Exoplanets Orbiting Asteroseismic TESS Stars

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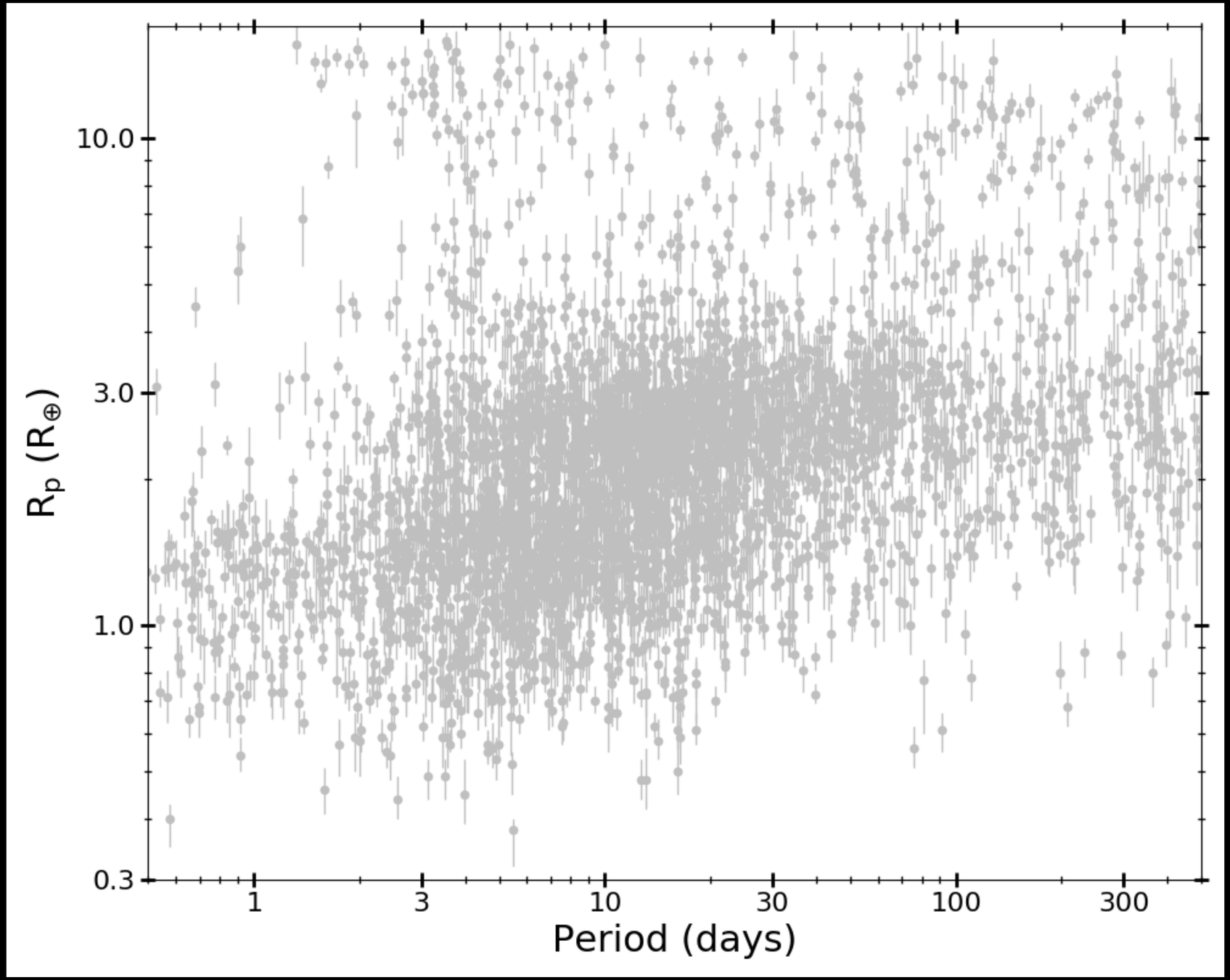
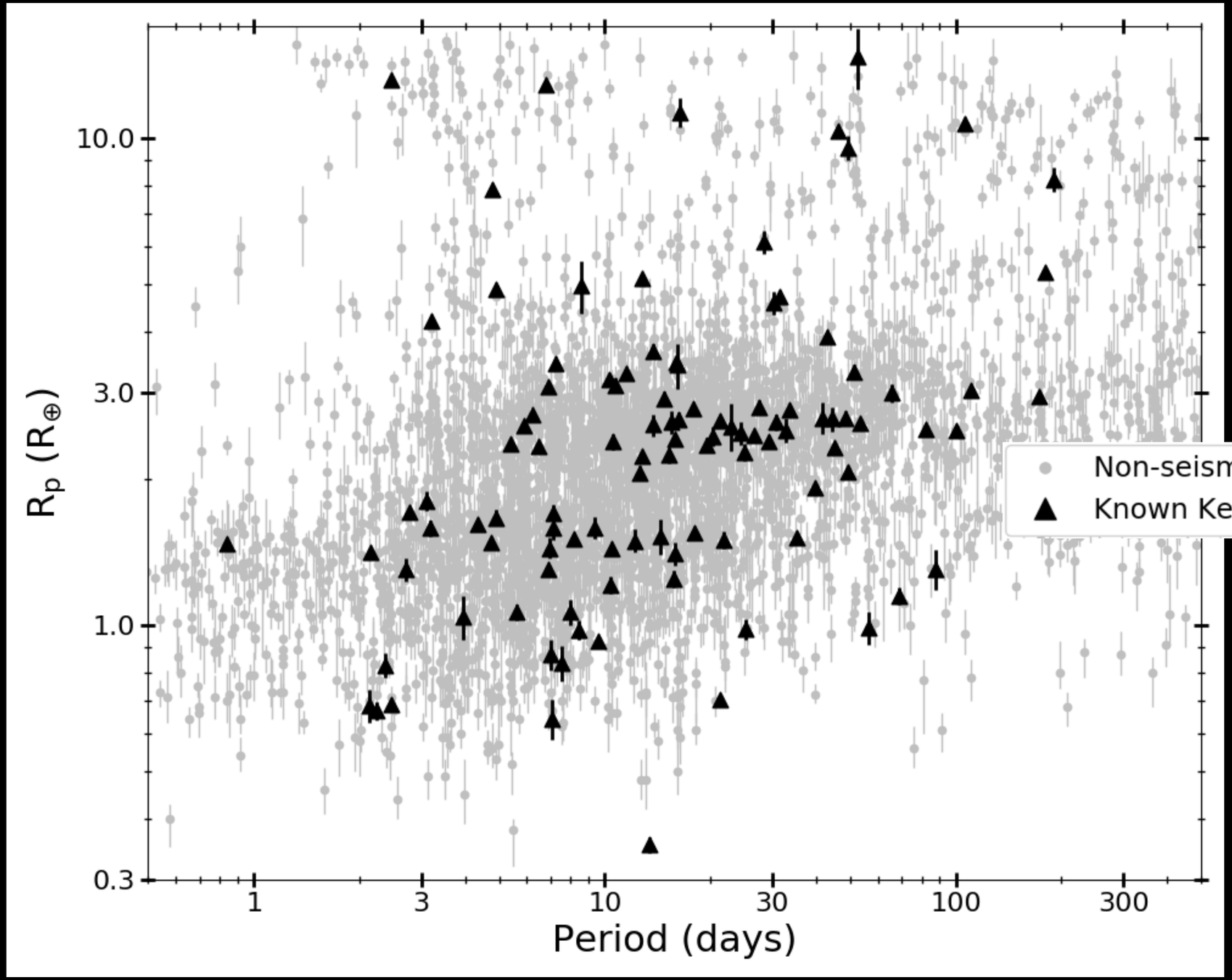
NSF GRFP Fellow

