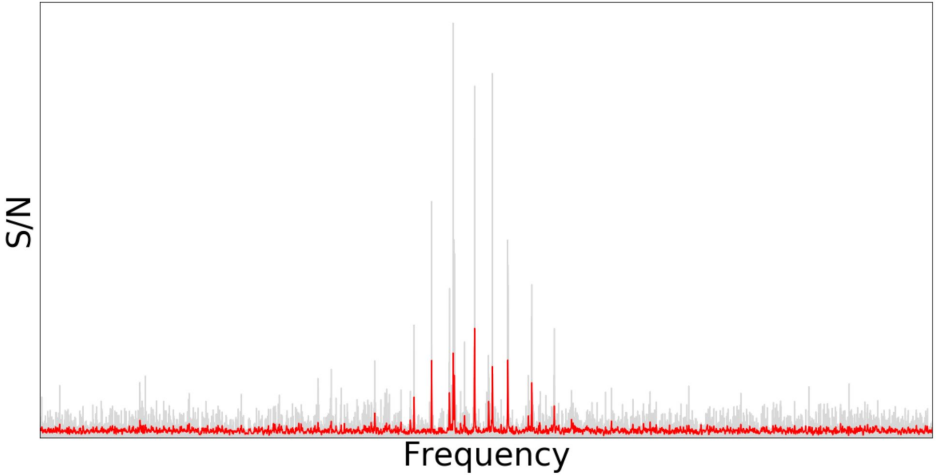
NB: Effective Temp from photometry

Examples



TIC286507416

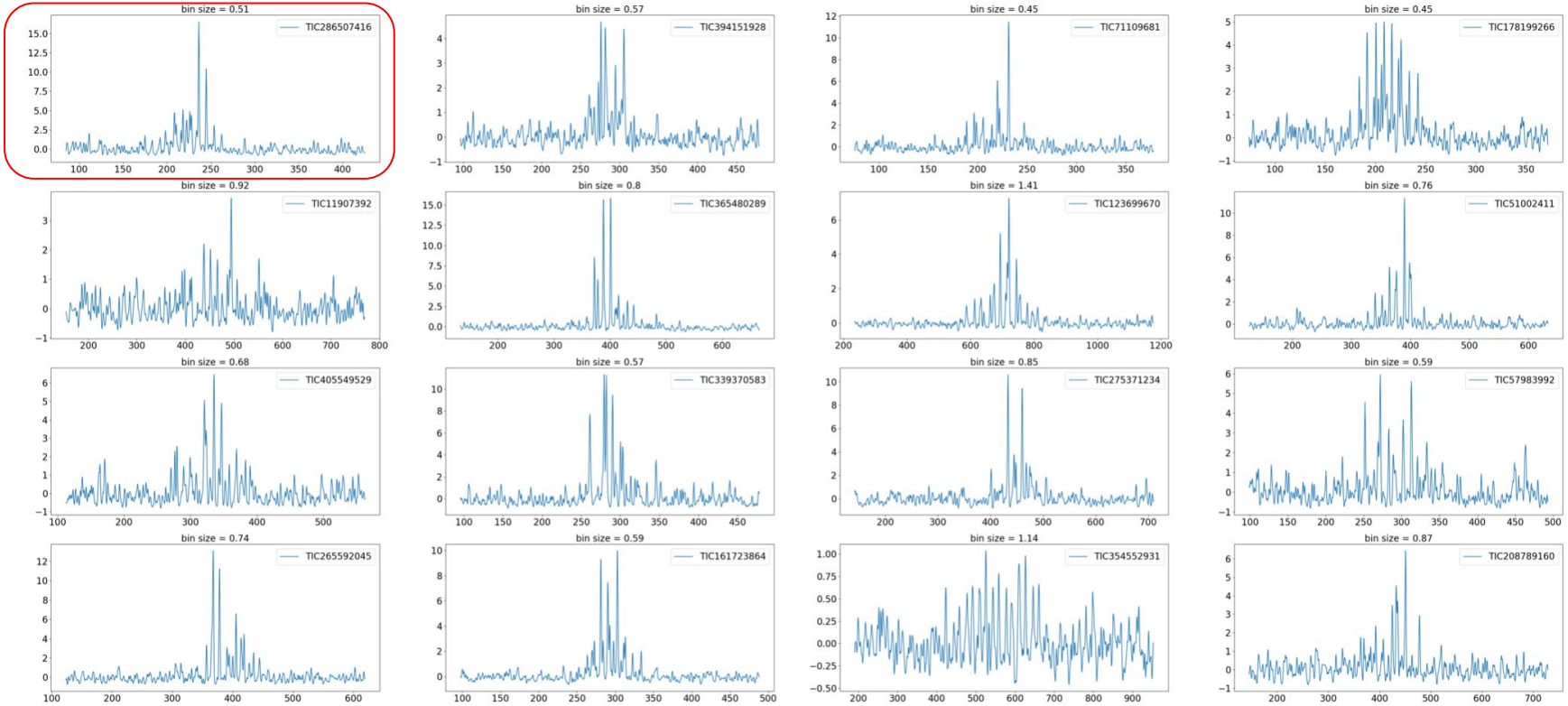
< 27.5 days



TIC219143616

~ 1 year

Examples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TIC286507416
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TIC394151928
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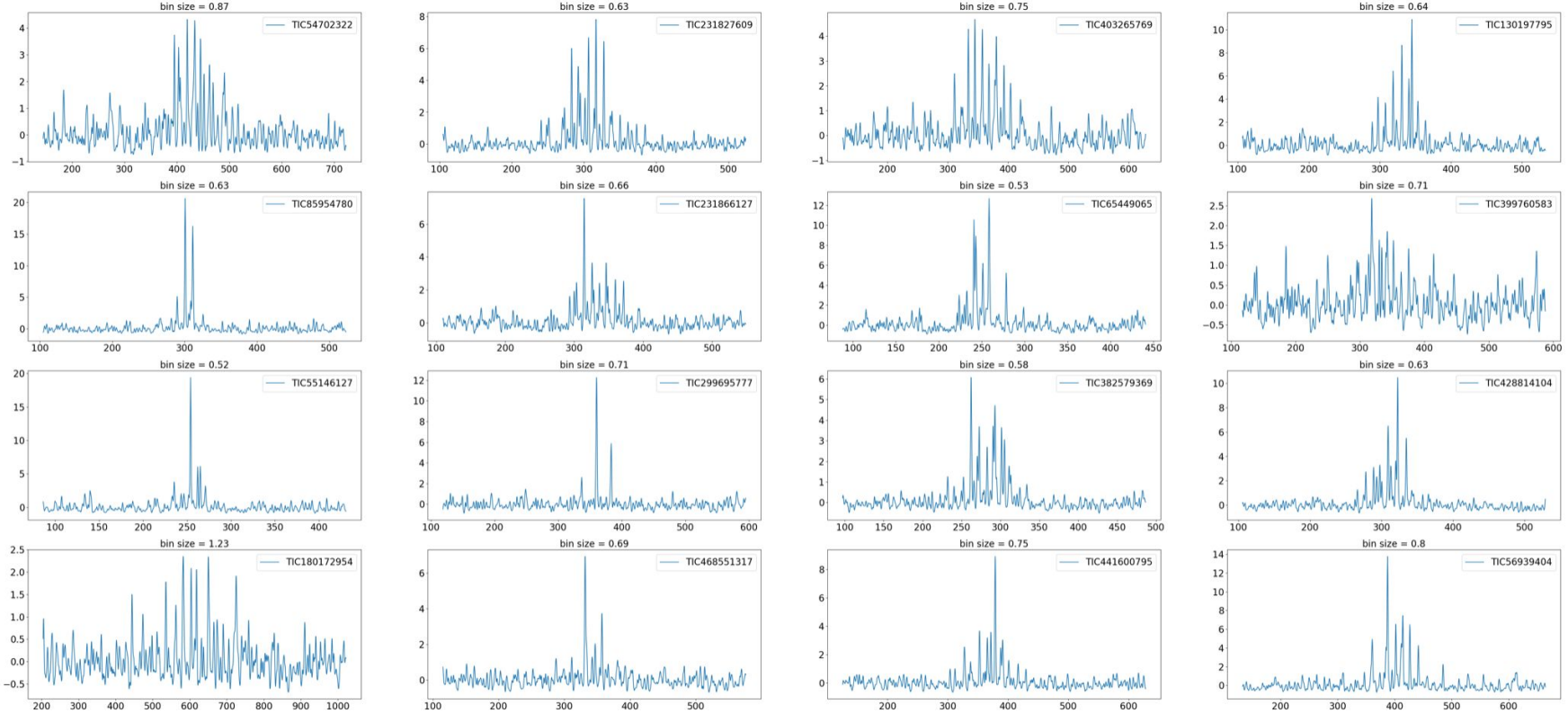
TIC71109681
bin size = 0.45
TIC178199266
bin size = 0.92
TIC11907392
bin size = 0.8
TIC365480289
bin size = 1.41
TIC123699670
bin size = 0.76
TIC51002411
bin size = 0.68
TIC405549529
bin size = 0.57
TIC339370583
bin size = 0.85
TIC275371234
bin size = 0.59
TIC57983992
bin size = 0.74
TIC265592045
bin size = 0.59
TIC161723864
bin size = 1.14
TIC354552931
bin size = 0.87
TIC208789160

