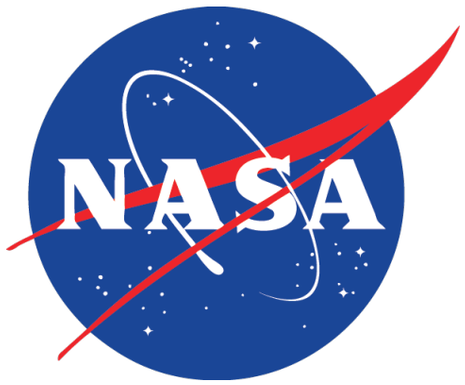
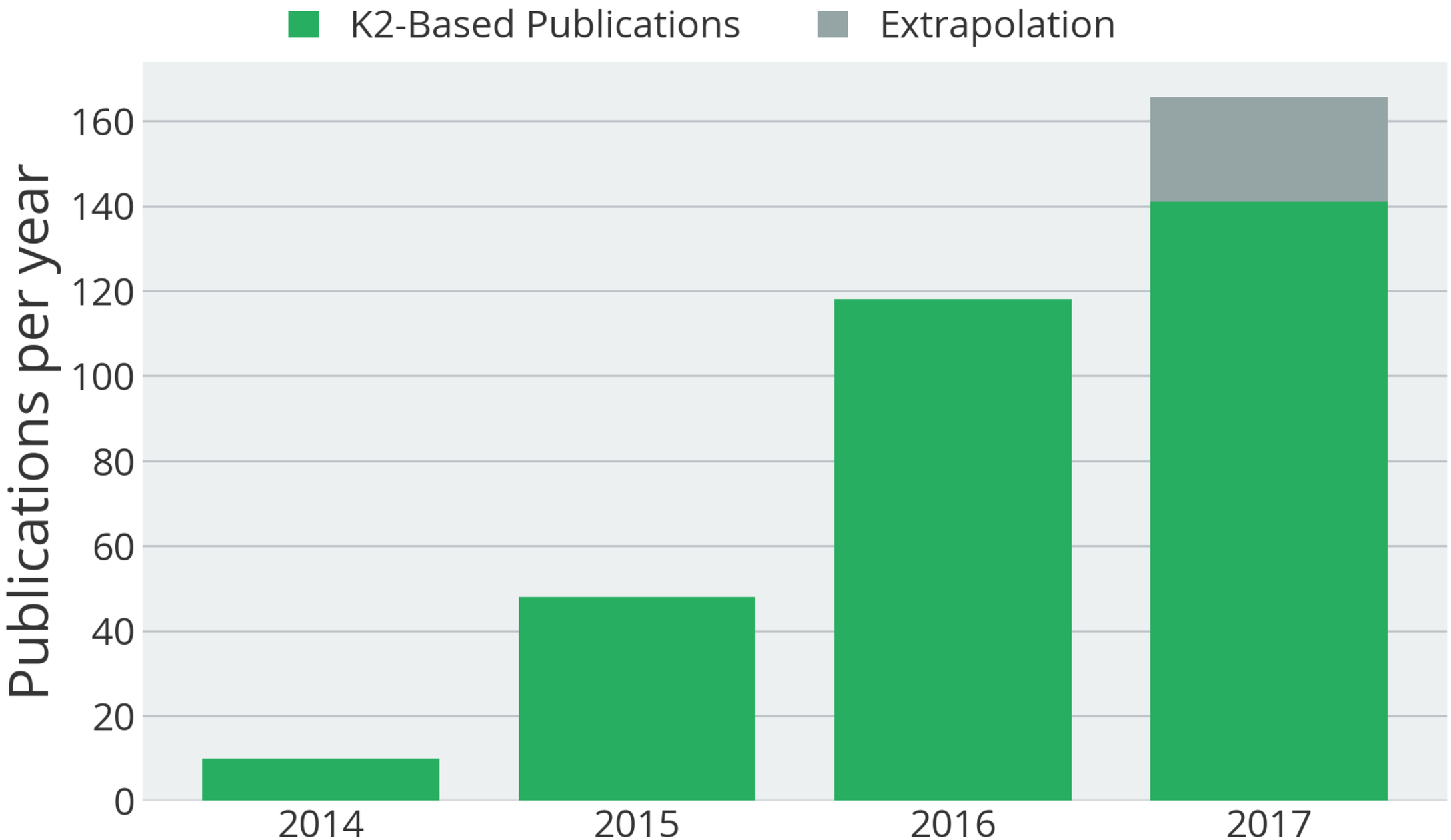


How Sagan Fellows are shaping the success of NASA's K2 Mission

Geert Barentsen
K2 GO Director
2017 Nov 9

K2 recently surpassed 300 publications!