July 30, 2019

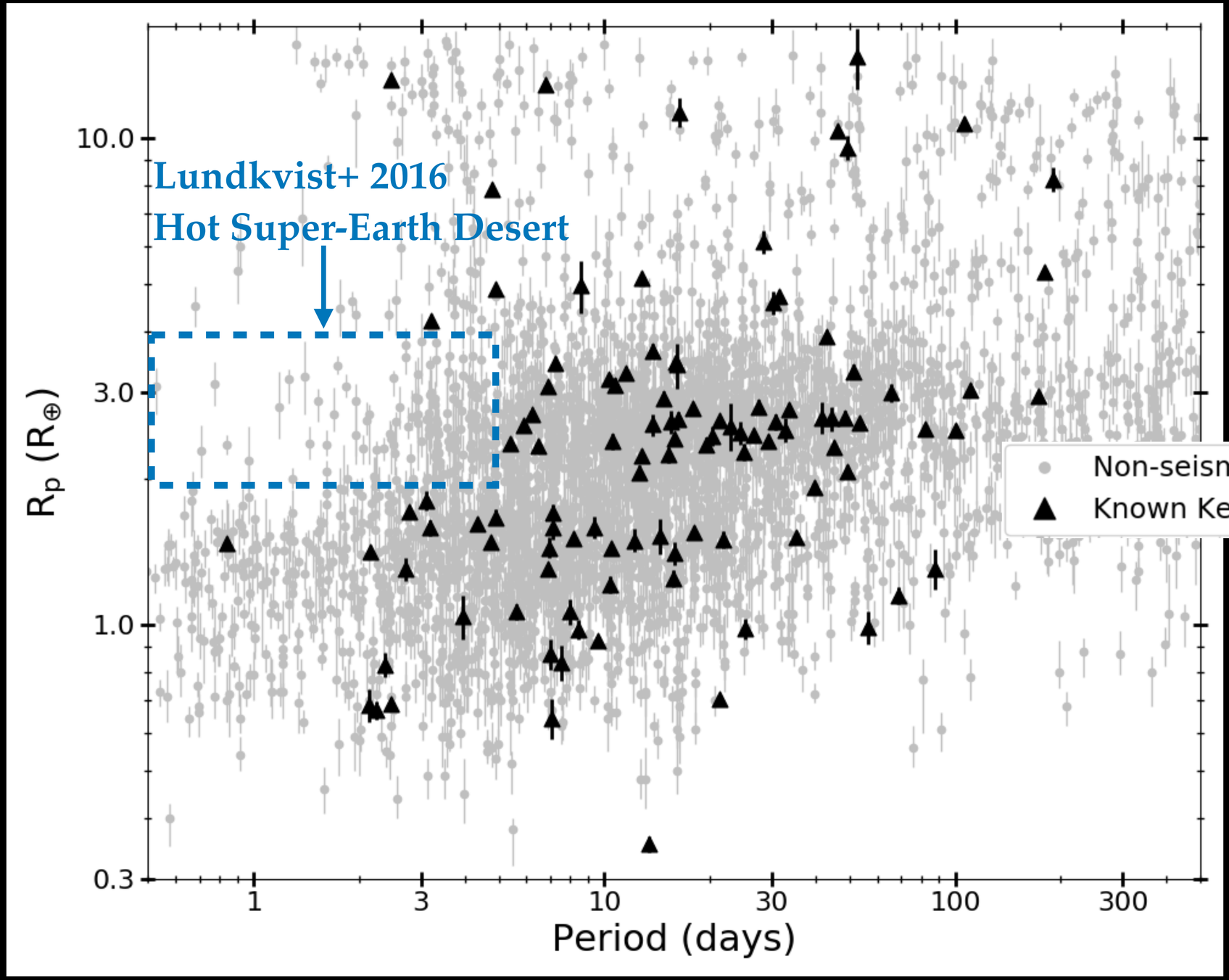
Asteroseismology to the Rescue

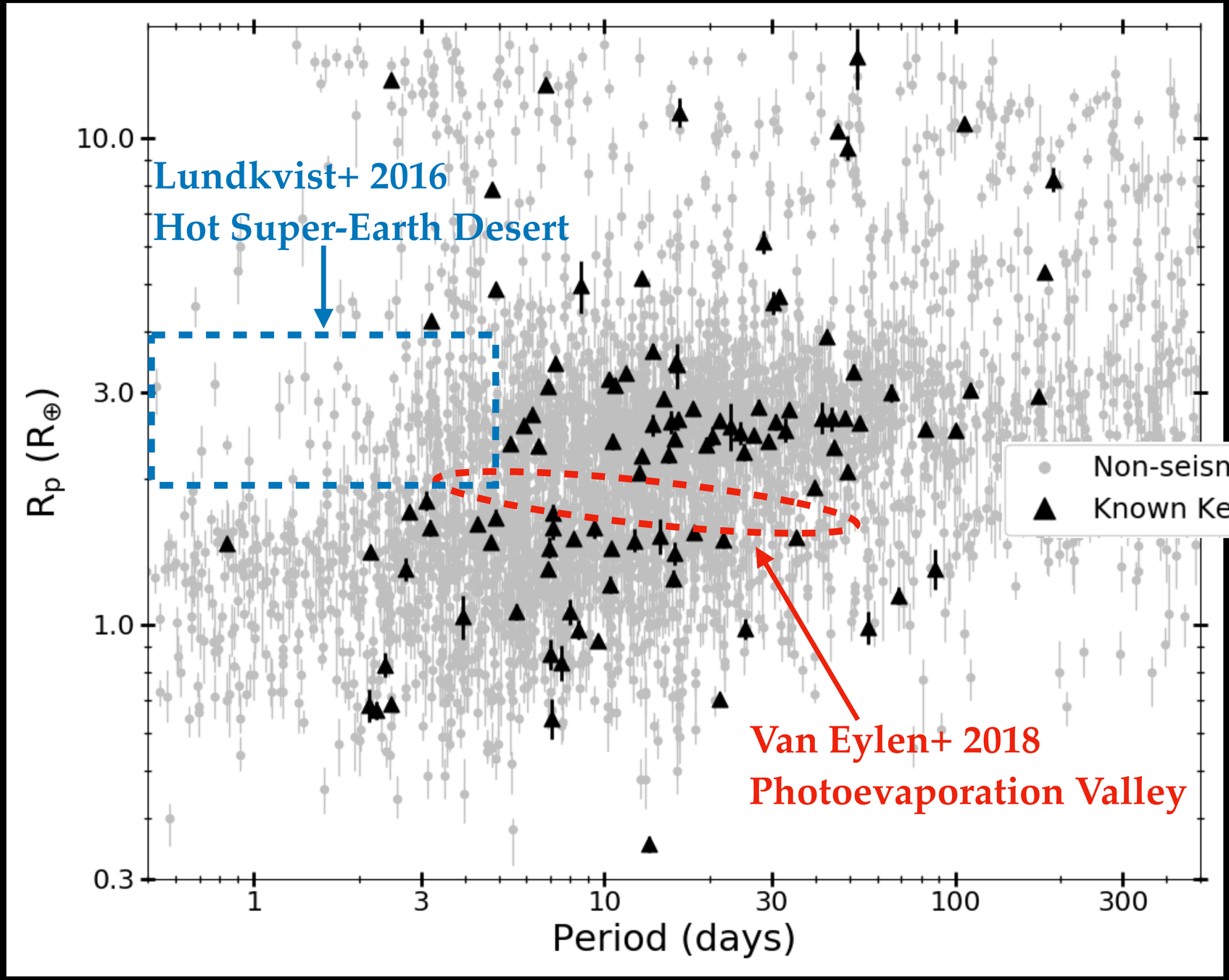


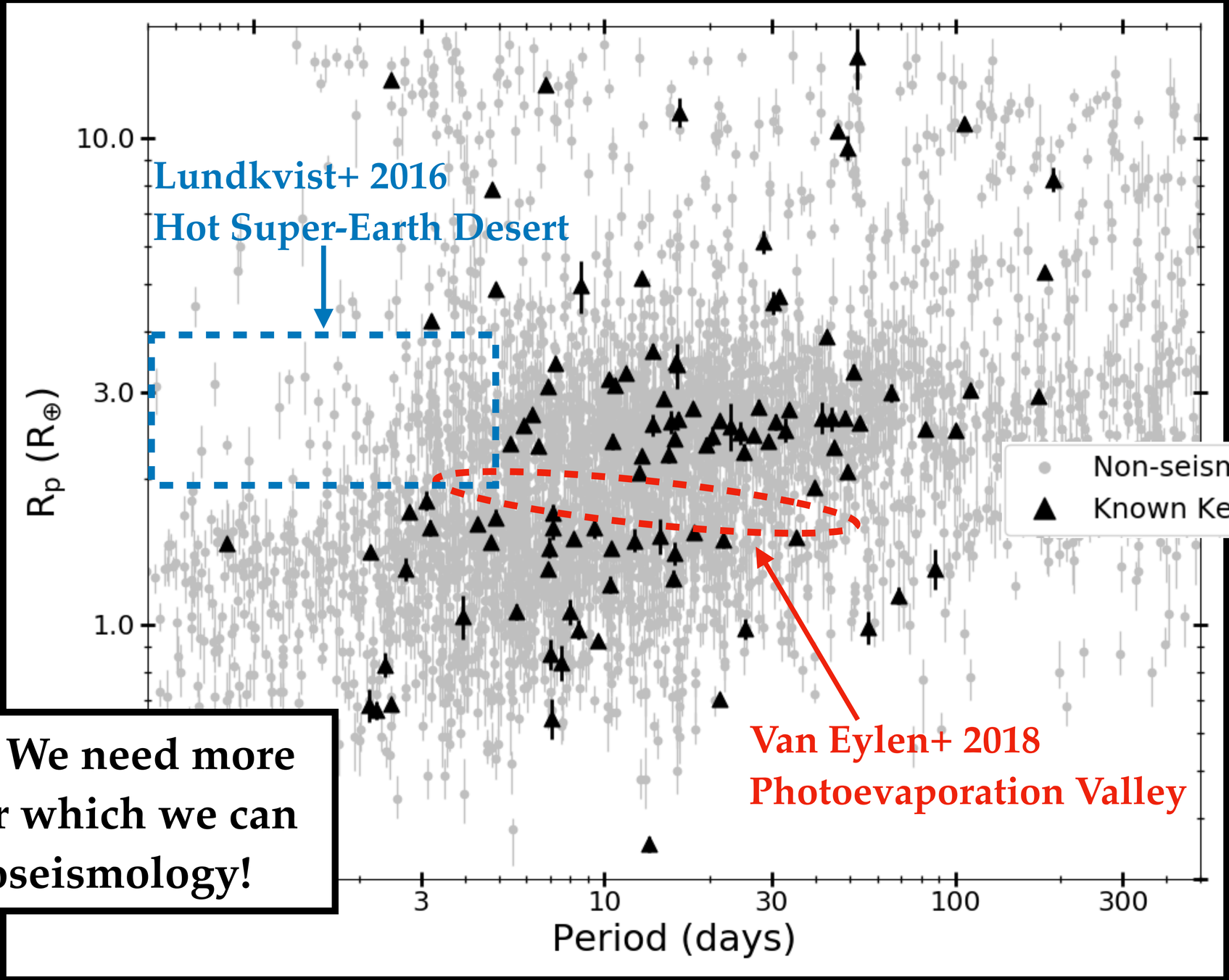
Berger+ 2018



Huber+ 2013
Lundkvist+ 2016

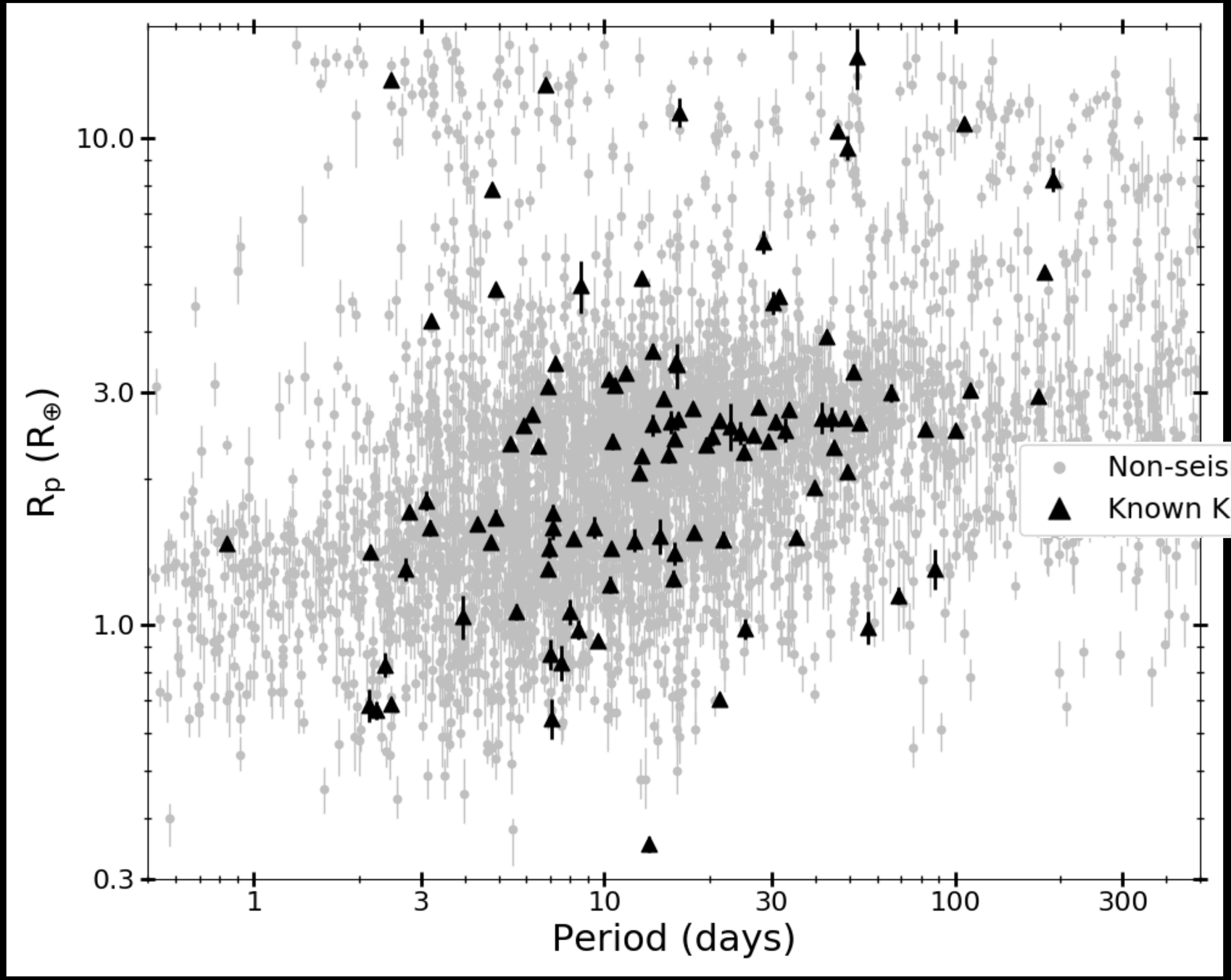

Lundkvist+ 2016
Hot Super-Earth Desert
10.0
3.0
1.0
0.3
R_p ($R_\oplus$)
1
3
10
30
100
300
Period (days)
Non-seismic hosts
Known Kepler seismic hosts


Lundkvist+ 2016
Hot Super-Earth Desert
Van Eylen+ 2018
Photoevaporation Valley
Non-seismic hosts
Known Kepler seismic hosts
R_p ($R_\oplus$)
10.0
3.0
1.0
0.3
1
3
10
30
100
300
Period (days)



Takeaway: We need more systems for which we can do asteroseismology!

Kepler


10.0
3.0
1.0
0.3
R_p ($R_\oplus$)
1
3
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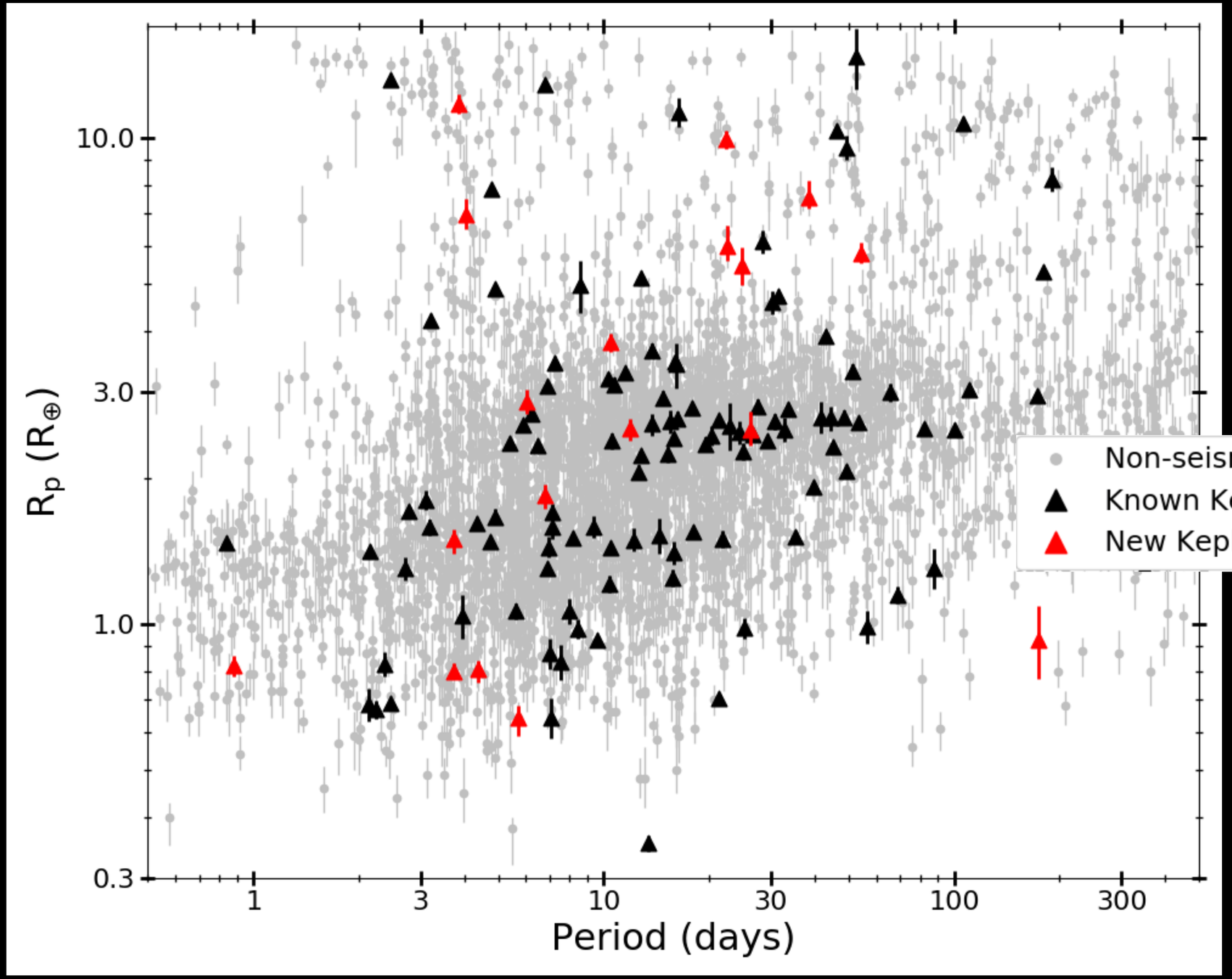
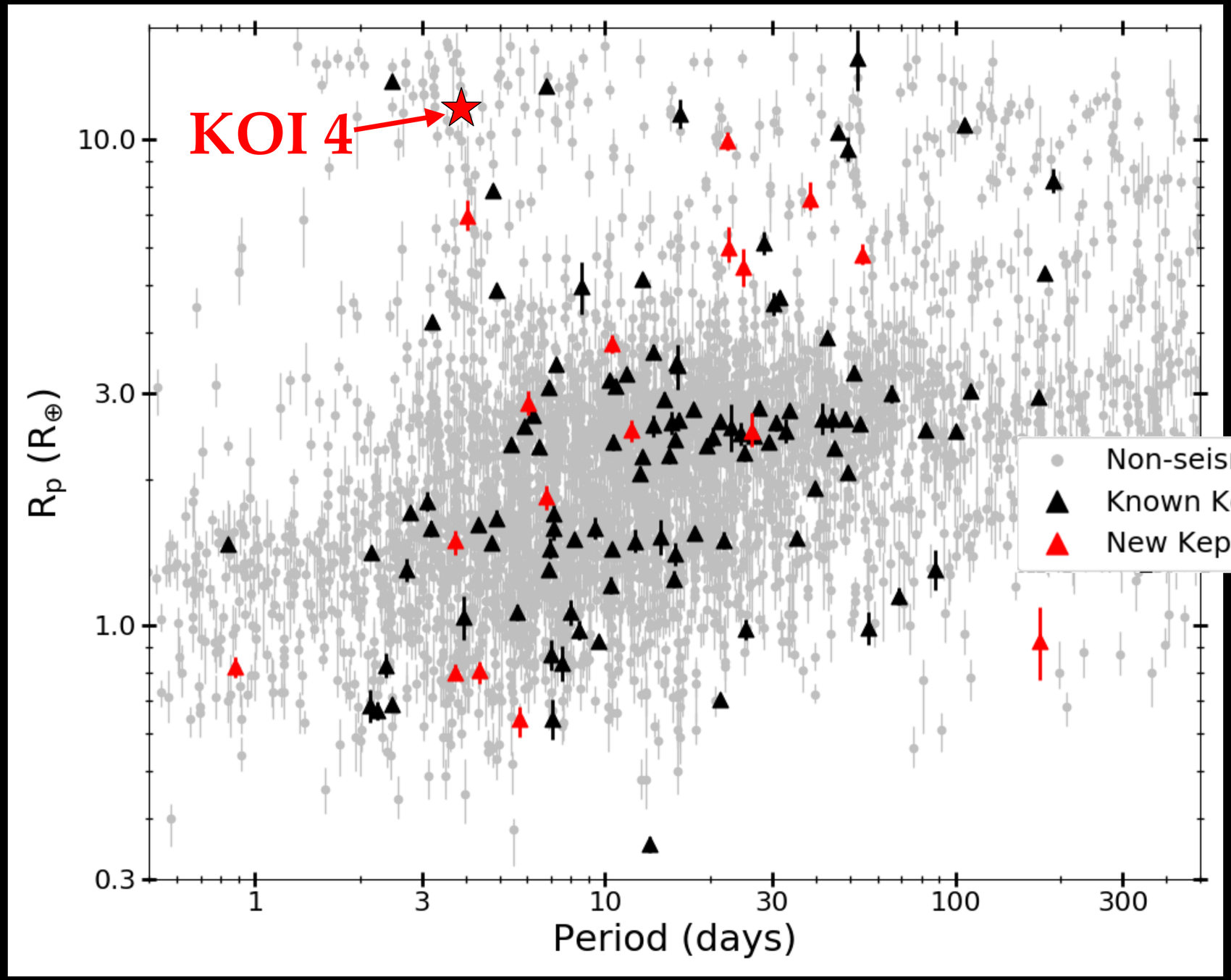
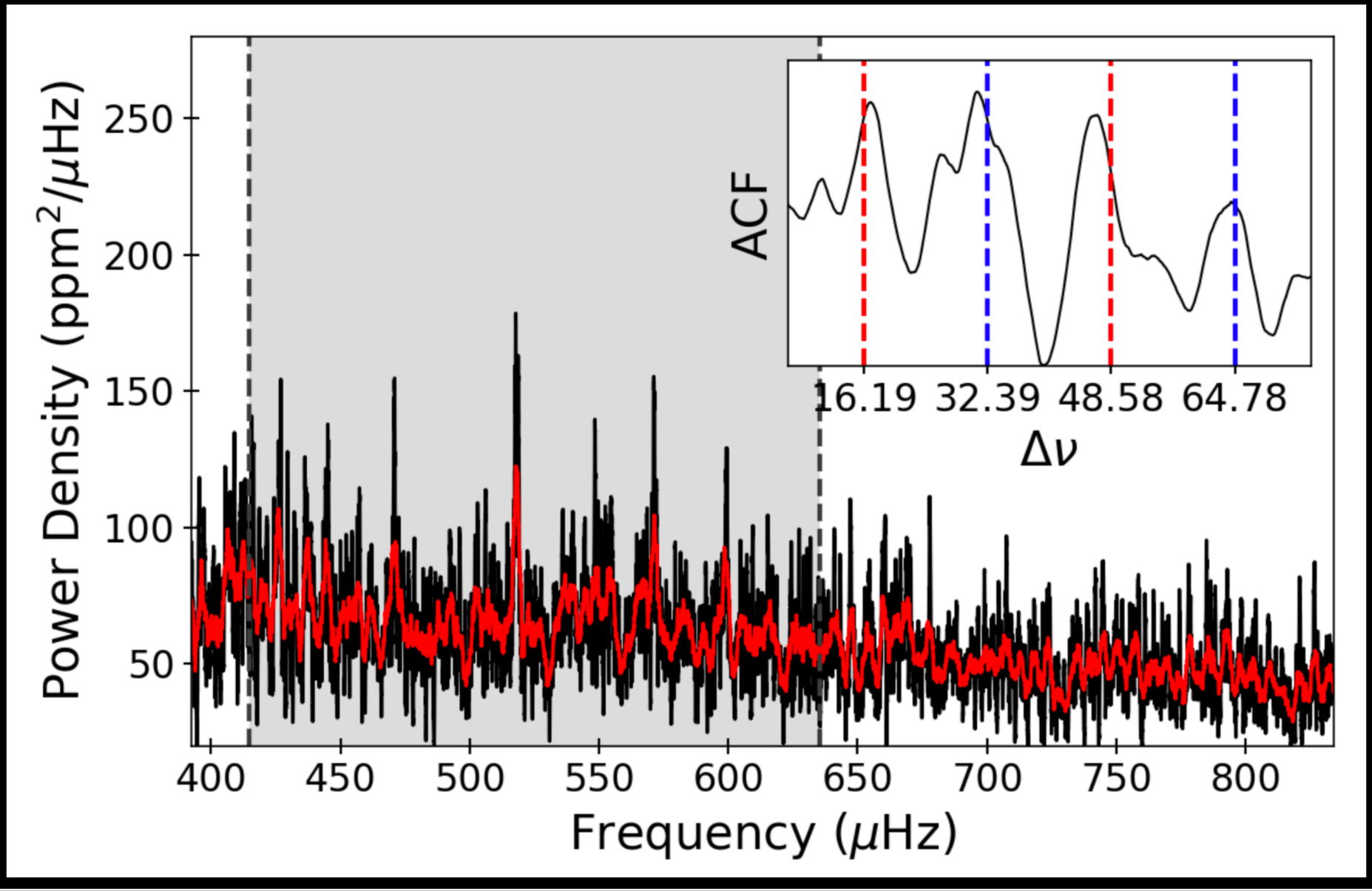
30
100
300
Period (days)
Non-seismic hosts
Known Kepler seismic hosts


10.0
3.0
1.0
0.3
R_p ($R_\oplus$)
1
3
10
30
100
300
Period (days)
Non-seismic hosts
Known Kepler seismic hosts
New Kepler seismic hosts

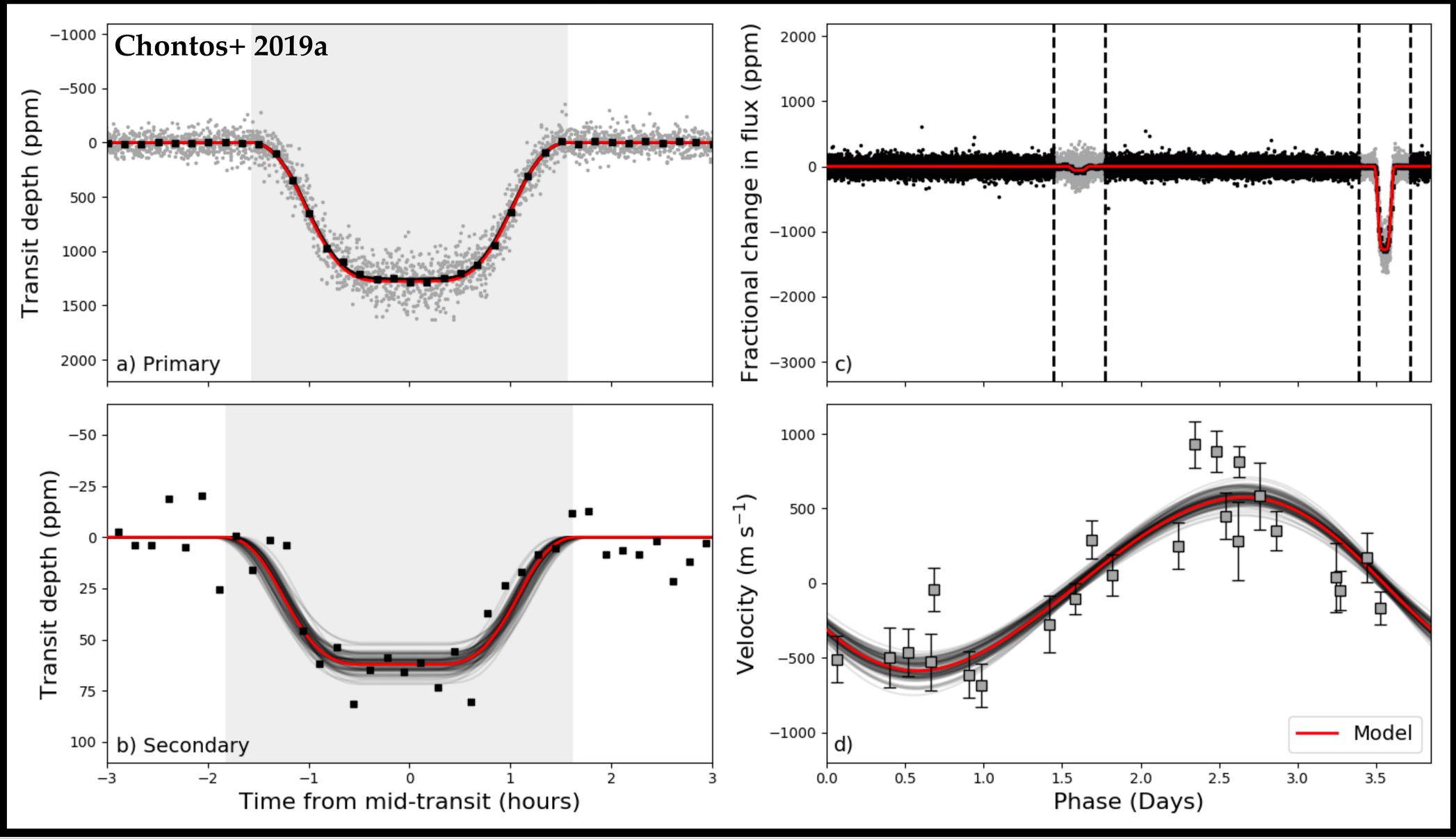

KOI 4
10.0
3.0
1.0
0.3
R_p ($R_\oplus$)
1
3
10
30
100
300
Period (days)
Non-seismic hosts
Known Kepler seismic hosts
New Kepler seismic hosts