Examples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bin size = 0.63
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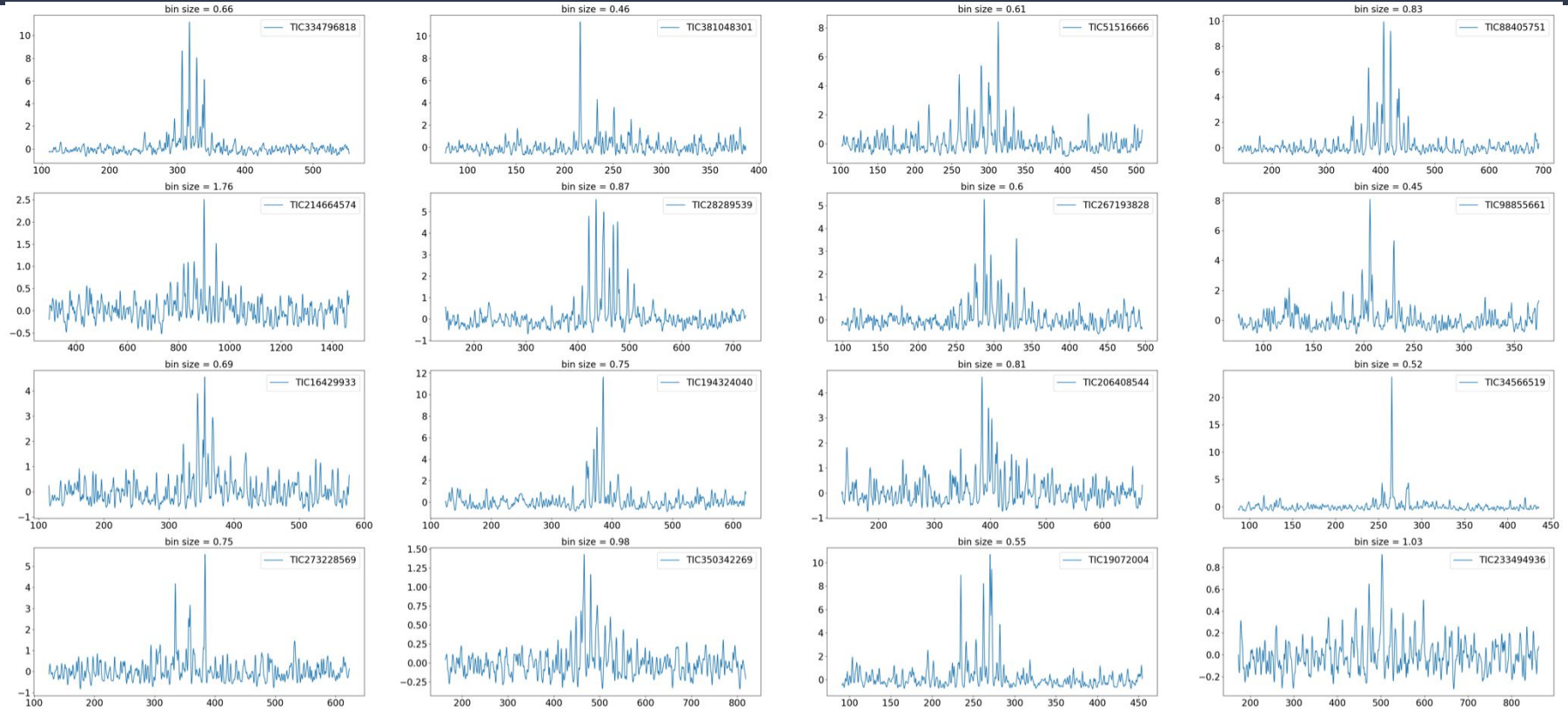
TIC85954780
bin size = 0.66
TIC231866127
bin size = 0.53
TIC65449065
bin size = 0.71
TIC399760583
bin size = 0.52
TIC55146127
bin size = 0.71
TIC299695777
bin size = 0.58
TIC382579369
bin size = 0.63
TIC428814104
bin size = 1.23
TIC180172954
bin size = 0.69
TIC468551317
bin size = 0.75
TIC441600795
bin size = 0.8
TIC56939404