Unique (co-)authors: 1422
Citations: 3285

RIP Kepler: NASA gives up fixing the planet-hunting space telescope

By Sebastian Anthony on August 16, 2013 at 7:32 am | 16 Comments

67 shares

NASA resurrects planet-hunting Kepler, replaces broken parts with magical Sun power

By Sebastian Anthony on November 27, 2013 at 3:30 pm | 8 Comments

183 shares

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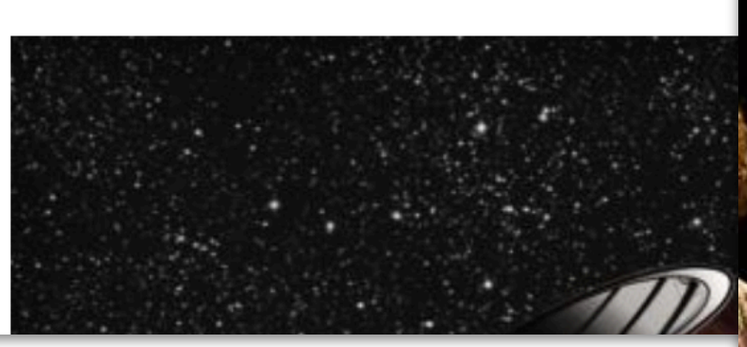

Doug Wiemer (Ball Aerospace) was awarded NASA's Exceptional Public Achievement medal last month for K2

For K2 to be funded, science had to be demonstrated

A TECHNIQUE FOR EXTRACTING HIGHLY PRECISE PHOTOMETRY FOR THE TWO–WHEELED *Kepler* MISSION

ANDREW VANDERBURG[1,2] & JOHN ASHER JOHNSON[3]
Harvard–Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138

A systematic search for transiting planets in the *K2* data

Daniel Foreman-Mackey[1,2], Benjamin T. Montet[3,4], David W. Hogg[2,5,6],
Timothy D. Morton[7], Dun Wang[2], & Bernhard Schölkopf[8]

Photometry of Very Bright Stars with *Kepler* and K2 Smear Data

B. J. S. Pope,[1⋆] T. R. White[2,3], D. Huber[4,5,6], S. J. Murphy[4,6], T. R. Bedding[4,6],
D. A. Caldwell[7,5], A. Sarai[4], S. Aigrain[1], and T. Barclay[7,8]

CAMPAIGN 9 OF THE *K2* MISSION:
OBSERVATIONAL PARAMETERS, SCIENTIFIC DRIVERS, AND COMMUNITY INVOLVEMENT FOR A SIMULTANEOUS SPACE- AND GROUND-BASED MICROLENSING SURVEY

CALEN B. HENDERSON[1,A], RADOSŁAW POLESKI[2,3], MATTHEW PENNY[2,B], RACHEL A. STREET[4], DAVID P. BENNETT[5],
DAVID W. HOGG[6,7], B. SCOTT GAUDI[2]

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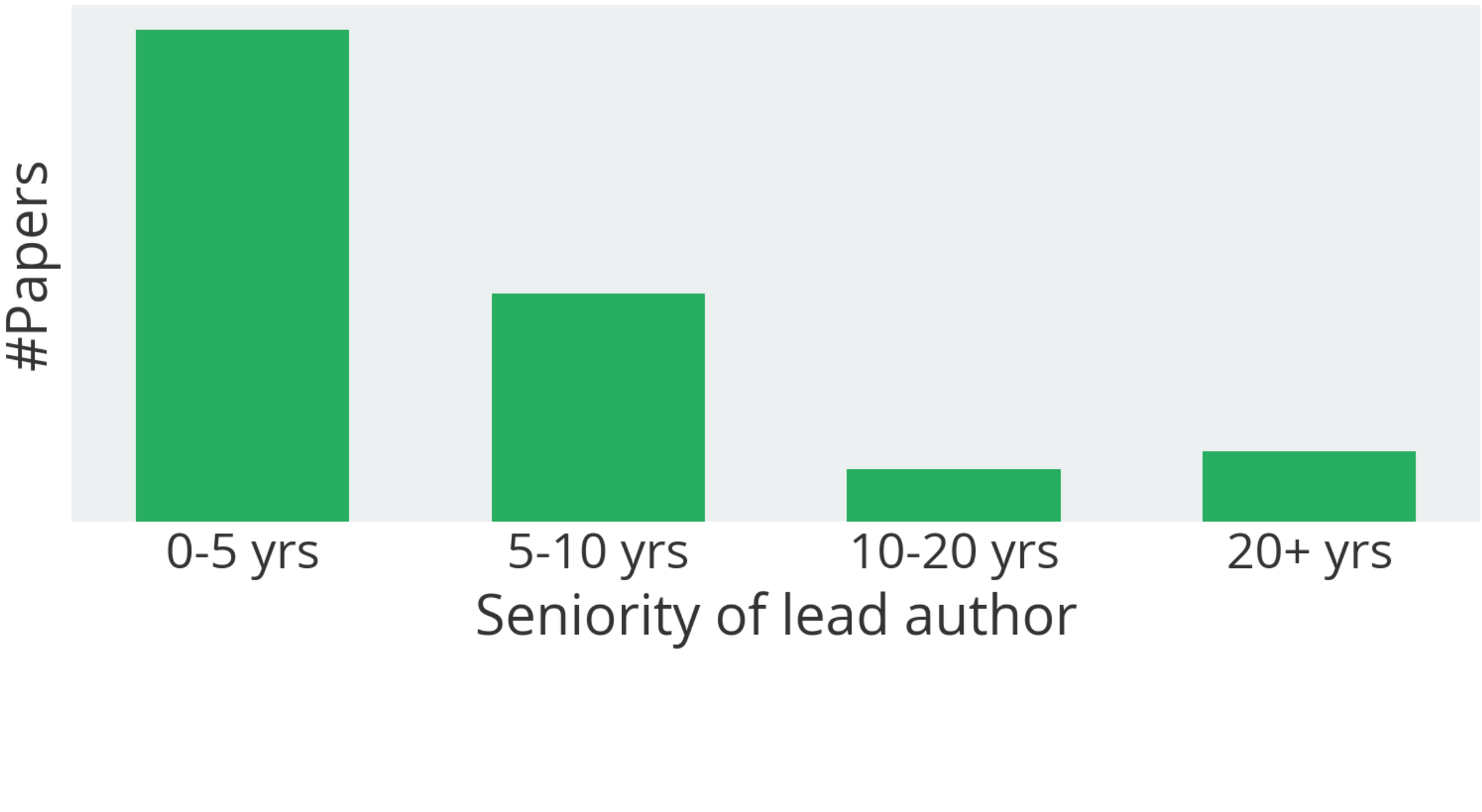
K2 lead authors are early-career researchers