KOI 4: *Kepler's* First Planet



Chontos+ 2019a

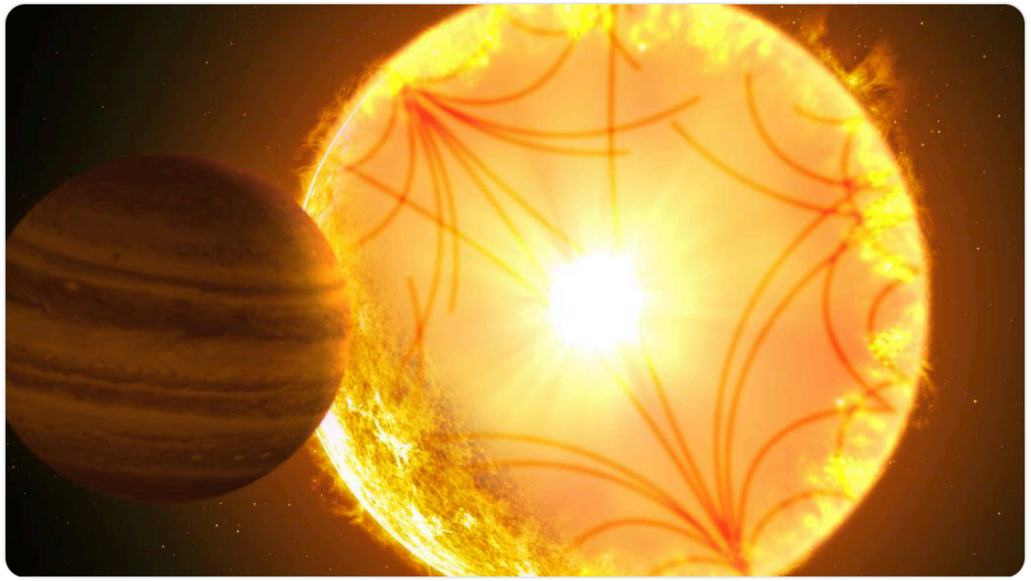
KOI 4: *Kepler's* First Planet



NASA
@NASA

Following

Despite being the 1st candidate planet discovered by the @NASAKepler telescope, Kepler-1658b had a rocky road to confirmation. 10 years later, scientists have now confirmed that it is, in fact, a planet. It whips around its star every 3.85 days. Info: go.nasa.gov/2TvTbKh

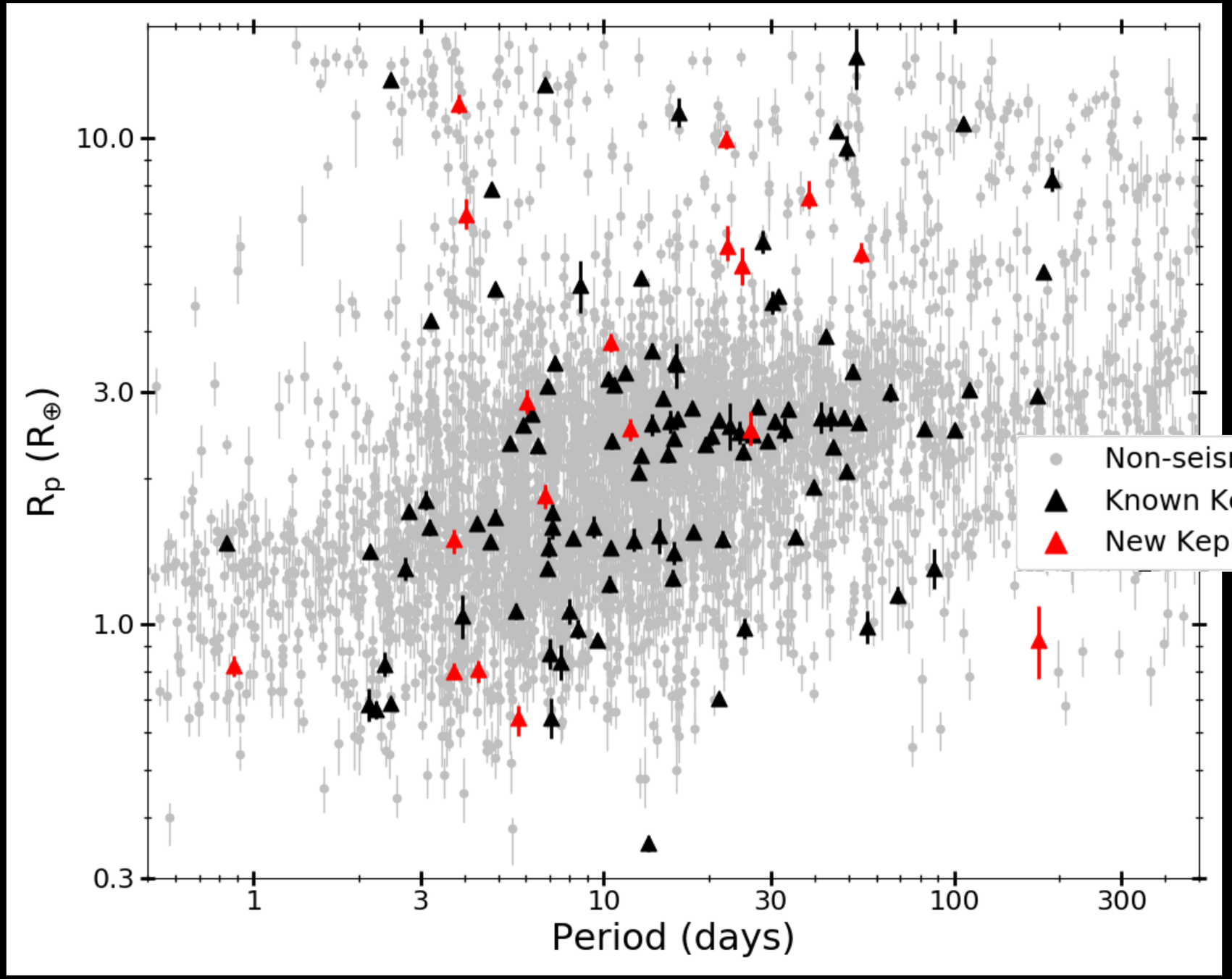


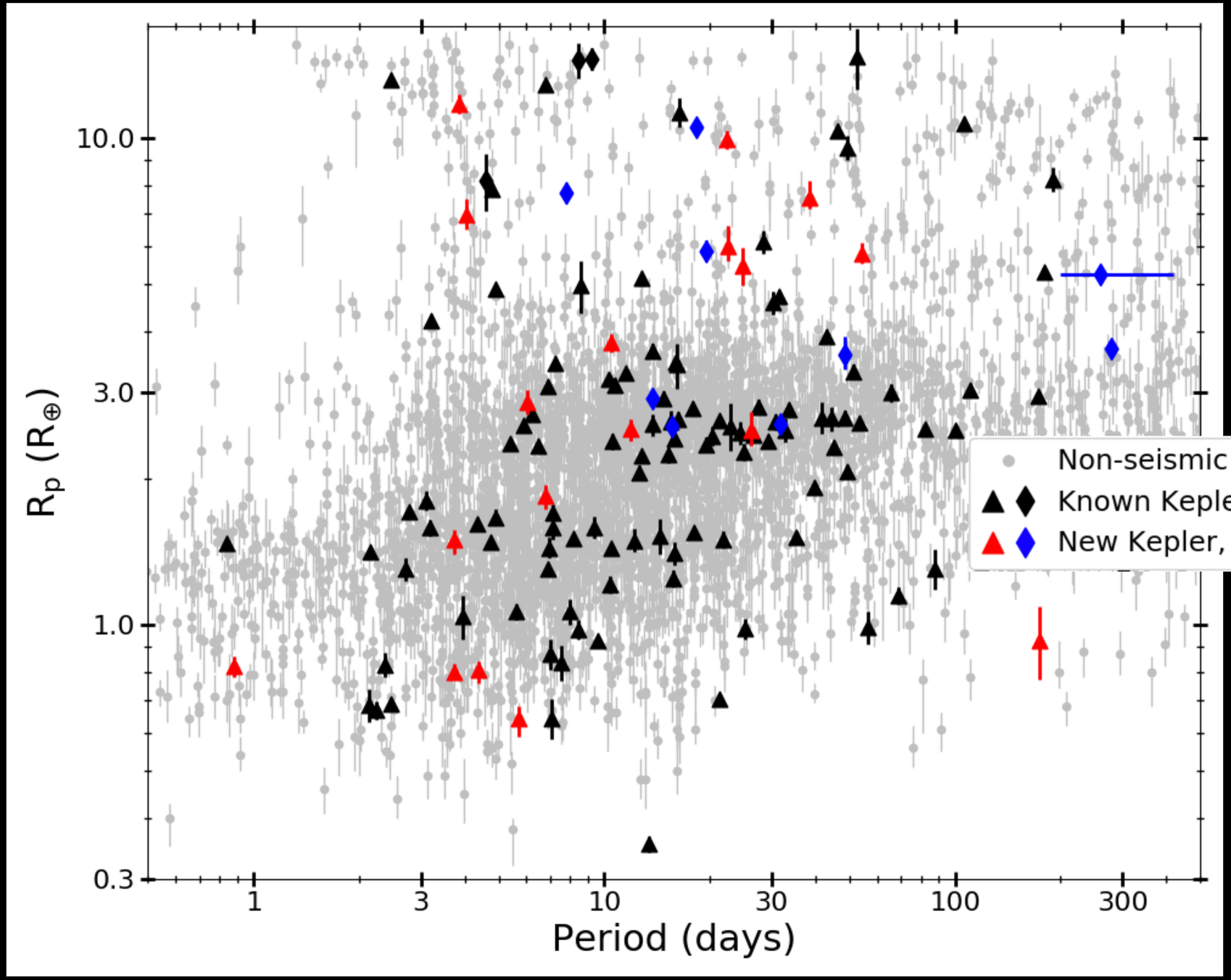
5:51 PM - 5 Mar 2019

592 Retweets **3,049** Likes

56 592 3.0K

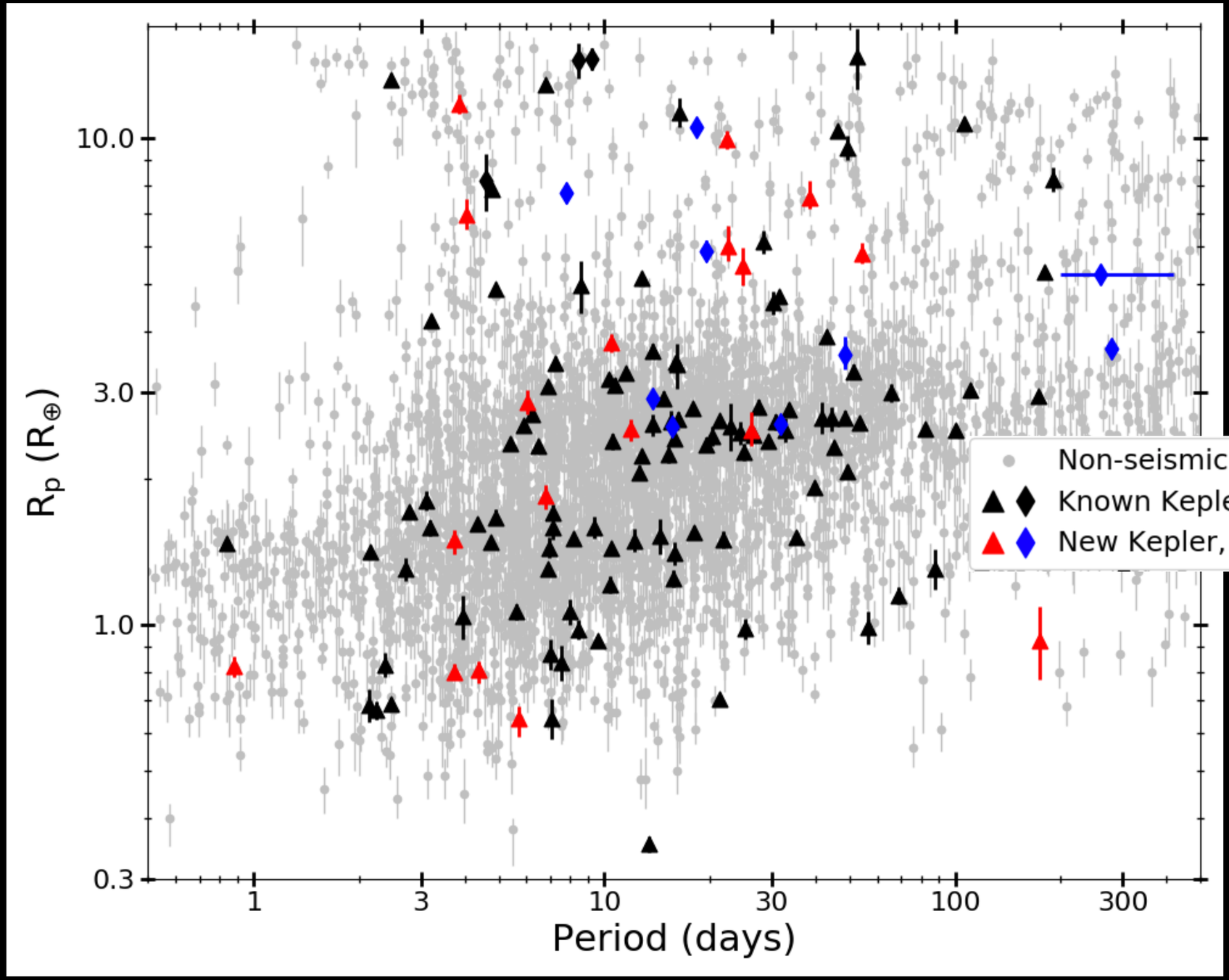
K2


10.0
3.0
1.0
0.3
R_p ($R_\oplus$)
1
3
10
30
100
300
Period (days)
Non-seismic hosts
Known Kepler seismic hosts
New Kepler seismic hosts



Van Eylen+ 2016
Grunblatt+ 2016
Grunblatt+ 2017

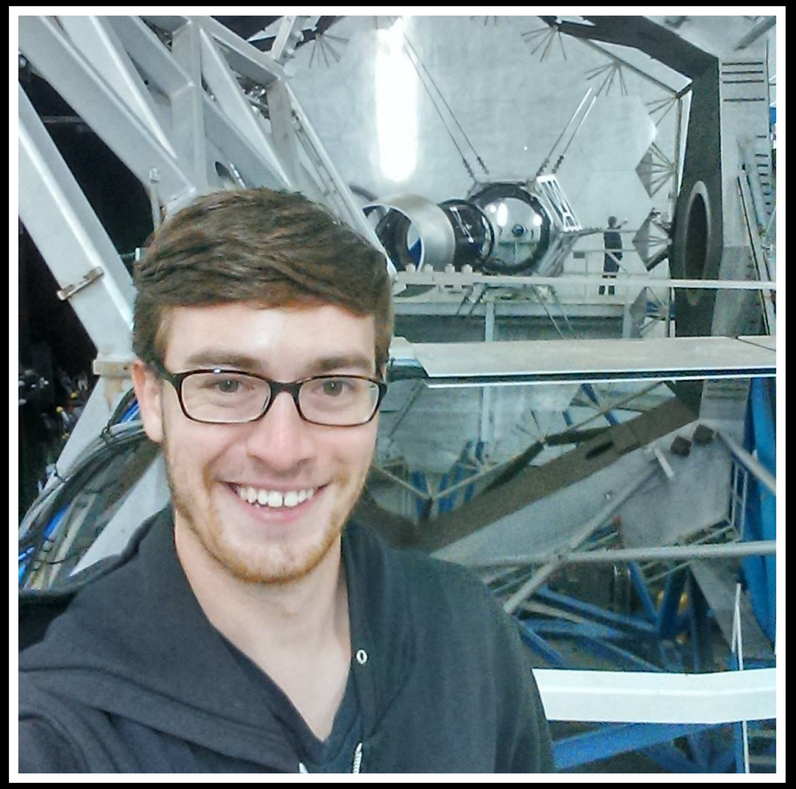
K2-93
K2-99
K2-196
K2-236
+ some interesting candidates