Examples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TIC51516666
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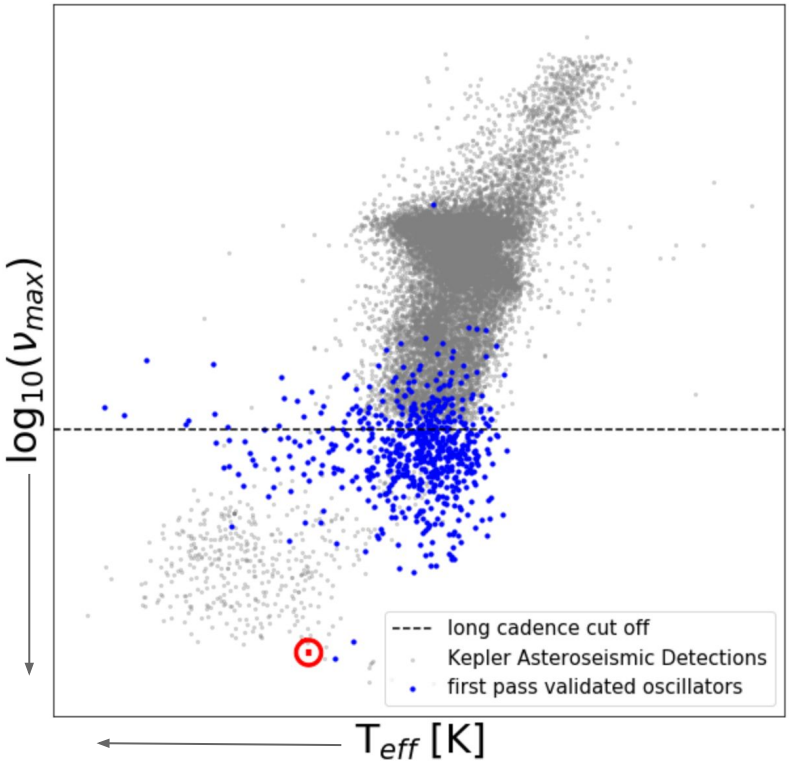
TIC214664574
bin size = 0.87
TIC28289539
bin size = 0.6
TIC267193828
bin size = 0.45
TIC98855661
bin size = 0.69
TIC16429933
bin size = 0.75
TIC194324040
bin size = 0.81
TIC206408544
bin size = 0.52
TIC34566519
bin size = 0.75
TIC273228569
bin size = 0.98
TIC350342269
bin size = 0.55
TIC19072004
bin size = 1.03
TIC233494936

Conclusion

- TESS gives us the opportunity to massively expand our pool of oscillators below the RGB
- Frequencies can be extracted even with just one sector of data
- Expect more oscillators - await the TASOC data