Success! Your work triggered NASA to fund K2 through the end of mission 🎉

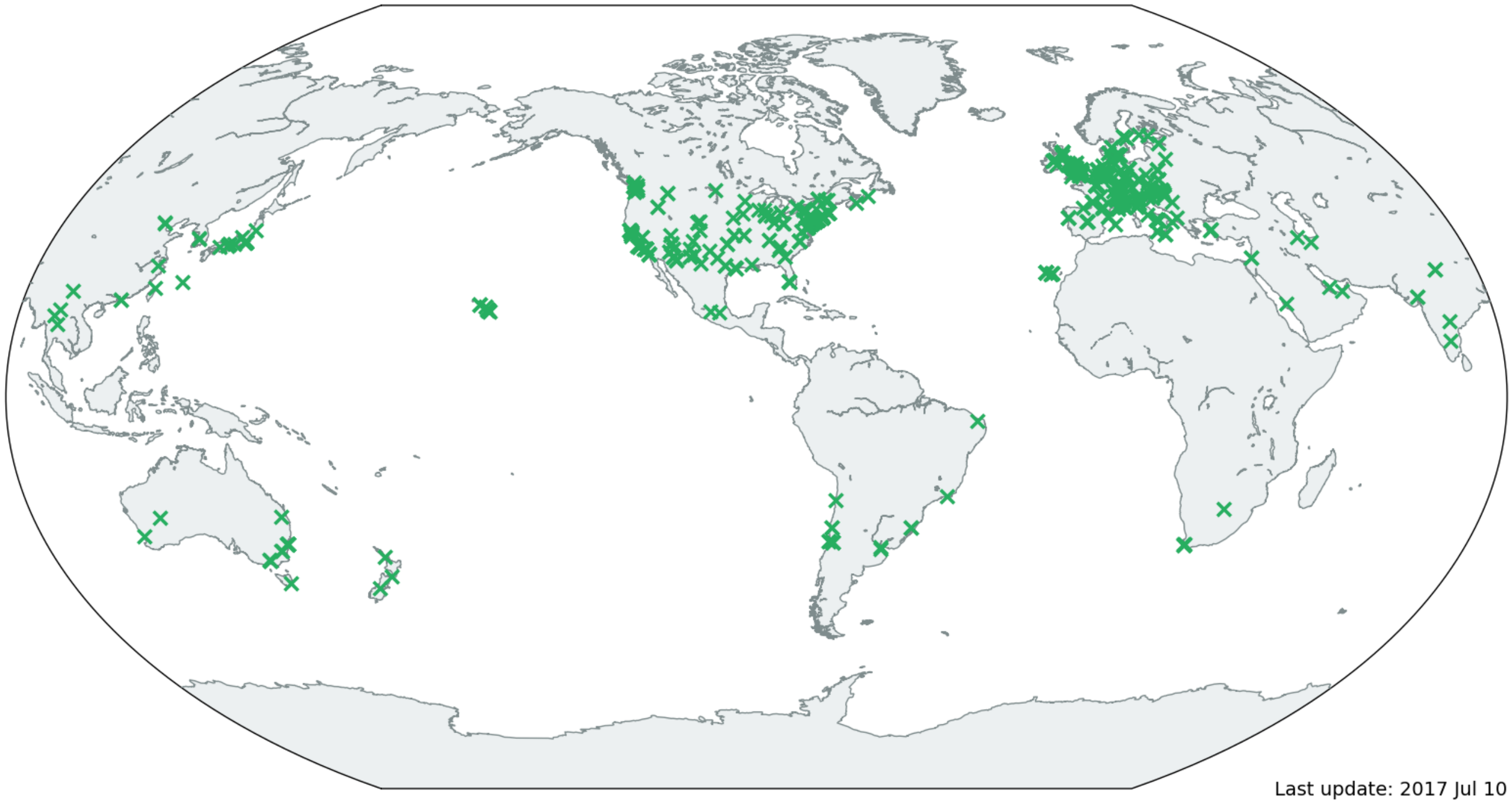
2016 NASA Astrophysics Senior Review

22-25 February, 2016

Summary of NASA decisions

- Chandra X-ray Observatory: continued operation is confirmed.
- Fermi Gamma-ray Space telescope: extension is approved.
- Hubble Space Telescope: continued operation is confirmed.
- K2 mission: extension is approved through end of mission.
- Nuclear Spectroscopic Telescope Array (NuSTAR): extension is

K2's open data is empowering talent across institutions



Crosses show the institutions of K2 paper authors and co-authors.