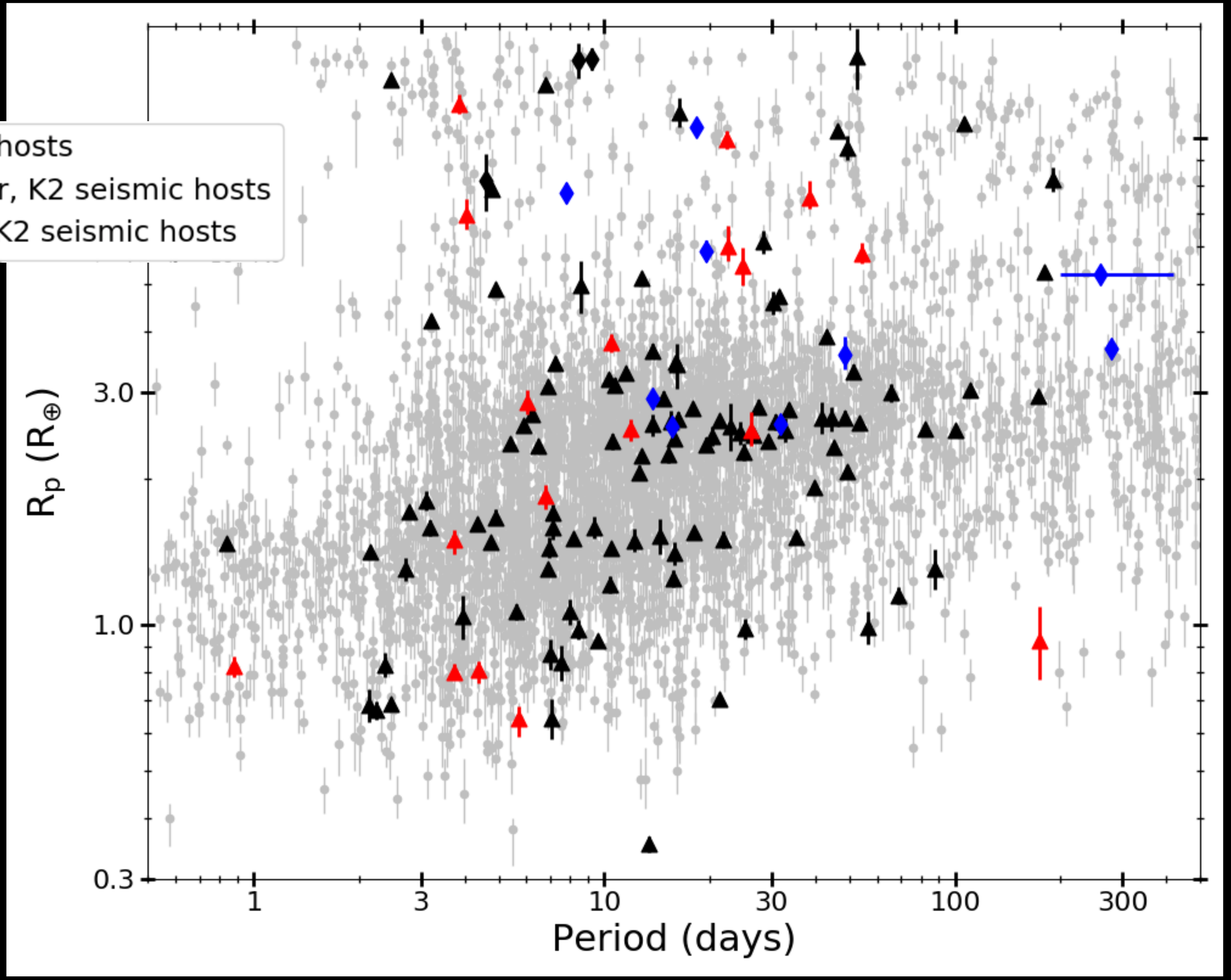
TESS

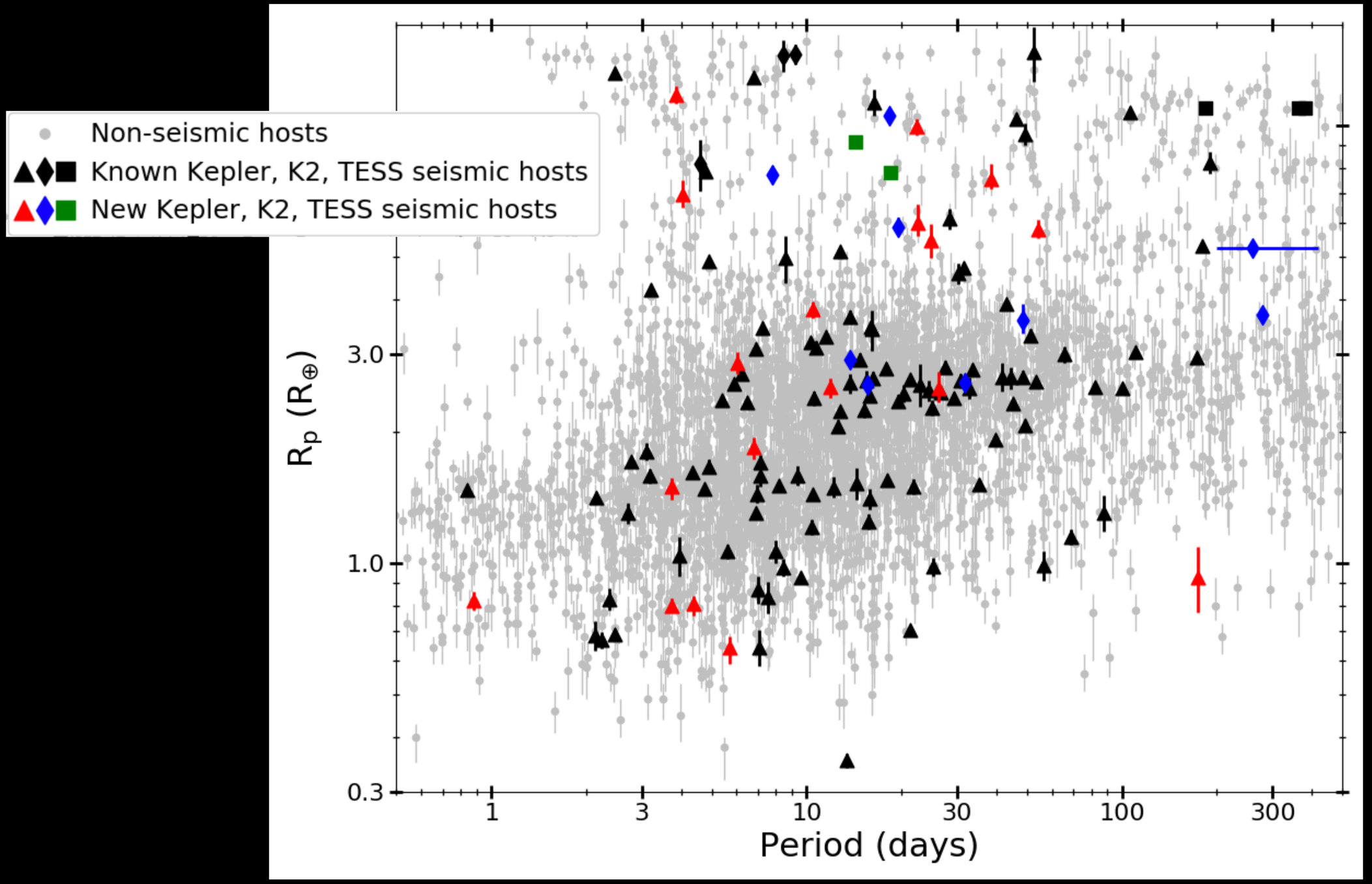
Sam Grunblatt

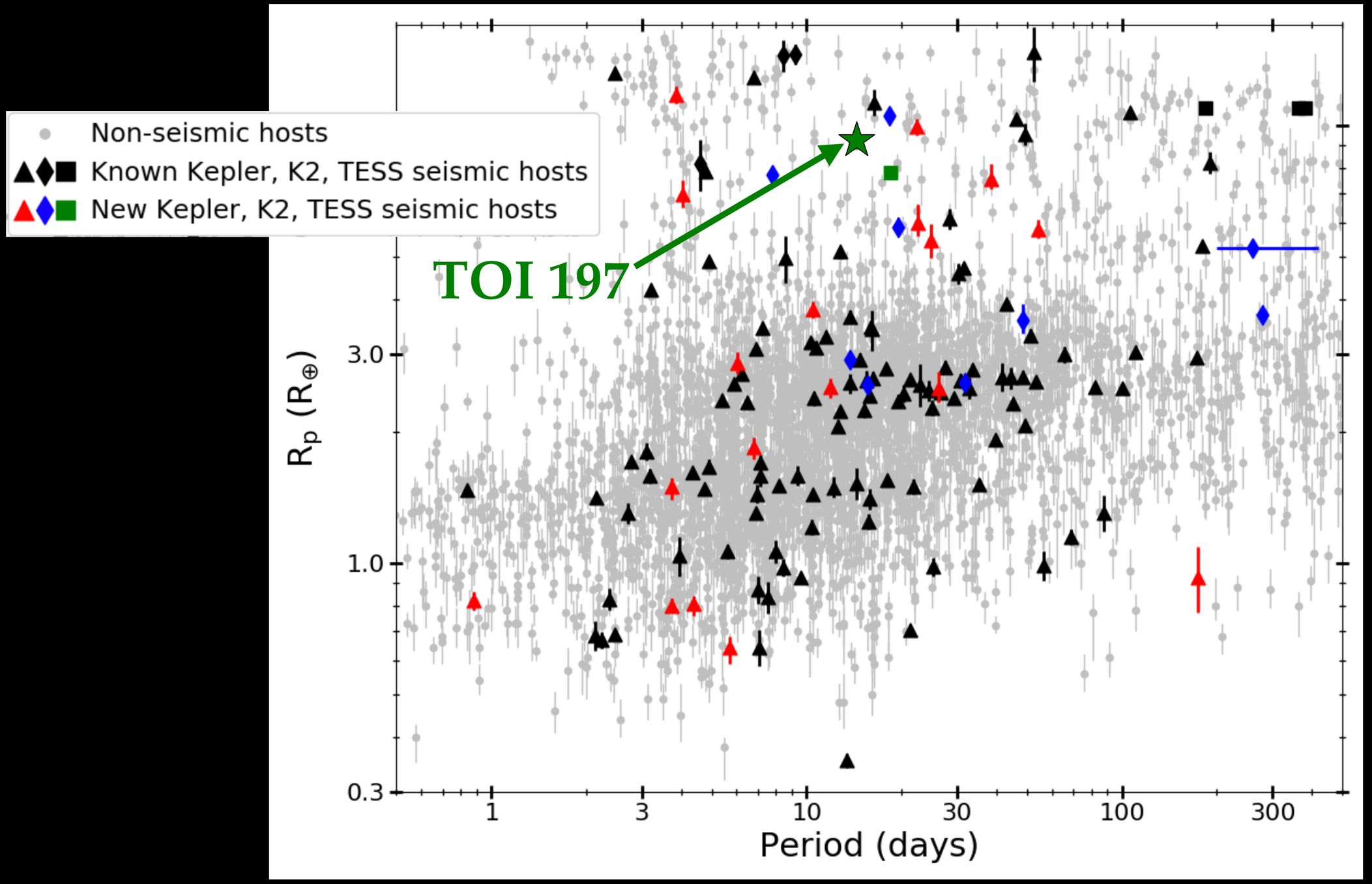
For planets orbiting TESS asteroseismic giants



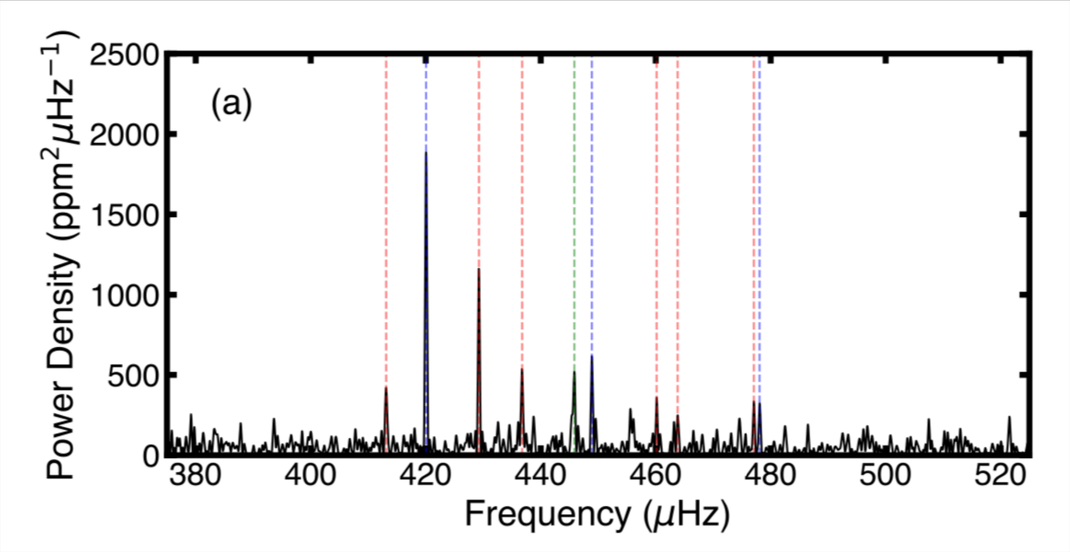
Poster 88


Non-seismic hosts
Known Kepler, K2 seismic hosts
New Kepler, K2 seismic hosts
R_p ($R_\oplus$)
3.0
1.0
0.3
1
3
10
30
100
300
Period (days)


Non-seismic hosts
Known Kepler, K2, TESS seismic hosts
New Kepler, K2, TESS seismic hosts
R_p ($R_\oplus$)
3.0
1.0
0.3
1
3
10
30
100
300
Period (days)


Non-seismic hosts
Known Kepler, K2, TESS seismic hosts
New Kepler, K2, TESS seismic hosts
TOI 197
R_p ($R_\oplus$)
3.0
1.0
0.3
1
3
10
30
100
300
Period (days)

TOI 197: First TESS Seismic Host



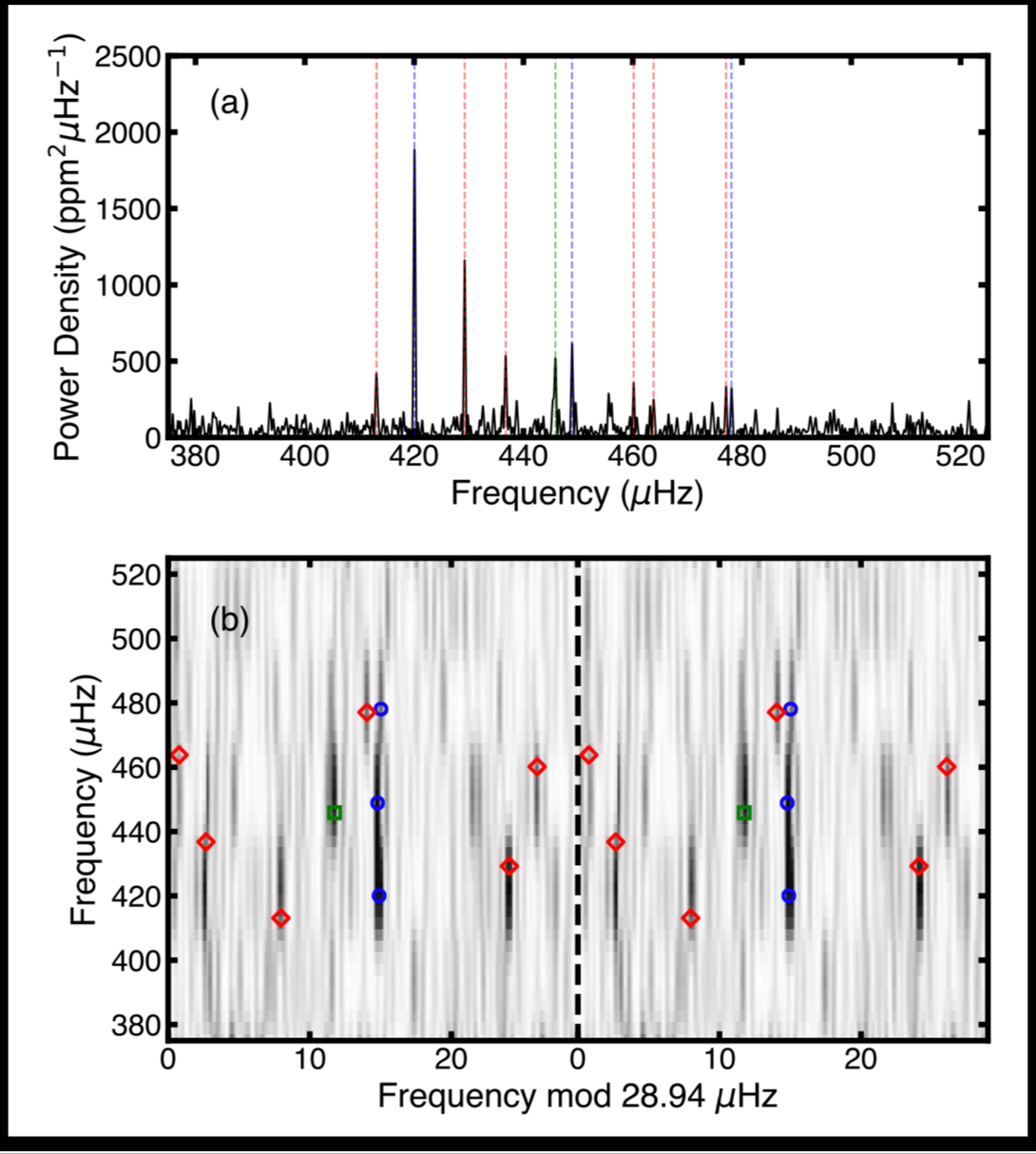
Huber, Chaplin, Chontos+ 2019

TOI 197: First TESS Seismic Host

A HOT SATURN ORBITING AN OSCILLATING LATE SUBGIANT DISCOVERED BY TESS

Daniel Huber,[1] William J. Chaplin,[2,3] Ashley Chontos,[1,4] Hans Kjeldsen,[3,5] Jørgen Christensen-Dalsgaard,[3] Timothy R. Bedding,[6,3] Warrick Ball,[2,3] Rafael Brahm,[7,8,9] Nestor Espinoza,[10] Thomas Henning,[10] Andrés Jordán,[8,9] Paula Sarkis,[10] Emil Knudstrup,[3] Simon Albrecht,[3] Frank Grundahl,[3,5] Mads Fredslund Andersen,[3] Pere L. Pallé,[11,12] Ian Crossfield,[13] Benjamin Fulton,[14] Andrew W. Howard,[15] Howard T. Isaacson,[16] Lauren M. Weiss,[1] Rasmus Handberg,[3] Mikkel N. Lund,[3] Aldo M. Serenelli,[17,18] Jakob Rørsted Mosumgaard,[3] Amalie Stokholm,[3] Allyson Bieryla,[19] Lars A. Buchhave,[20] David W. Latham,[19] Samuel N. Quinn,[19] Eric Gaidos,[21] Teruyuki Hirano,[22,1] George R. Ricker,[13] Roland K. Vanderspek,[13] Sara Seager,[13,23,24] Jon M. Jenkins,[25] Joshua N. Winn,[26] H. M. Antia,[27] Thierry Appourchaux,[28] Sarbani Basu,[29] Keaton J. Bell,[30,3] Othman Benomar,[31] Alfio Bonanno,[32] Derek L. Buzasi,[33] Tiago L. Campante,[34,35] Z. Çelik Orhan,[36] Enrico Corsaro,[32] Margarida S. Cunha,[34] Guy R. Davies,[2,3] Sebastien Deheuvels,[37] Samuel K. Grunblatt,[1] Amir Hasanzadeh,[38] Maria Pia Di Mauro,[39] Rafael A. García,[40,41] Patrick Gaulme,[30,3] Léo Girardi,[42] Joyce A. Guzik,[43] Marc Hon,[44] Chen Jiang,[45] Thomas Kallinger,[46] Steven D. Kawaler,[47] James S. Kuszlewicz,[30,3] Yveline Lebreton,[48,49] Tanda Li,[6,3] Miles Lucas,[47] Mia S. Lundkvist,[3,50] Andrew W. Mann,[51] Stéphane Mathis,[40,41] Savita Mathur,[11,12] Anwesh Mazumdar,[52] Travis S. Metcalfe,[53,54] Andrea Miglio,[2,3] Mário J. P. F. G. Monteiro,[34,35] Benoit Mosser,[48] Anthony Noll,[37] Benard Nsamba,[34,35] Jia Mian Joel Ong,[29] S. Örtel,[36] Filipe Pereira,[34,35] Pritesh Ranadive,[52] Clara Régulo,[11,12] Thaíse S. Rodrigues,[42] Ian W. Roxburgh,[55] Victor Silva Aguirre,[3] Barry Smalley,[56] Mathew Schofield,[2,3] Sérgio G. Sousa,[34] Keivan G. Stassun,[57,58] Dennis Stello,[44,6,3] Jamie Tayar,[1,59] Timothy R. White,[60] Kuldeep Verma,[3] Mathieu Vrard,[34] M. Yildiz,[36] David Baker,[61] Michaël Bazot,[31] Charles Beichmann,[62] Christoph Bergmann,[63] Lisa Bugnet,[40,41] Bryson Cale,[64] Roberto Carlino,[65] Scott M. Cartwright,[66] Jessie L. Christiansen,[62] David R. Ciardi,[62] Orlagh Creevey,[67] Jason A. Dittmann,[19] Jose-Dias Do Nascimento Jr.,[19,68] Vincent Van Eylen,[26] Gabor Fürész,[13] Jonathan Gagné,[69] Peter Gao,[16] Kosmas Gazeas,[70] Frank Giddens,[71] Oliver J. Hall,[2,3] Saskia Hekker,[30,3] Michael J. Ireland,[60] Natasha Latouf,[64] Danny LeBrun,[64] Alan M. Levine,[13] William Matzko,[64] Eva Natinsky,[61] Emma Page,[61] Peter Plavchan,[64] Masoud Mansouri-Samani,[65] Sean McCauliff,[72] Susan E. Mullally,[73] Brendan Orenstein,[60] Aylin Garcia Soto,[23] Martin Paegert,[19] Jennifer L. van Saders,[1] Chloe Schnaible,[61] David R. Soderblom,[73] Róbert Szabó,[74,75] Angelle Tanner,[76] C. G. Tinney,[63] Johanna Teske,[69,77,59] Alexandra Thomas,[2,3] Regner Trampedach,[53,3] Duncan Wright,[78] Thomas T. Yuan,[61] and Farzaneh Zohrabi[76]