END

Power Excess

Power Excess:

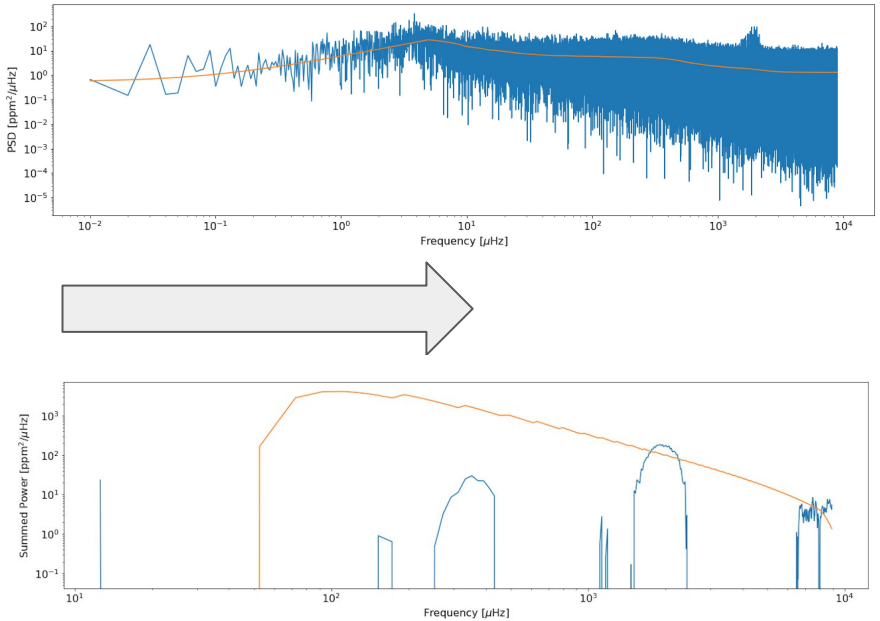
$$p(x|N) = \frac{exp(-x)}{\gamma(N)} x^{N-1}$$

H0: x = 1 + SNR

H1: x = (1 + SNR)/(1 + SNR_pred)

N: number of bins ∝ width of the envelope

$$p(H1|SNR,\theta) = \frac{p(H1)\mathcal{L}(SNR,\theta|H1)}{p(H0)\mathcal{L}(SNR|H0)+p(H1)\mathcal{L}(SNR,\theta|H1)}$$

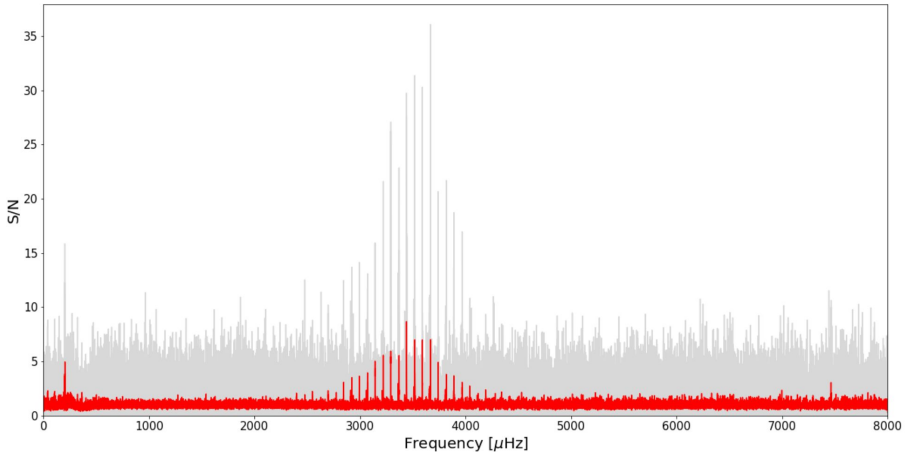


Autocorrelation Function

$$\nu_{n,\ell} \simeq \left(n + \frac{\ell}{2} + \varepsilon_0\right) \Delta\nu_0 - \ell(\ell+1)\, D_0.$$