K2’s open data is empowering citizen scientists

A K2 citizen science project led by Ian Crossfield and Jessie Christiansen featured on prime-time TV in Australia this year (1 million viewers)

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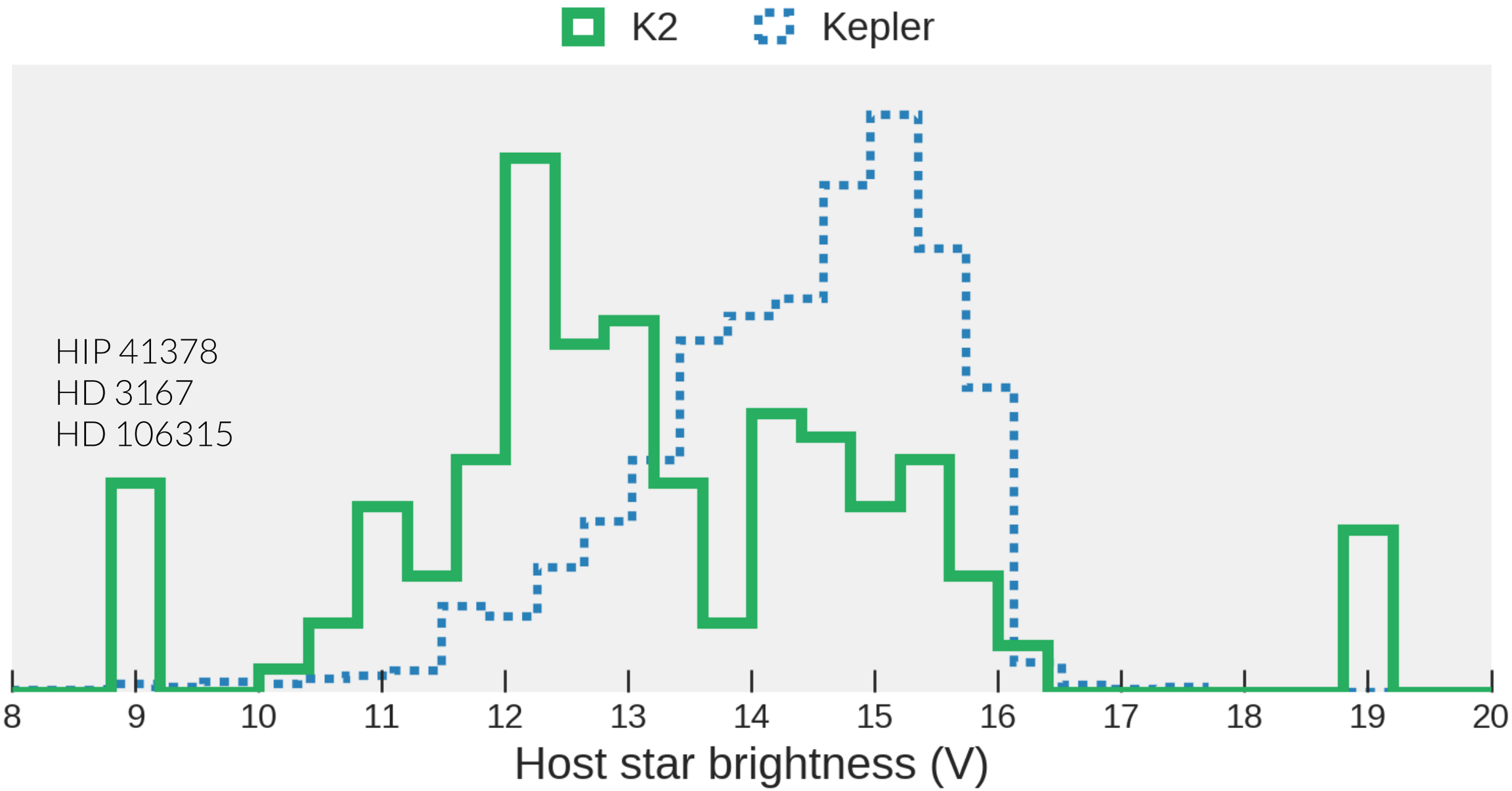
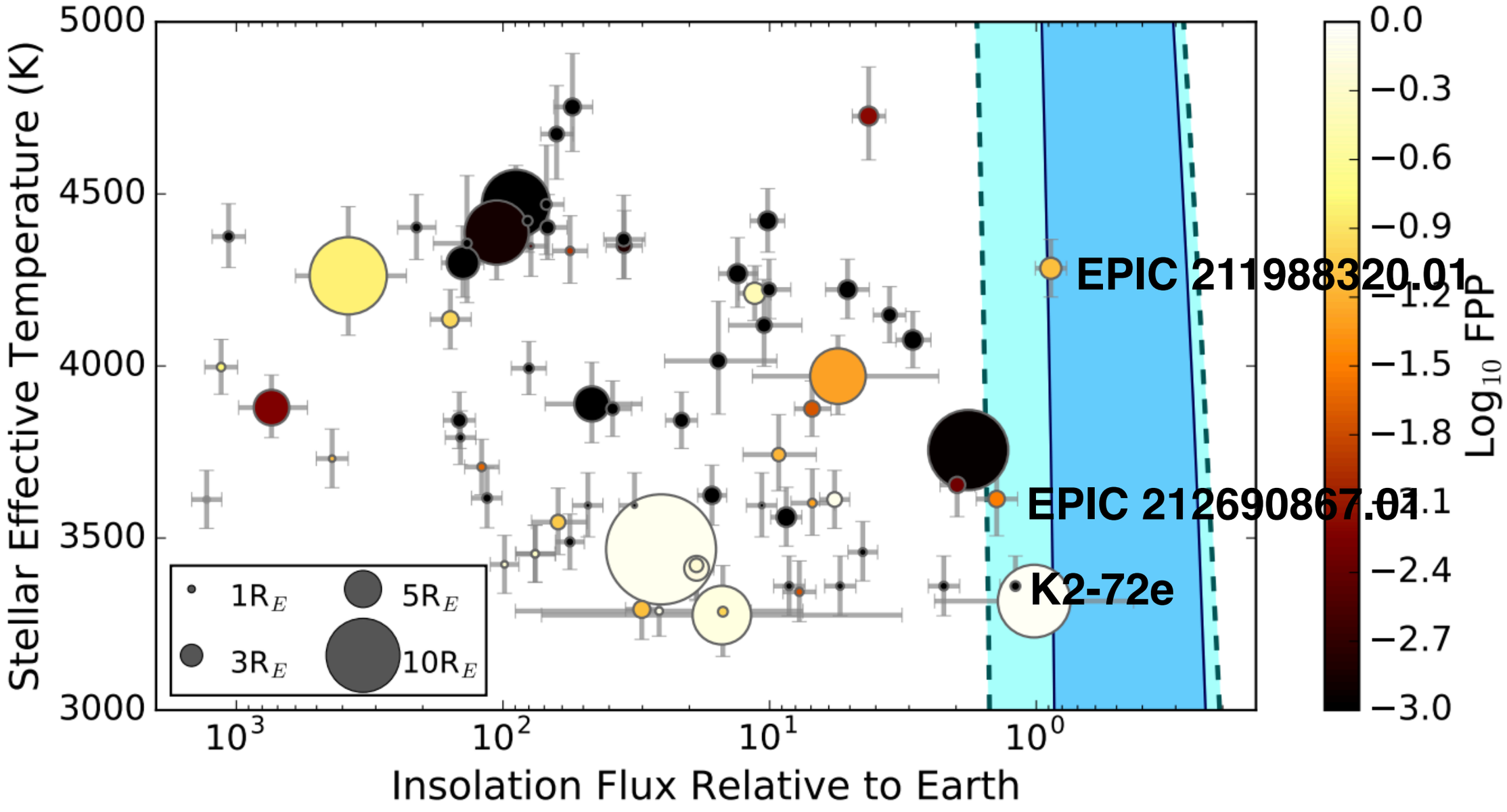
K2 is finding planets around bright stars