TOI 197: First TESS Seismic Host



Huber, Chaplin, Chontos+ 2019

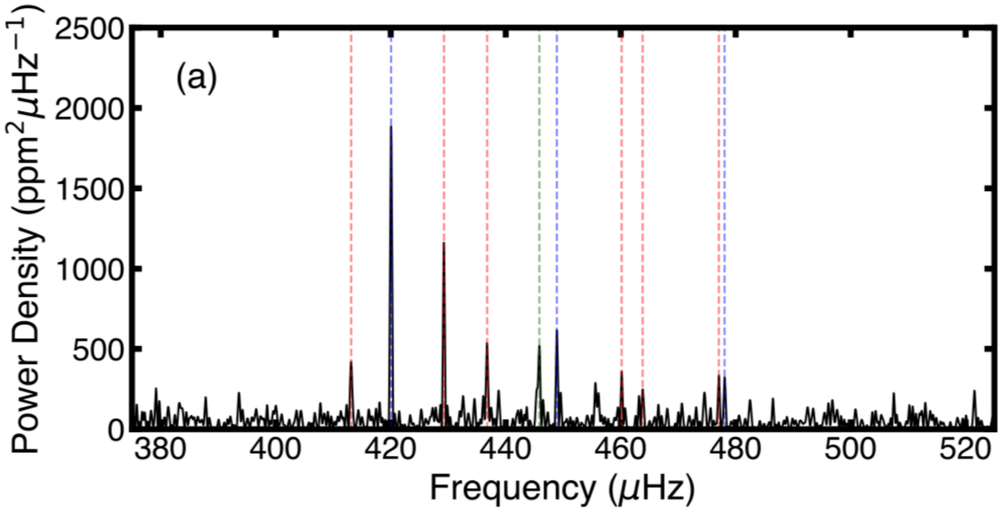
$\log g = 3.584 \pm 0.010$ cgs

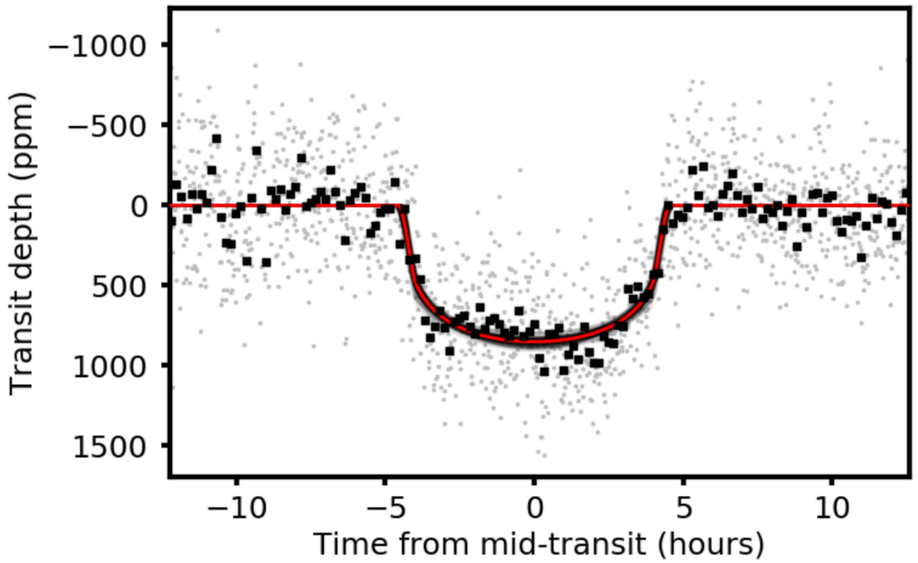
$R_\star = 2.943 \pm 0.064\ R_\odot$

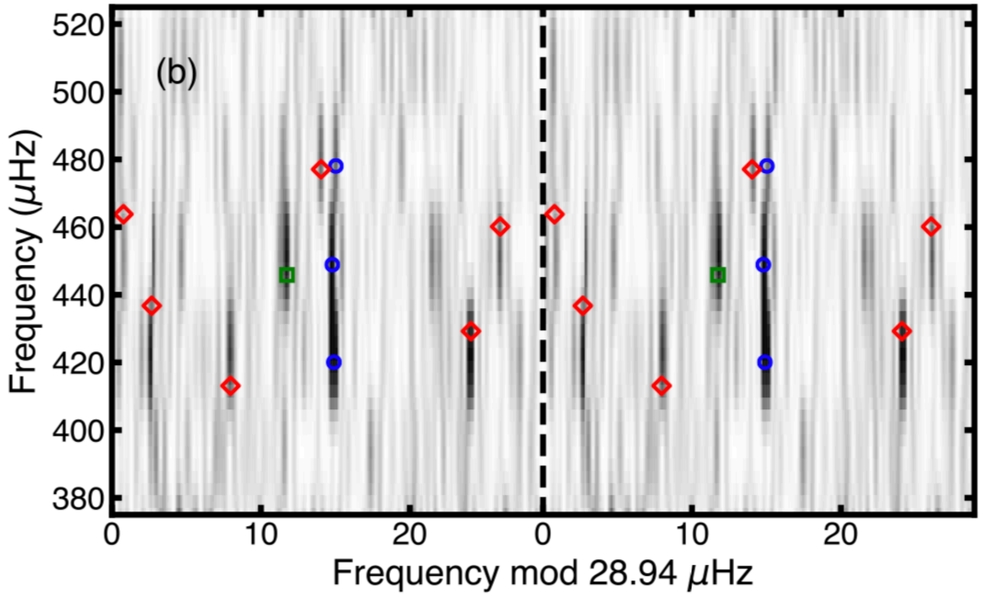
$M_\star = 1.212 \pm 0.074\ M_\odot$

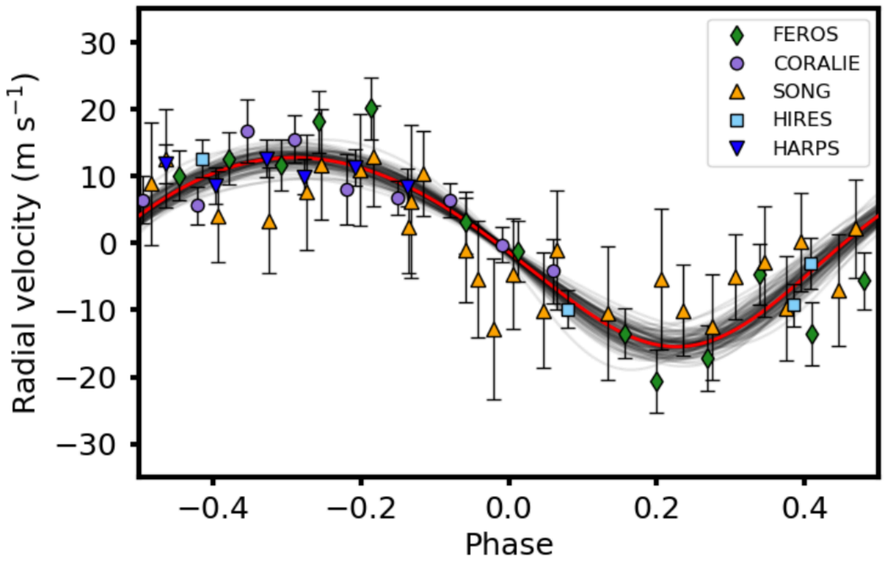
$t = 4.9 \pm 1.1$ Gyr

TOI 197: First TESS Seismic Host

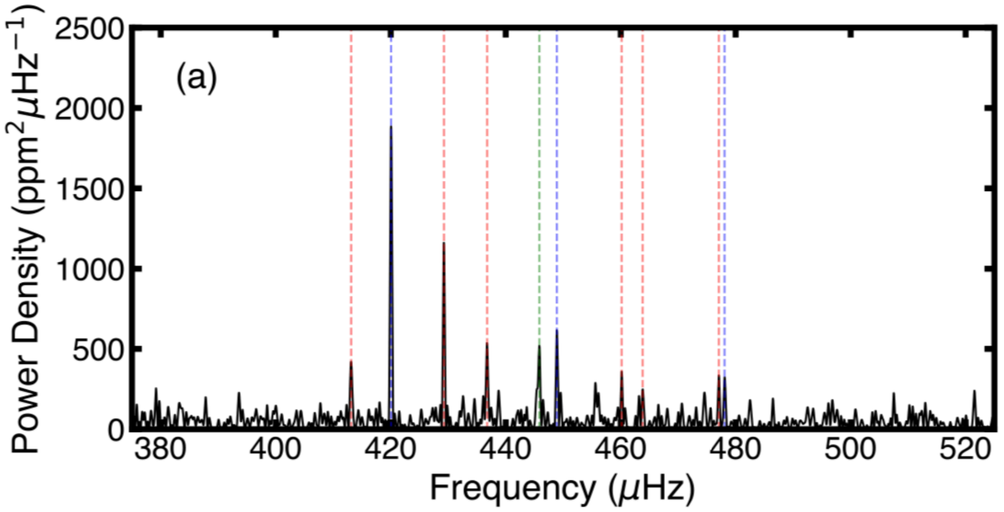


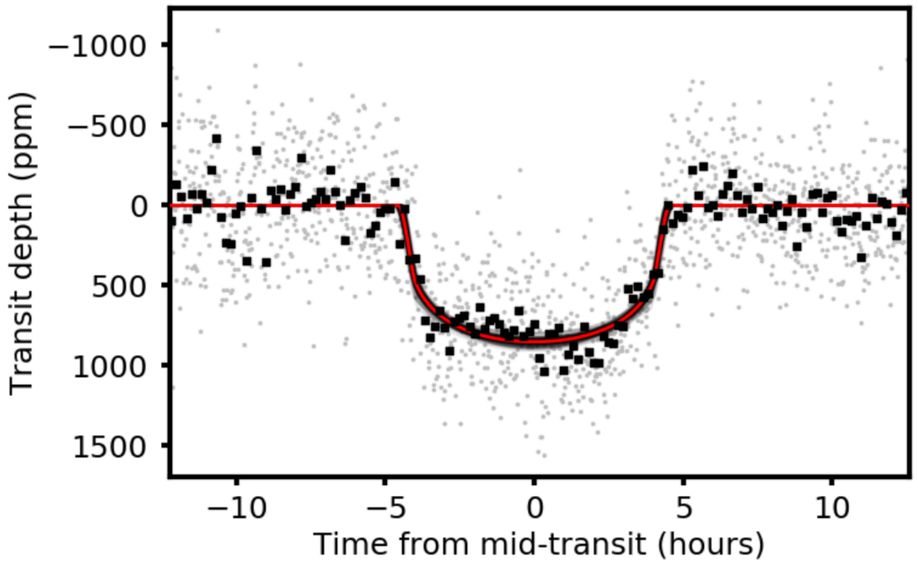


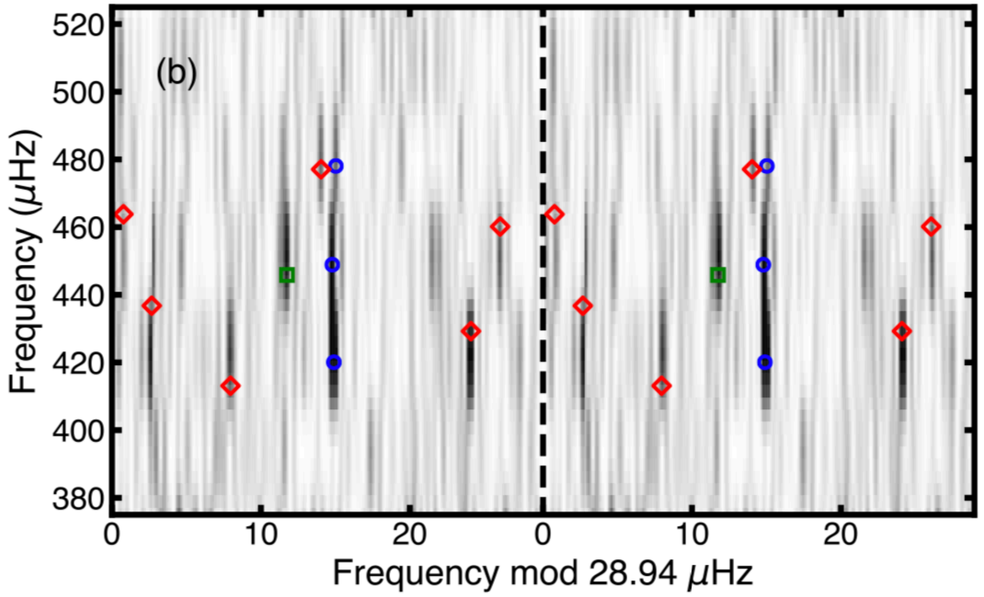


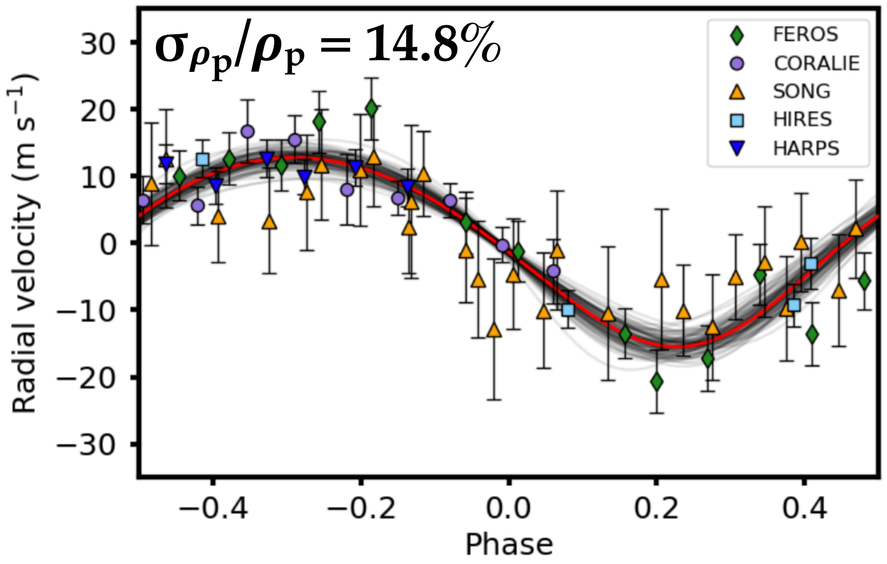


TOI 197: First TESS Seismic Host









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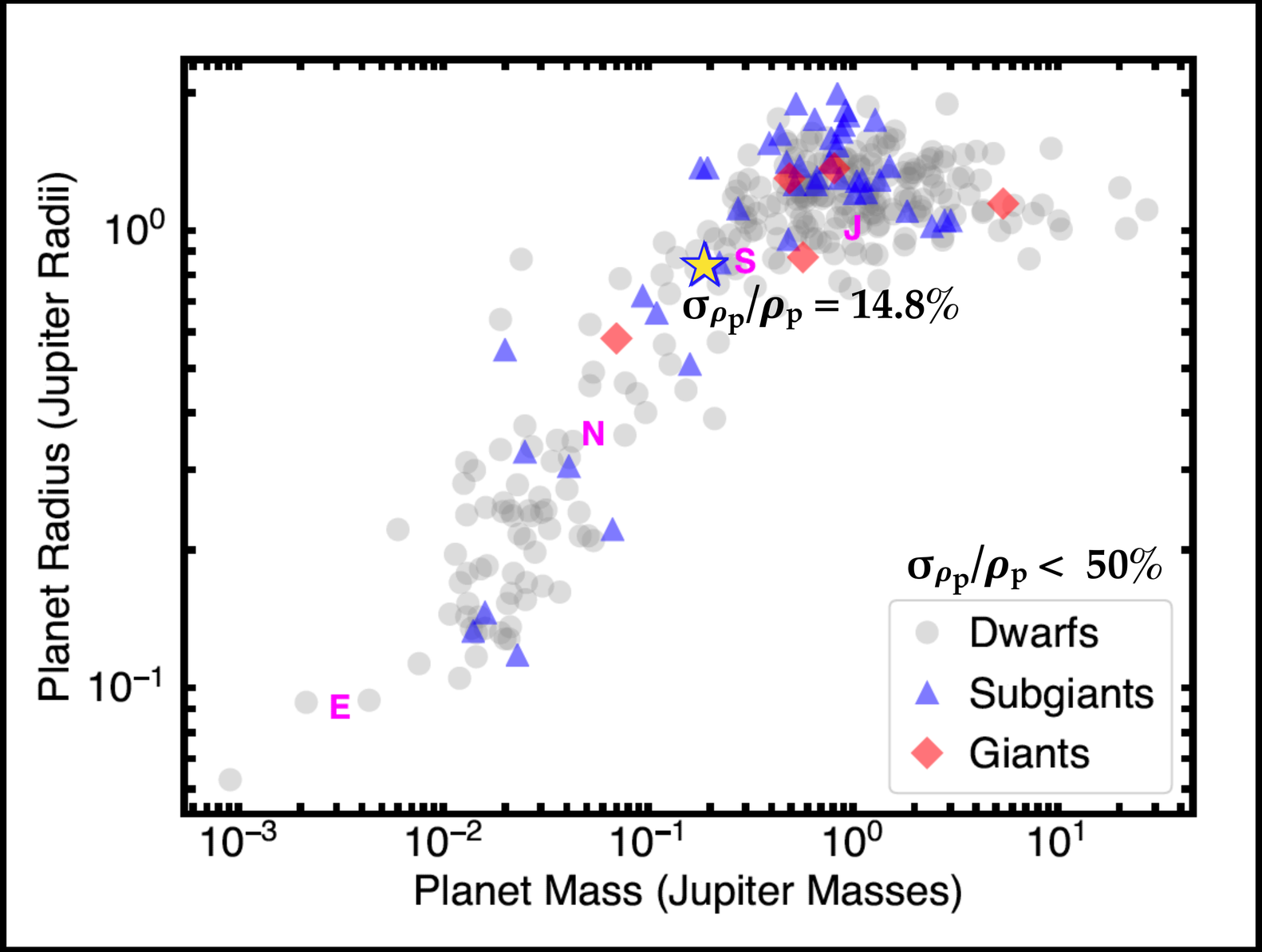
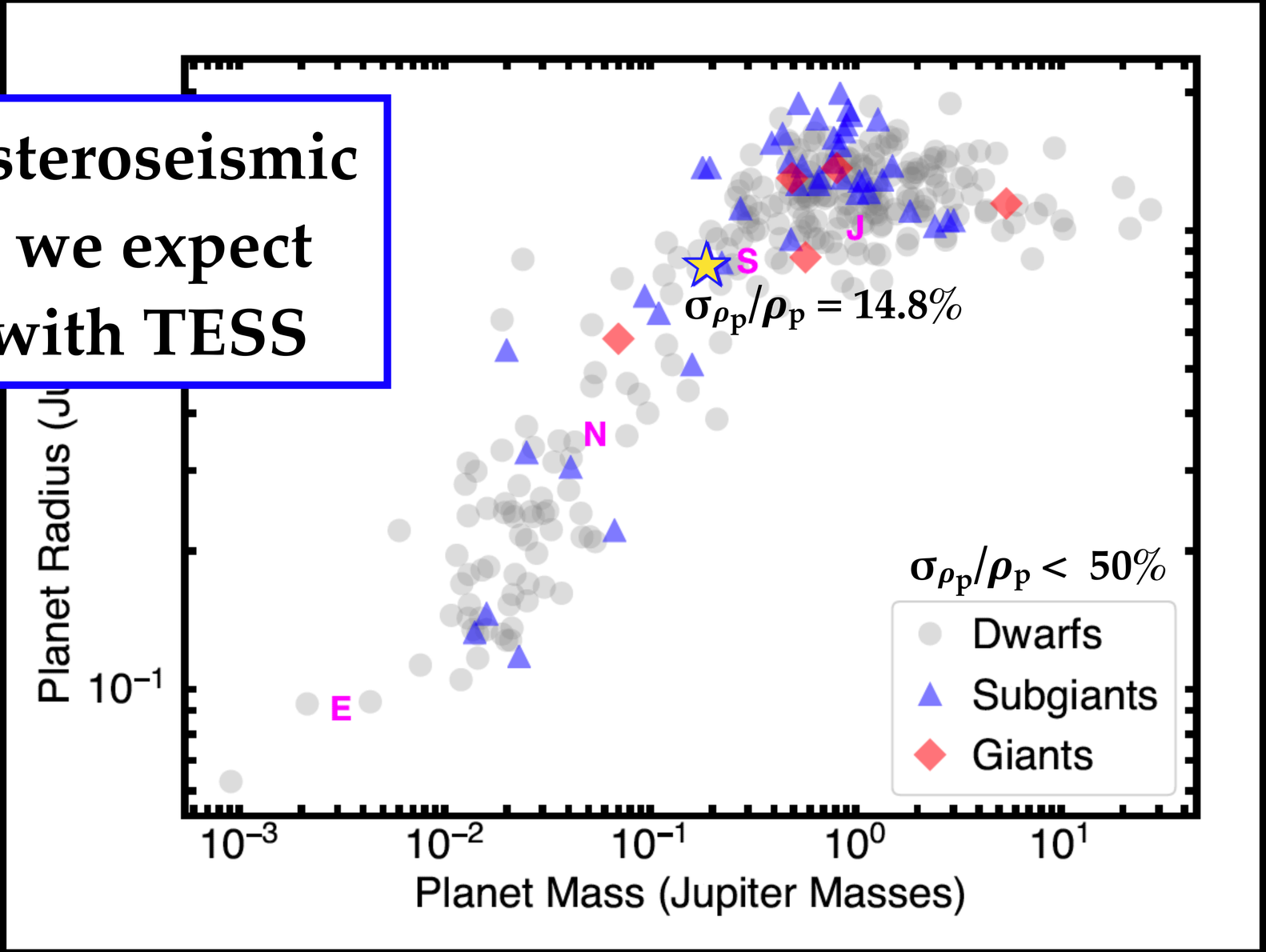