$$C = \int_{\nu_c - \delta\nu_H}^{\nu_c + \delta\nu_H} X(\nu) X^*(\nu)\, \mathcal{F}(\nu)\, e^{i2\pi\nu\tau}\, d\nu.$$

$$\mathcal{A}^\star = \left|C(\tau)^2\right| / \left|C(0)^2\right|.$$

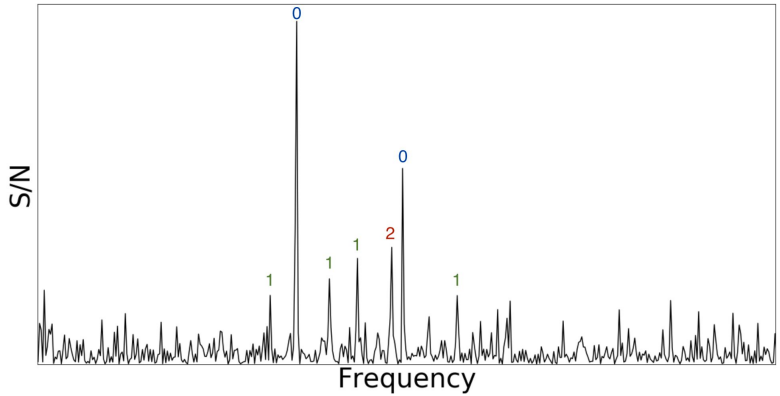


Hanning filter

The Science

Exoplanetary Science: HD 221416

- Late subgiant (spectroscopy) + warm saturn
- 6th case of planet detected around a late subgiant/early red giant
- Mean density to ~15%
- Just one sector



D. Huber et al 2019

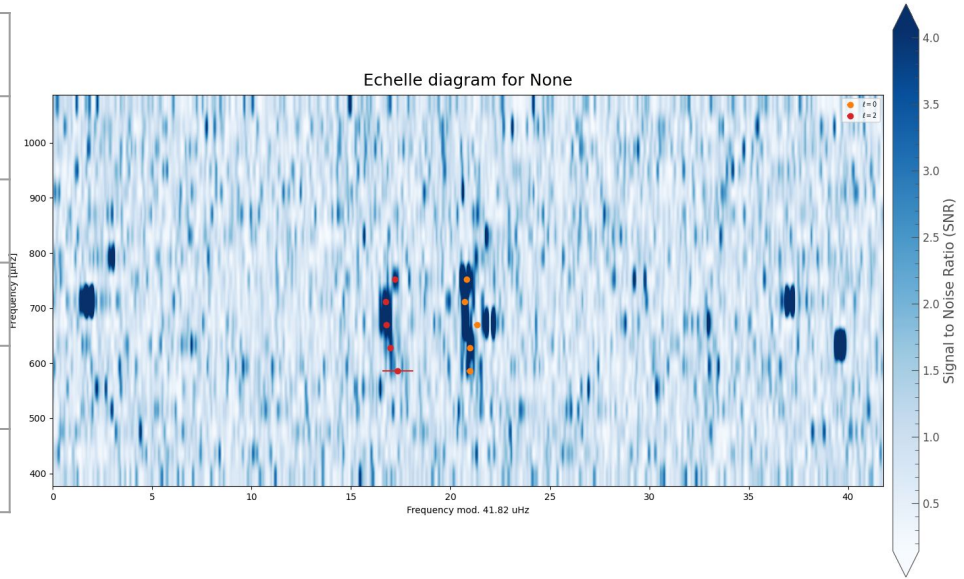
Short cadence selection criterion

- RPM
- T < 12 (all with Teff), T < 13 and Teff < 5500K
- log(g) >= 4.1
- Additional stars from cool dwarf, hot subgiant, bright star, known exoplanet and guest observer lists

Peakbagging in the CVZ

HD 40105

Element	Abundance
[Na/H]	0.15
[Mg/H]	0.16
[Al/H]	0.22
[Si/H]	0.19
[Ca/H]	0.23



References (72 between 1850 and 2021) (Total 72)

Peakbagging in the CVZ - TIC219143616

Detailed studies:

Abundances

Vsini

Chromospheric activity estimates