Data: NASA Exoplanet Archive.

K2's sample includes small ~HZ planets around low-mass stars



Dressing, Vanderburg, Schlieder, Crossfield, et al (2017)

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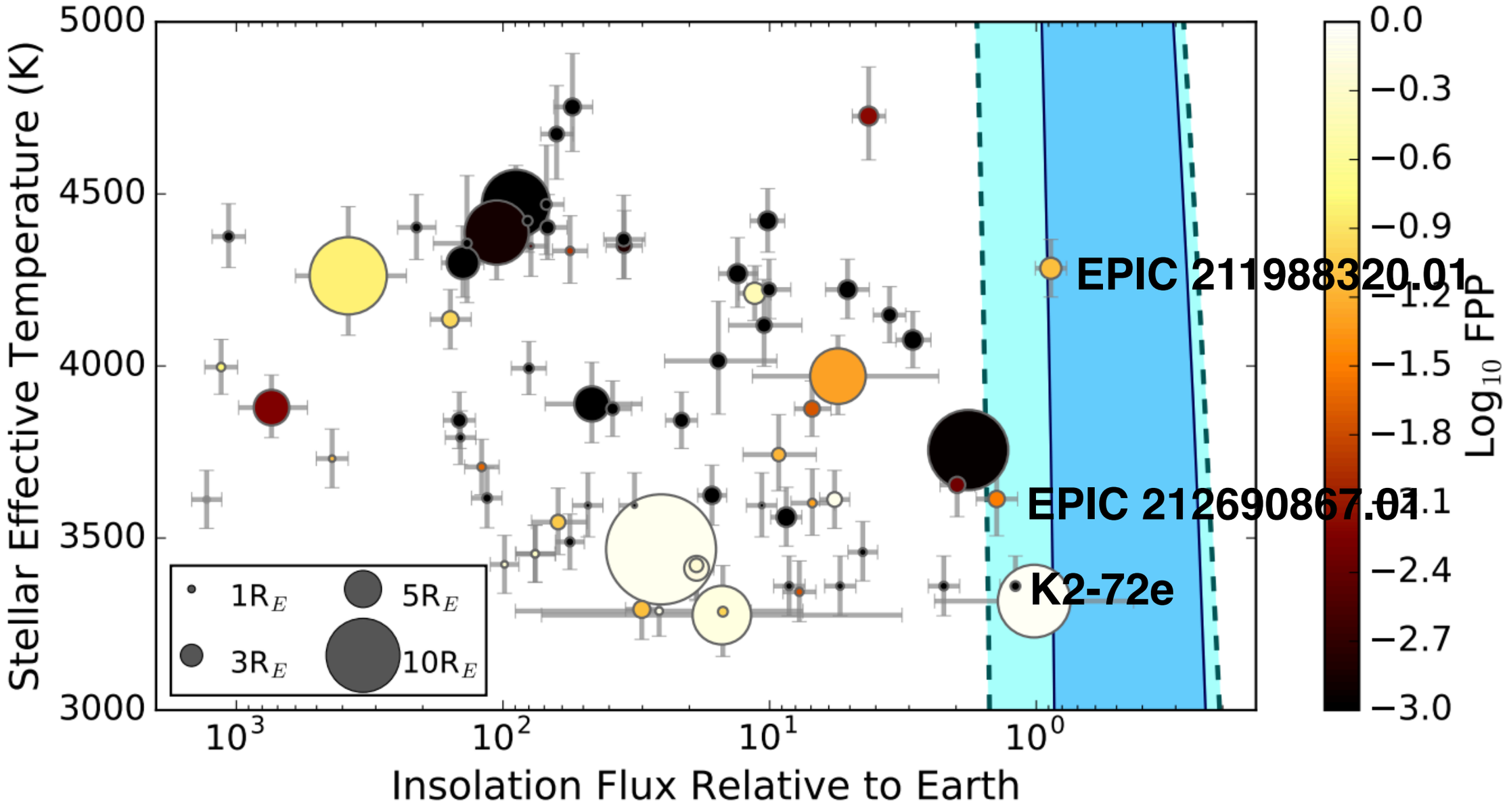