TOI 197: First TESS Seismic Host

Typical asteroseismic systems we expect to find with TESS



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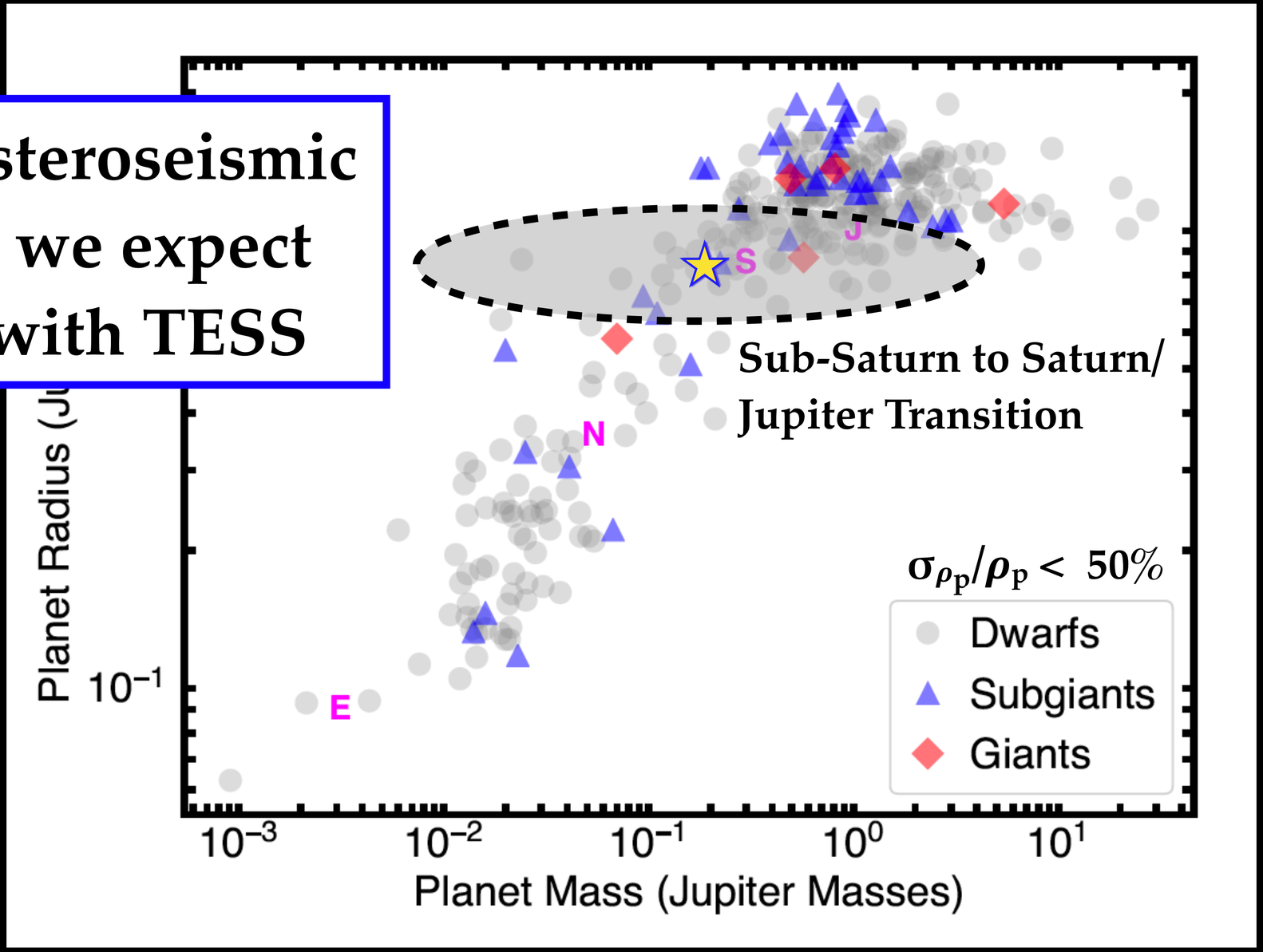
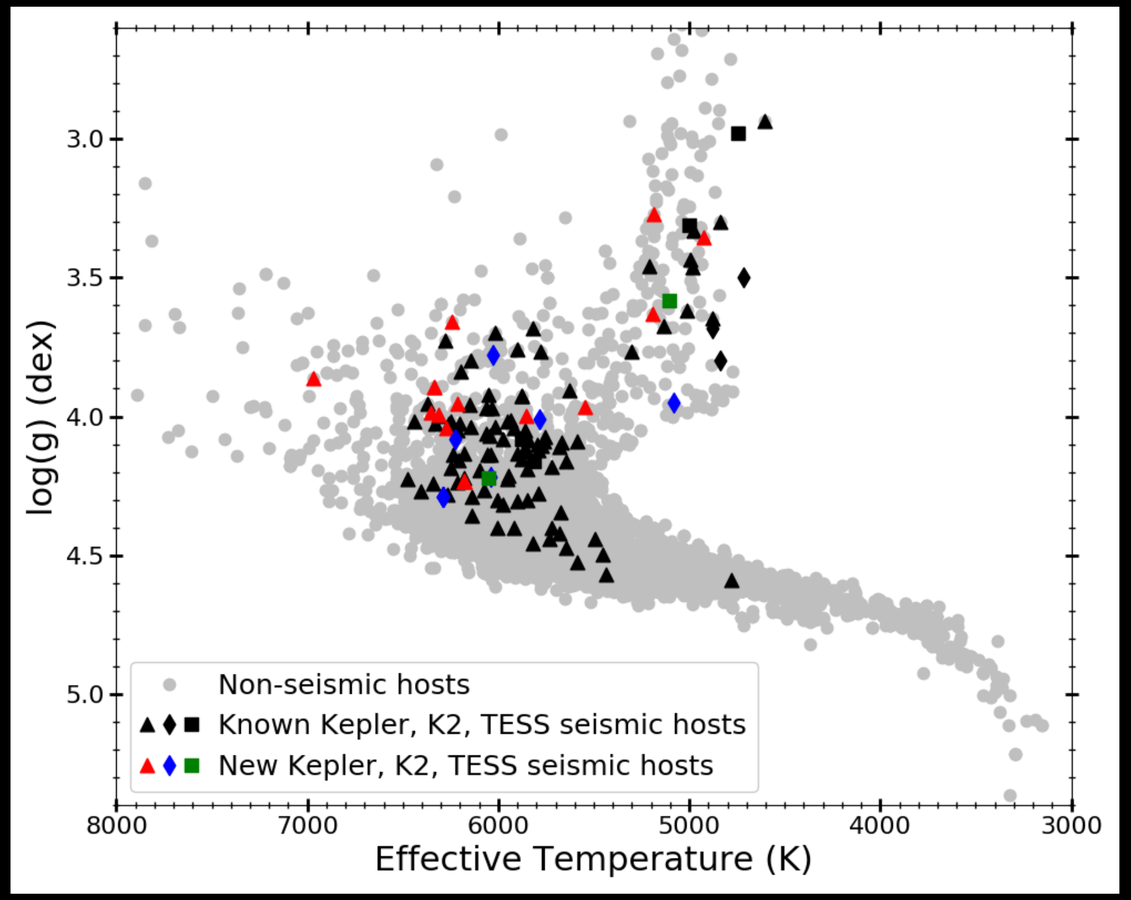
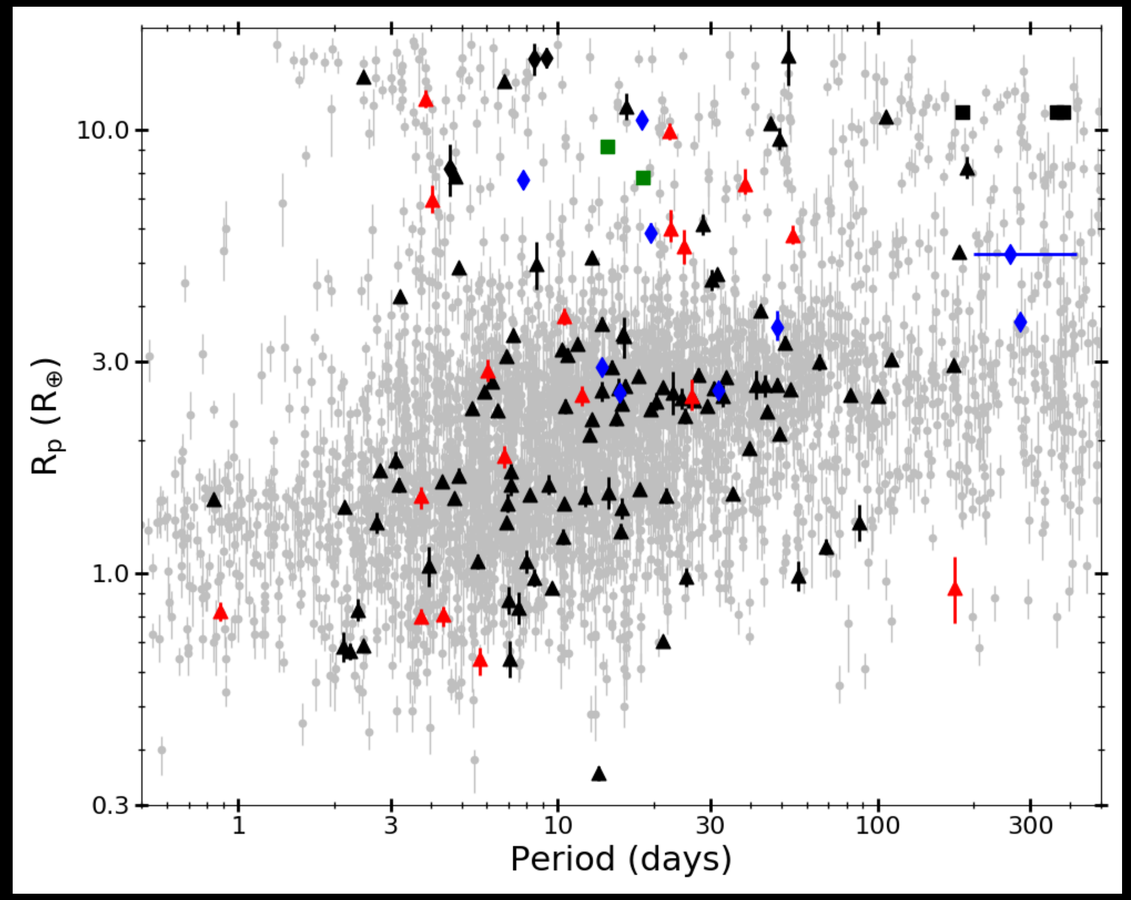


(not yet) Complete Seismic Host Catalog





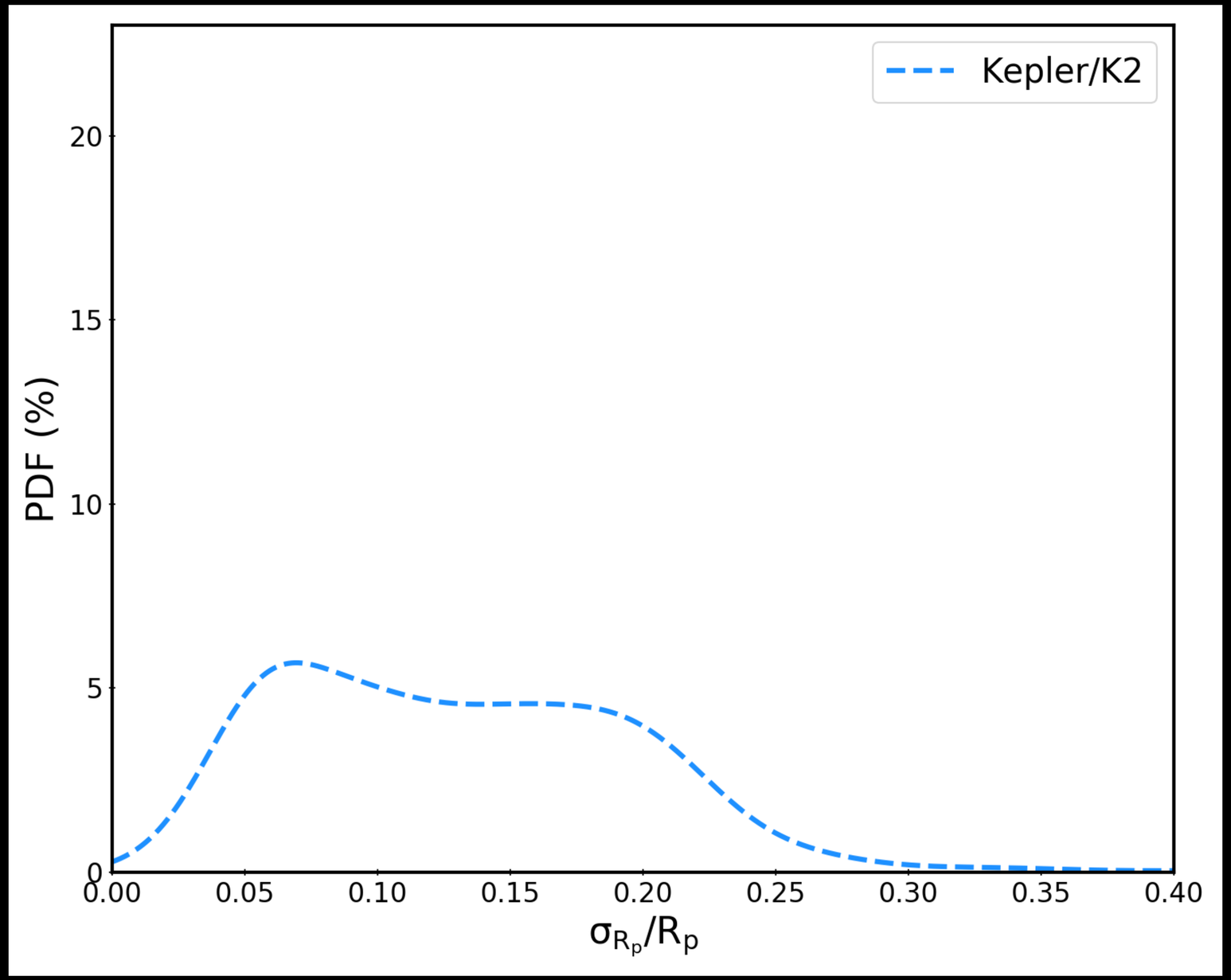
77 known asteroseismic hosts (114 known planets)

+= 26 new asteroseismic hosts (34 new planets)

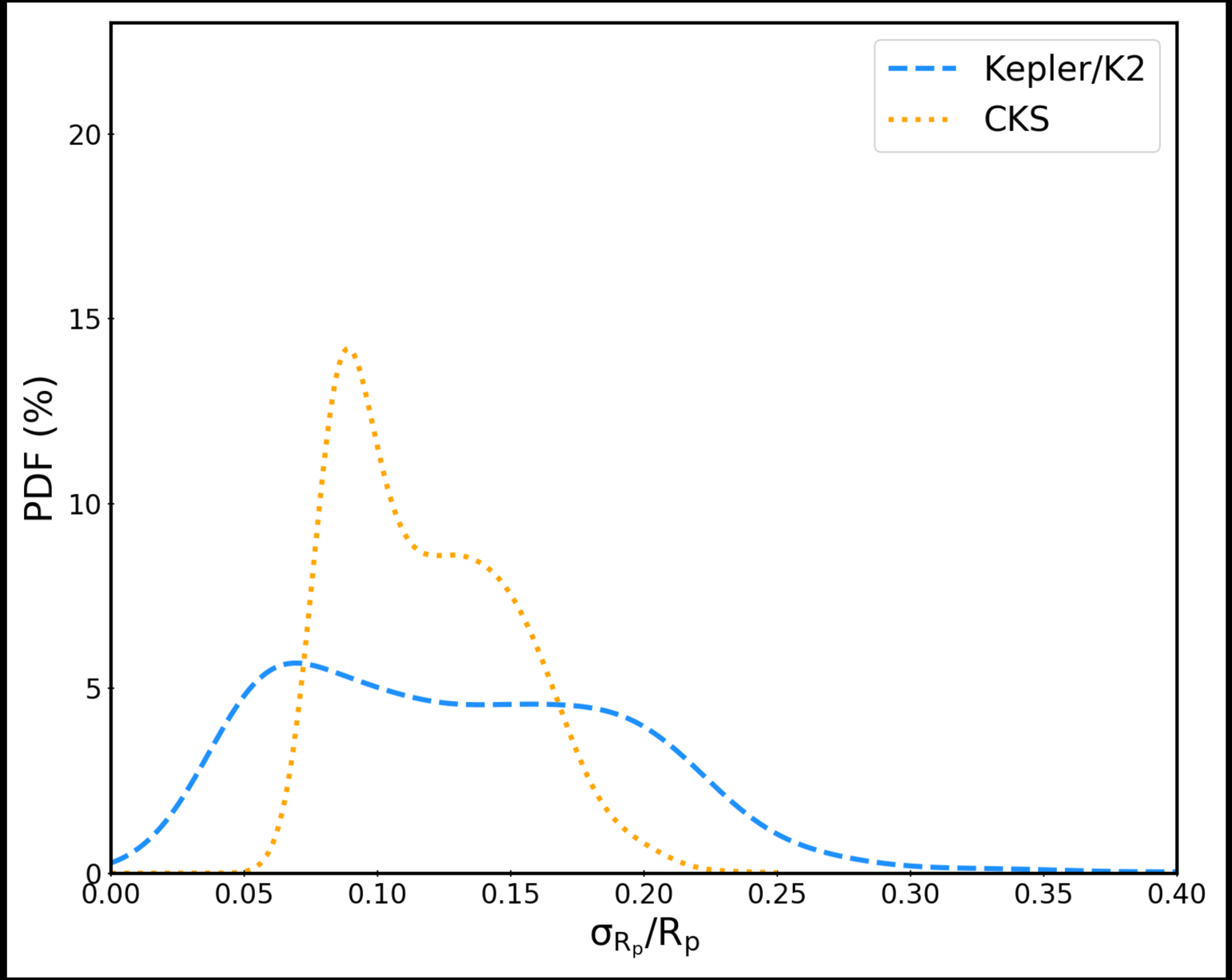
+= many more to come!

Extra Slides

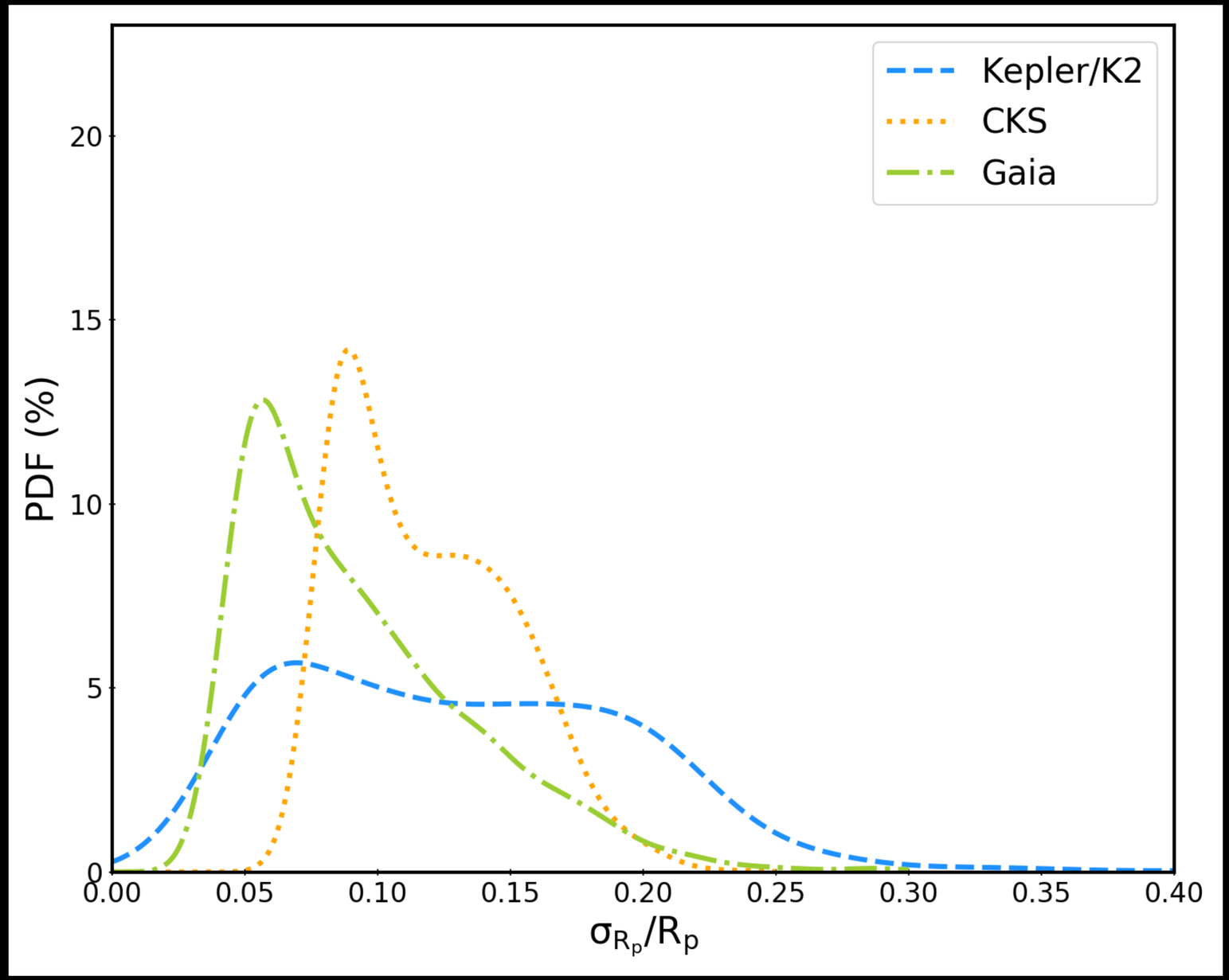
Kepler Planet Radius Uncertainties



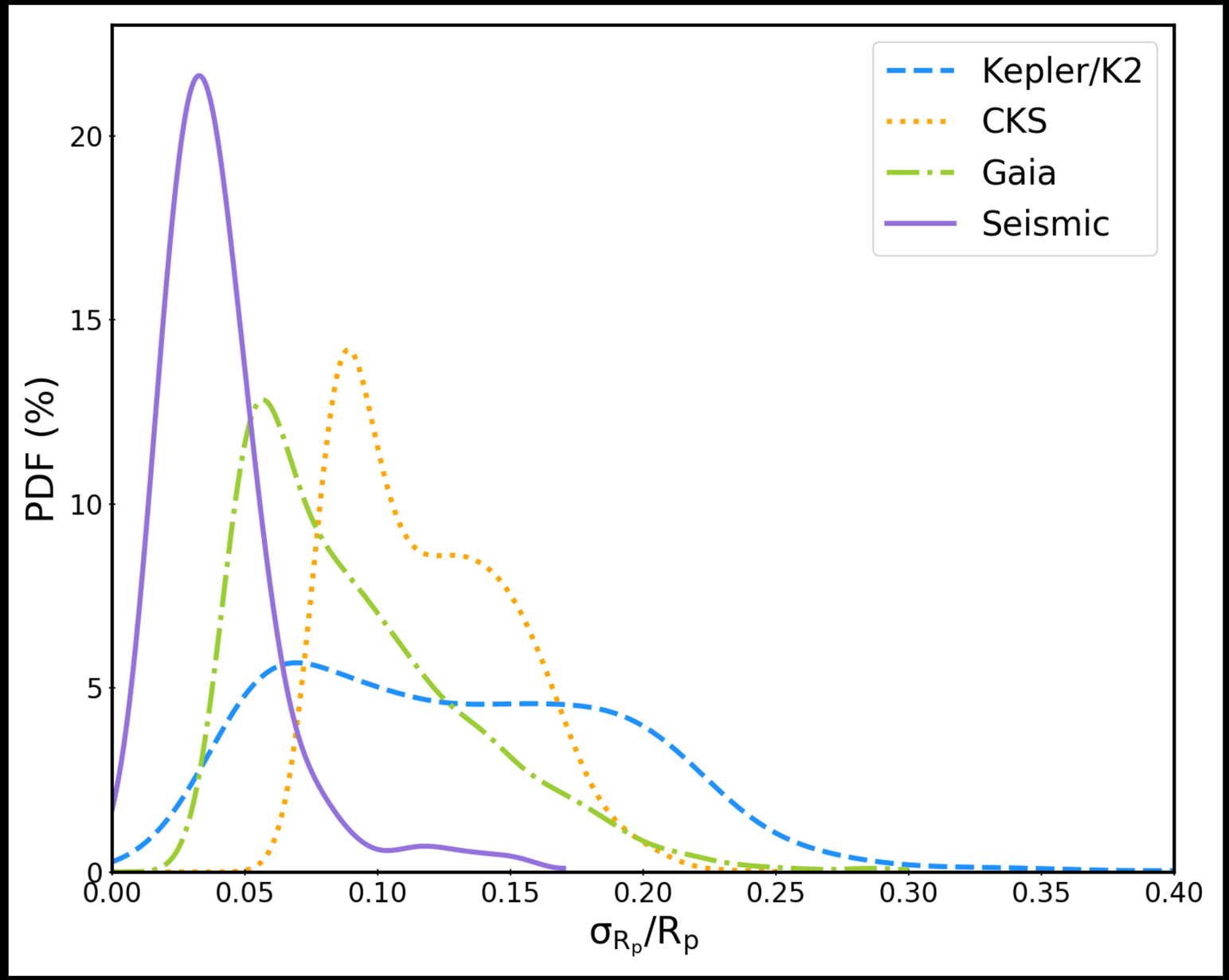
Kepler Planet Radius Uncertainties



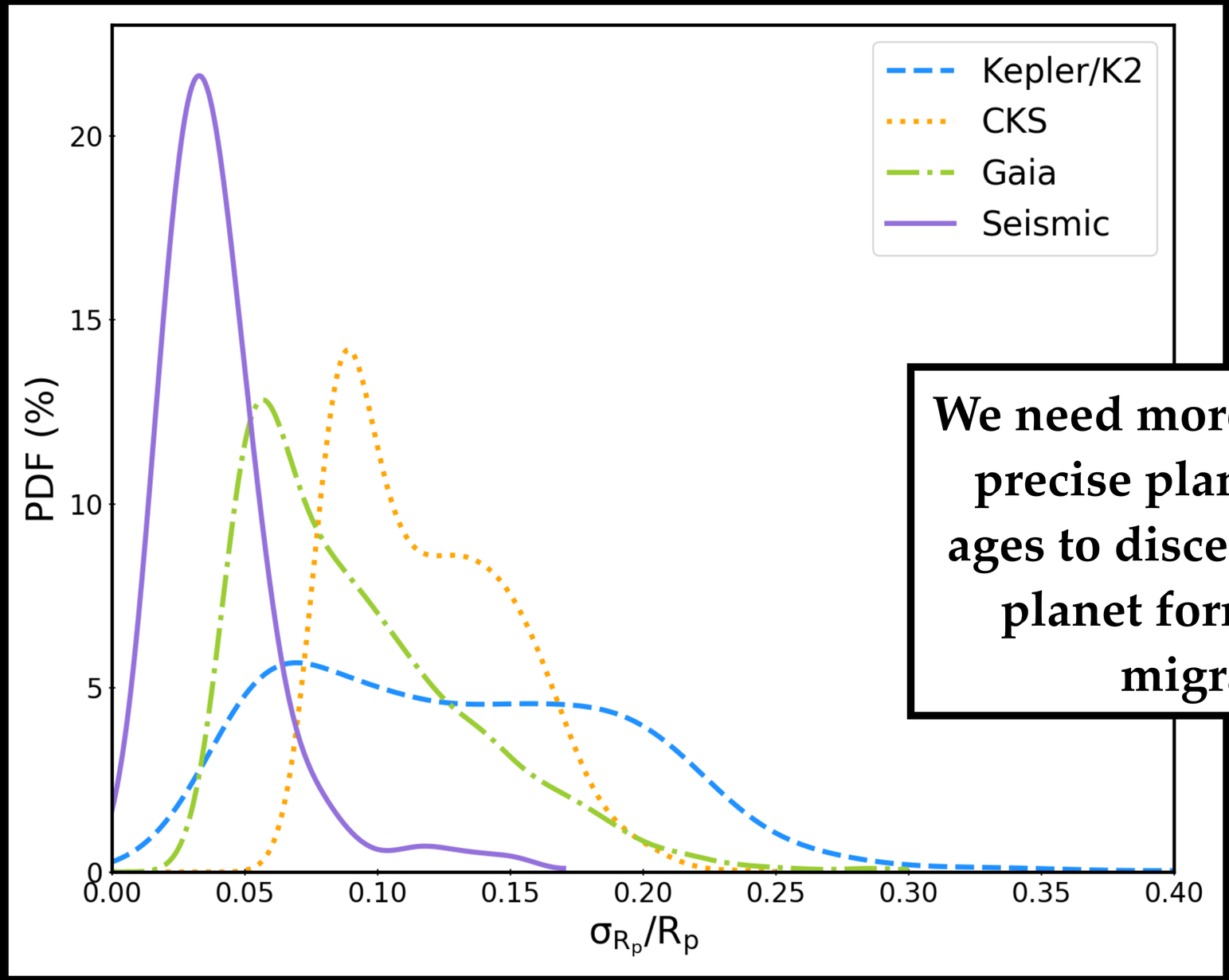
Kepler Planet Radius Uncertainties



Kepler Planet Radius Uncertainties

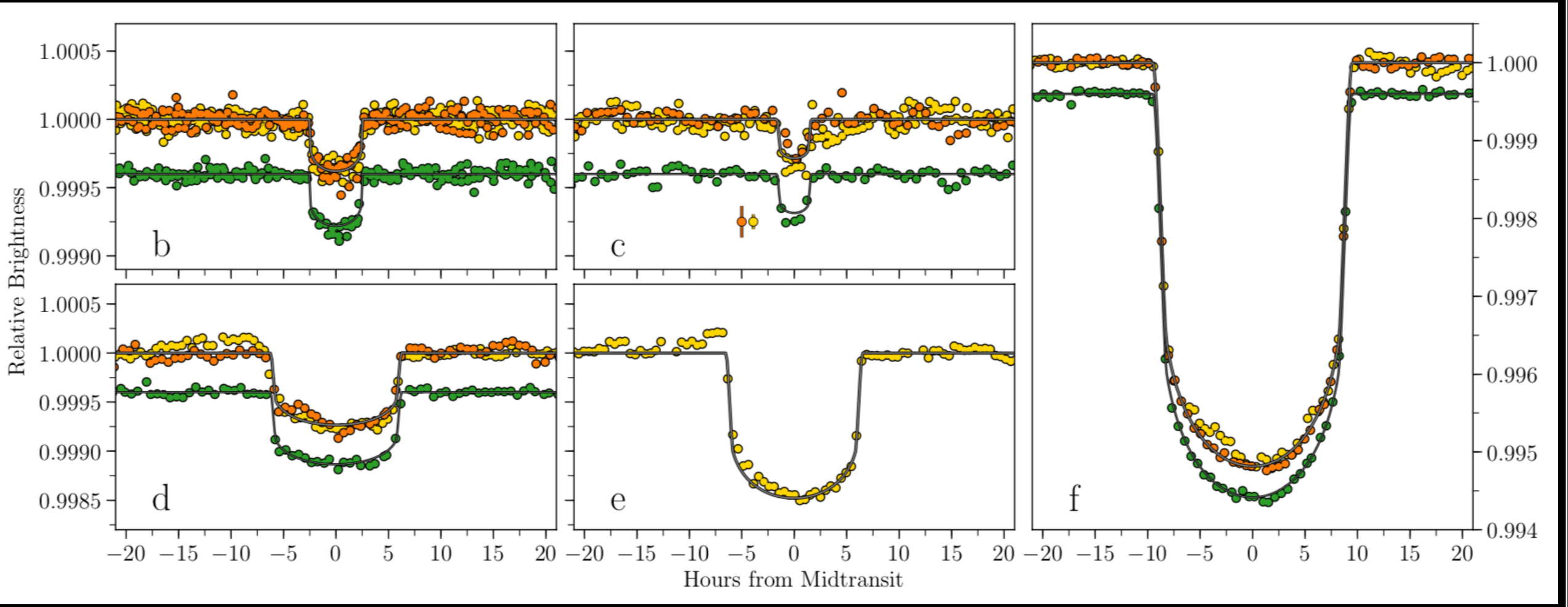


Kepler Planet Radius Uncertainties



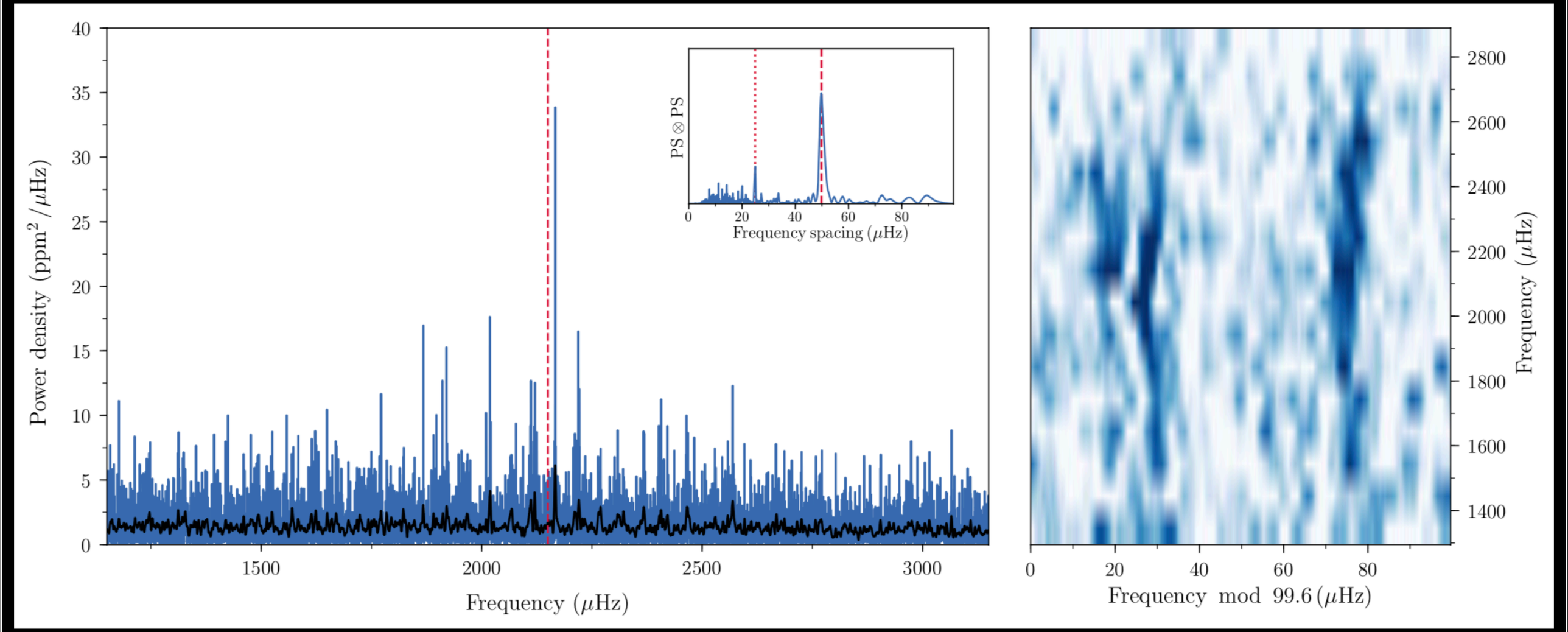
We need more accurate and precise planet radii and ages to discern theories of planet formation and migration!