Dressing, Vanderburg, Schlieder, Crossfield, et al (2017)

Sagan Fellows

The ~best known Super-Earths for transit spectroscopy

TABLE 3
THE BEST CONFIRMED PLANETS FOR TRANSMISSION SPECTROSCOPY WITH $R_P < 3\,R_\oplus$

Planet	$R_P(R_\oplus)$	S/N[a]	Reference
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55 Cnc e[b]	1.91 ± 0.08	0.41	Dawson & Fabrycky (2010)
HD 97658 b	$2.34^{+0.17}_{-0.15}$	0.36	Dragomir et al. (2013)
TRAPPIST-1f	1.045 ± 0.038	0.24	(Gillon et al. 2017)
GJ 9827 b	$1.64^{+0.22}_{-0.20}\ R_\oplus$	**0.14**	**this work**
HD 3167 c	$2.85^{+0.24}_{-0.15}$	0.14	Vanderburg et al. (2016c); Christiansen et al. (2017)
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Rodriguez et al (2017)

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K2 discoveries, all from the past 14 months

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Sagan Fellow

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Rodriguez et al (2017)

K2 discoveries, all from the past 14 months

The K2 mission is your mission.

99 Kepler/K2 papers have a Sagan Fellow as first author.

These papers have been cited 3943 times.

Sagan, Koch, & Tarter gave the Kepler spacecraft its name

(4) orbit changed from Lagrange L2 to a heliocentric orbit. (This change allowed omission of rocket engines and fuel required to stay at L2, allowed the use of a smaller launch vehicle, and decreased the estimated cost.)

(5) mission name changed from FRESIP to Kepler at the request of several team members (Dave Koch, Carl Sagan, Jill Tarter). The name change honored Johannes Kepler, the astronomer who discovered the laws of planetary motion and who had contributed to the development of optics.

To demonstrate that the Mission would fit within the cost

Borucki (2016)

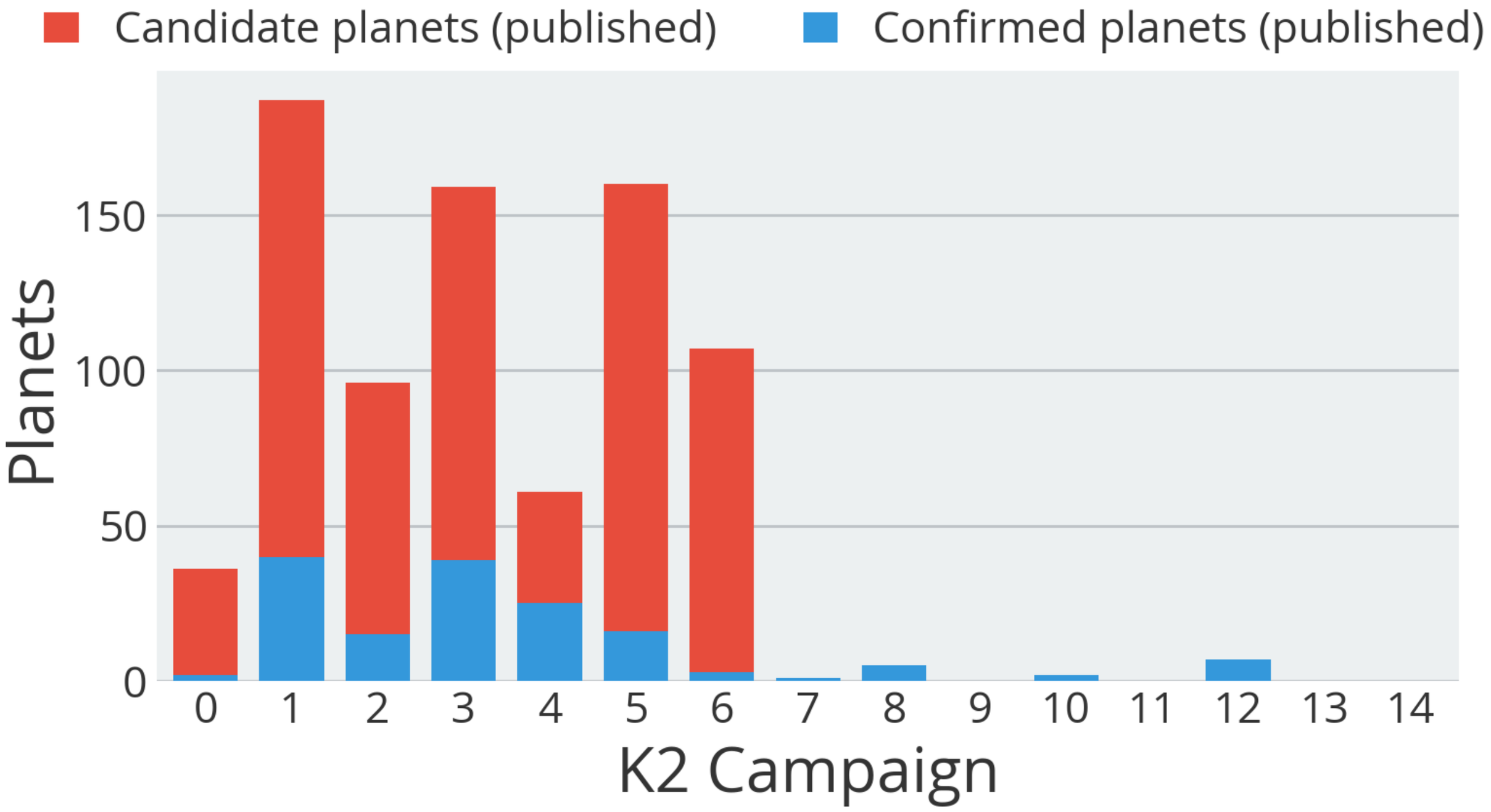
Should we rename K2 to the “Sagan Fellow Mission”?