K2-93: A Benchmark K2 System



Lund, Knudstrup, Silva Aguirre, Basu, Chontos+ 2019 (submitted)

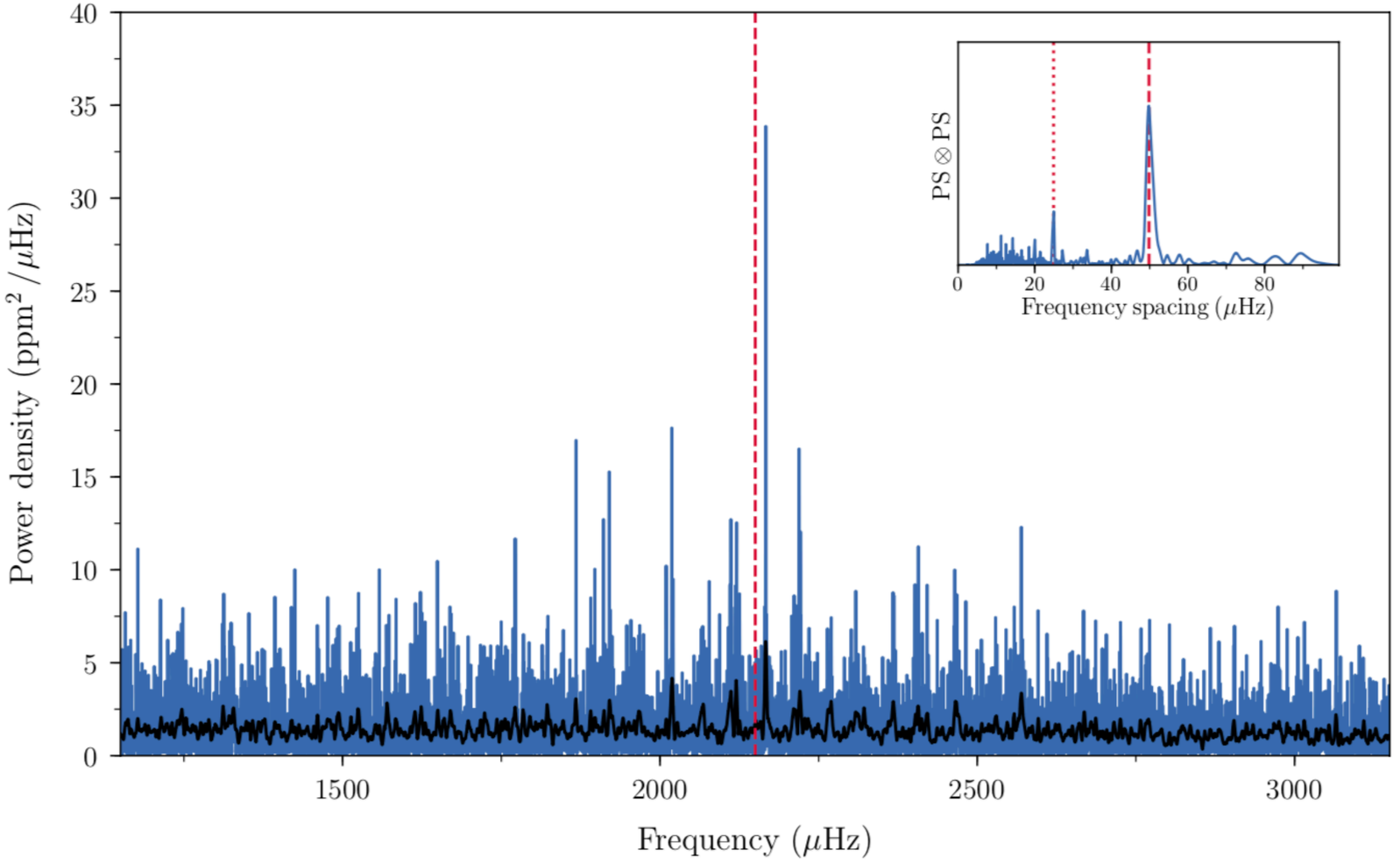
K2-93: A Benchmark K2 System

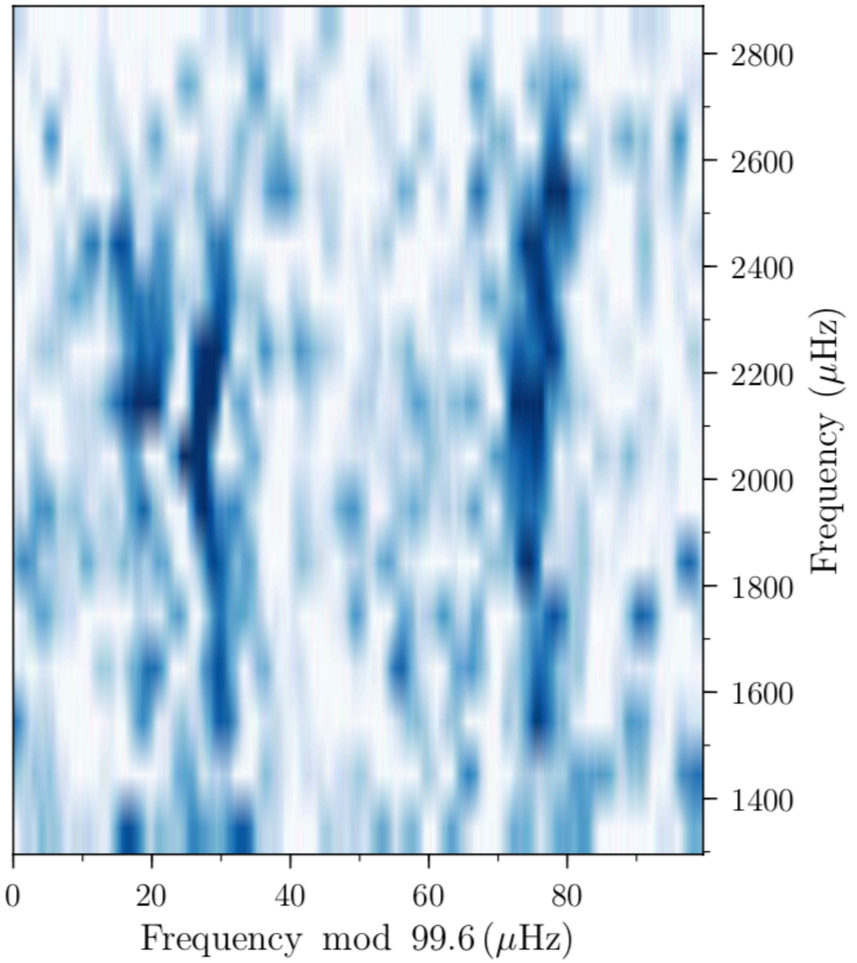


Lund, Knudstrup, Silva Aguirre, Basu, Chontos+ 2019 (submitted)

K2-93: A Benchmark K2 System

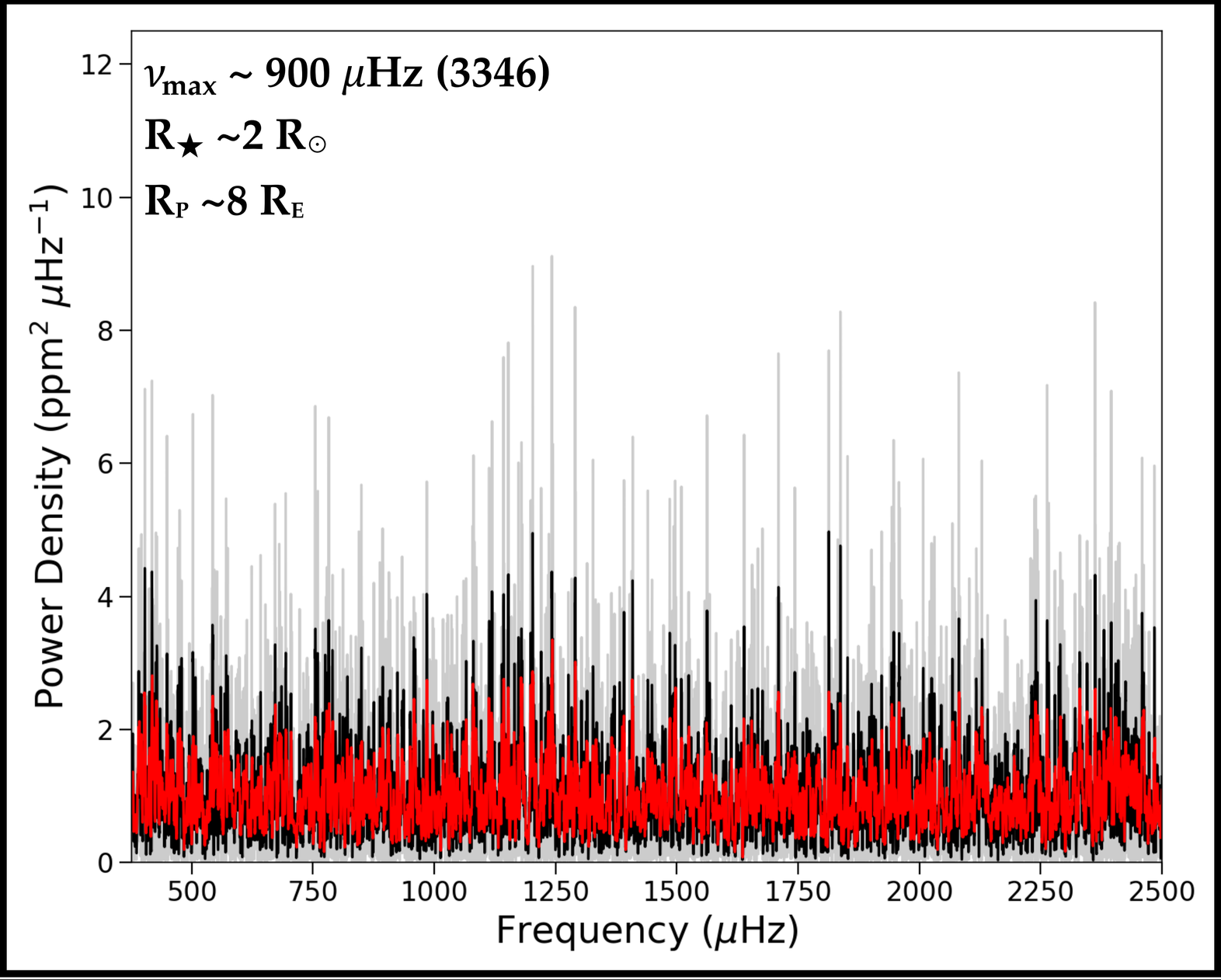
Age = 2.07 ± 0.32 Gyr



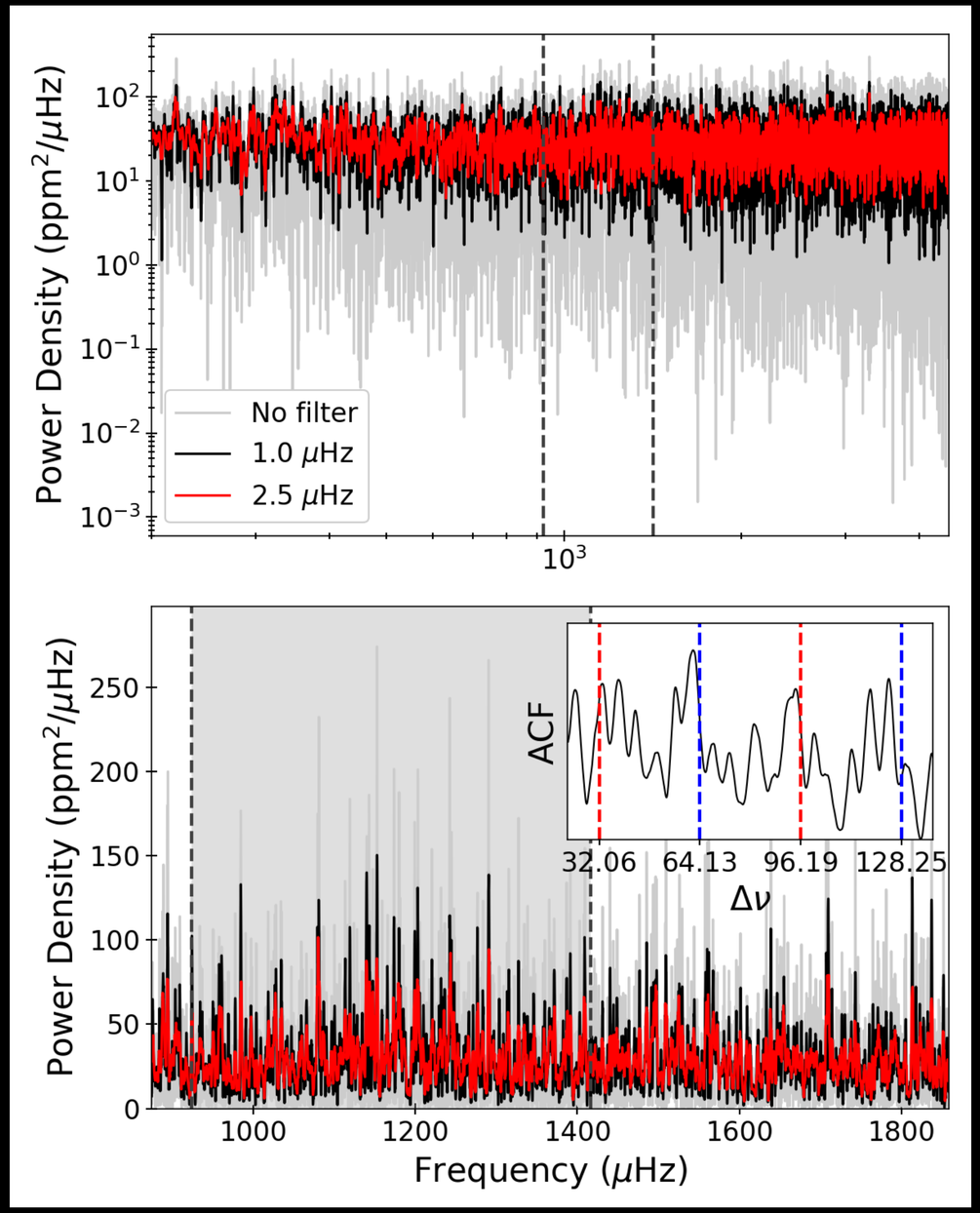


Lund, Knudstrup, Silva Aguirre, Basu, Chontos+ 2019 (submitted)

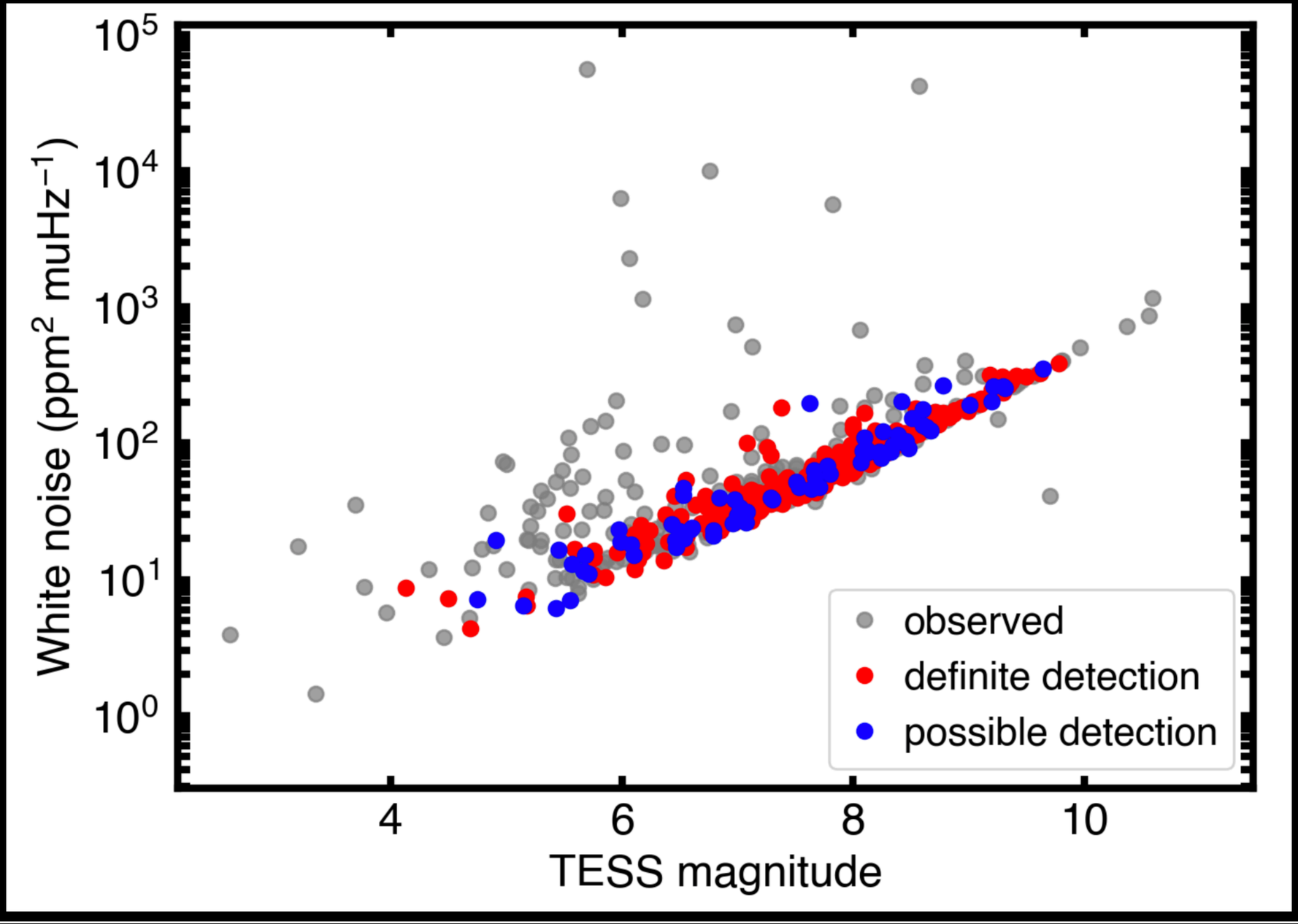
TOI 257: New TESS Seismic Host



TOI 257: New TESS Seismic Host



Solar-like Oscillators



Solar-like Oscillators