Vanderburg et al (2017)

“Not yet! The Sagan Fellows have work left to do.”

— nobody in particular

You have planets left to find, confirm, and publish!



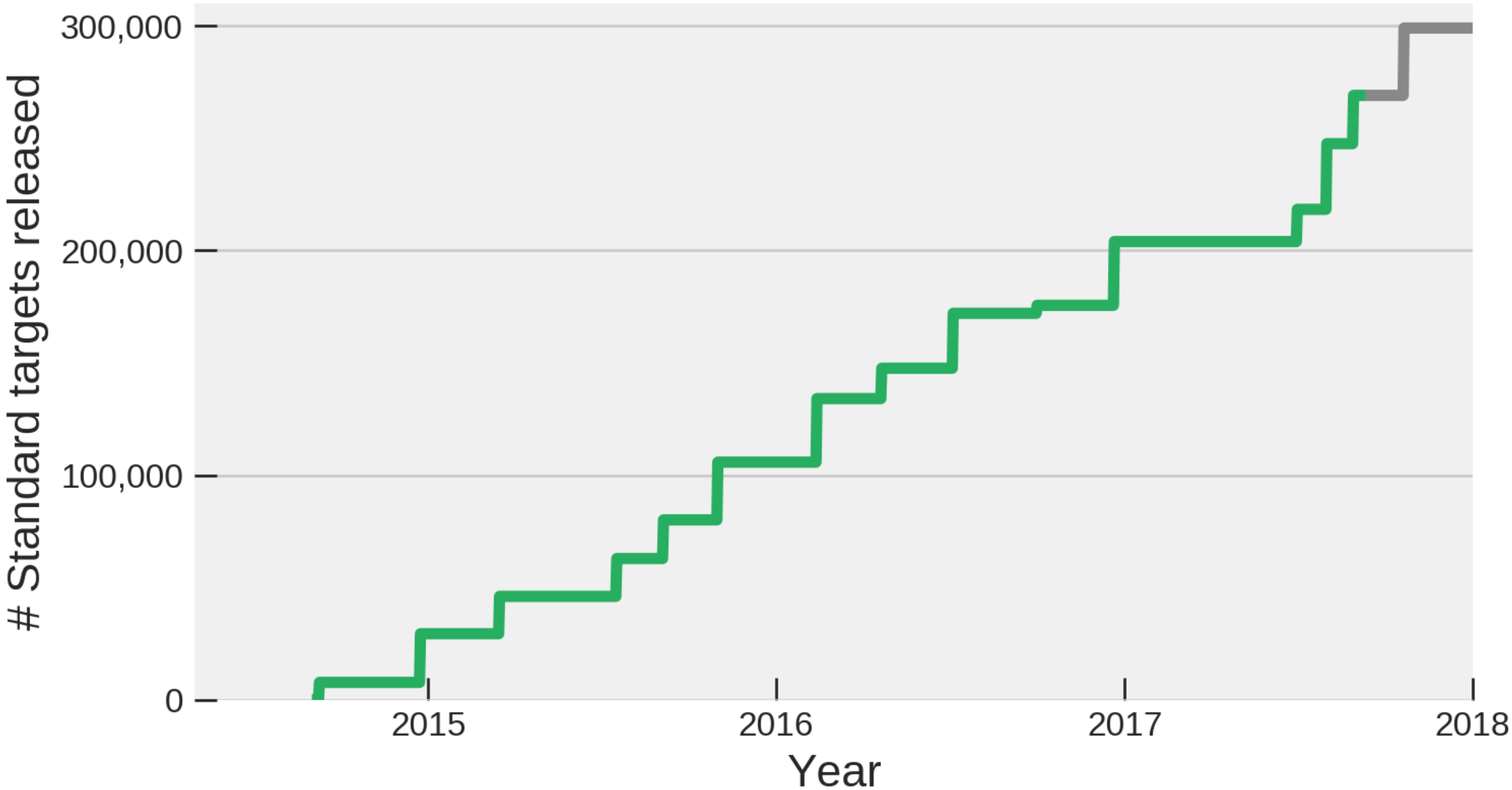
(It may take a few years to get things right.)

PLANETARY CANDIDATES OBSERVED BY *Kepler*. VIII.
A FULLY AUTOMATED CATALOG WITH MEASURED COMPLETENESS AND RELIABILITY
BASED ON DATA RELEASE 25

Susan E. Thompson,[1,2,3,*] Jeffrey L. Coughlin,[2,1] Kelsey Hoffman,[1] Fergal Mullally,[1,2,4]
Jessie L. Christiansen,[5] Christopher J. Burke,[2,1,6] Steve Bryson,[2] Natalie Batalha,[2] Michael R. Haas,[2,†]
Joseph Catanzarite,[1,2] Jason F. Rowe,[7] Geert Barentsen,[8] Douglas A. Caldwell,[1,2] Bruce D. Clarke,[1,2]
Jon M. Jenkins,[2] Jie Li,[1] David W. Latham,[9] Jack J. Lissauer,[2] Savita Mathur,[10] Robert L. Morris,[1,2]
Shawn E. Seader,[11] Jeffrey C. Smith,[1,2] Todd C. Klaus,[2] Joseph D. Twicken,[1,2] Jeffrey E. Van Cleve,[1]

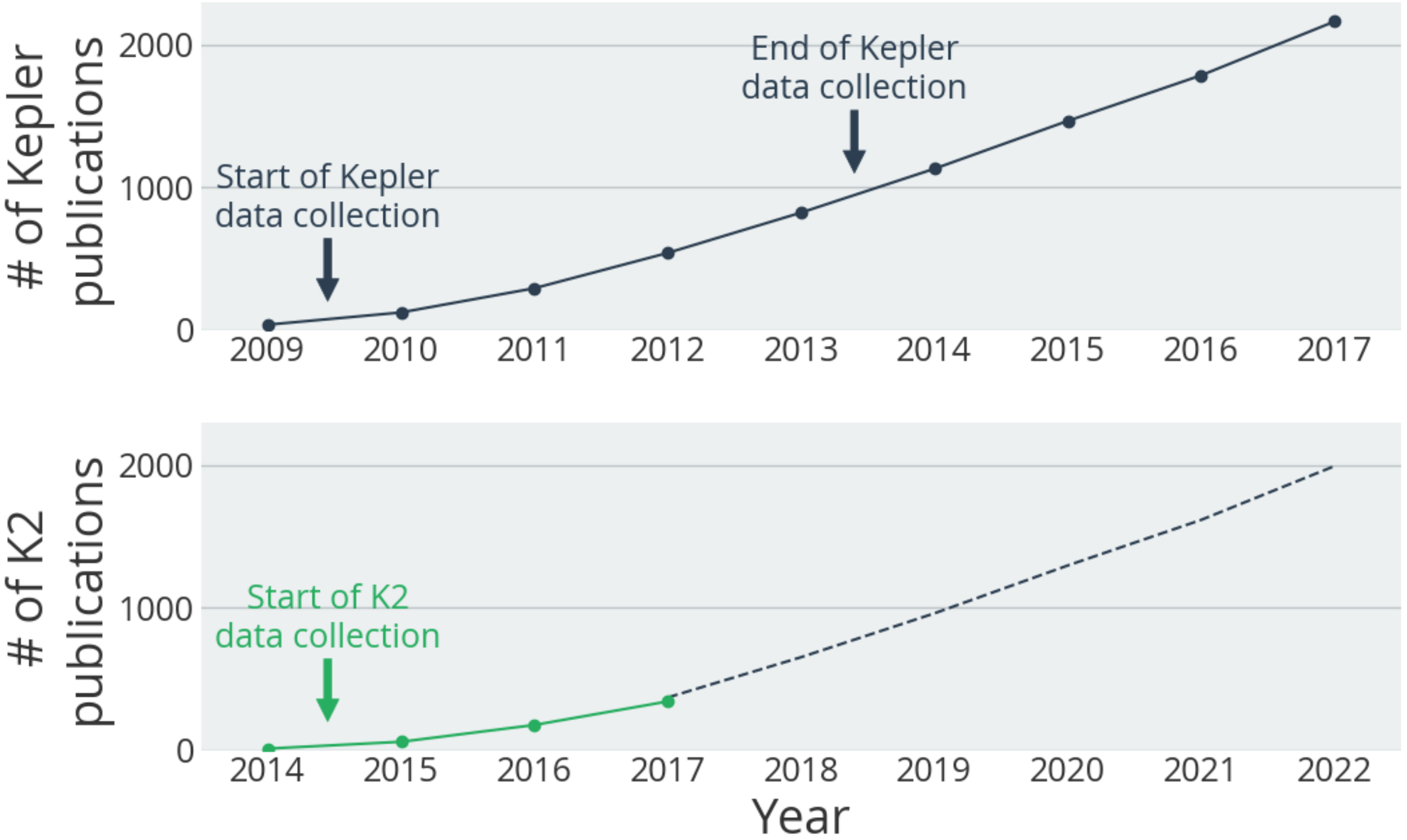
Thompson et al (2017)
arXiv:1710.06758

K2's archived data set size just increased by 50%



K2 has now surpassed the number of unique targets that were observed during Kepler's prime mission

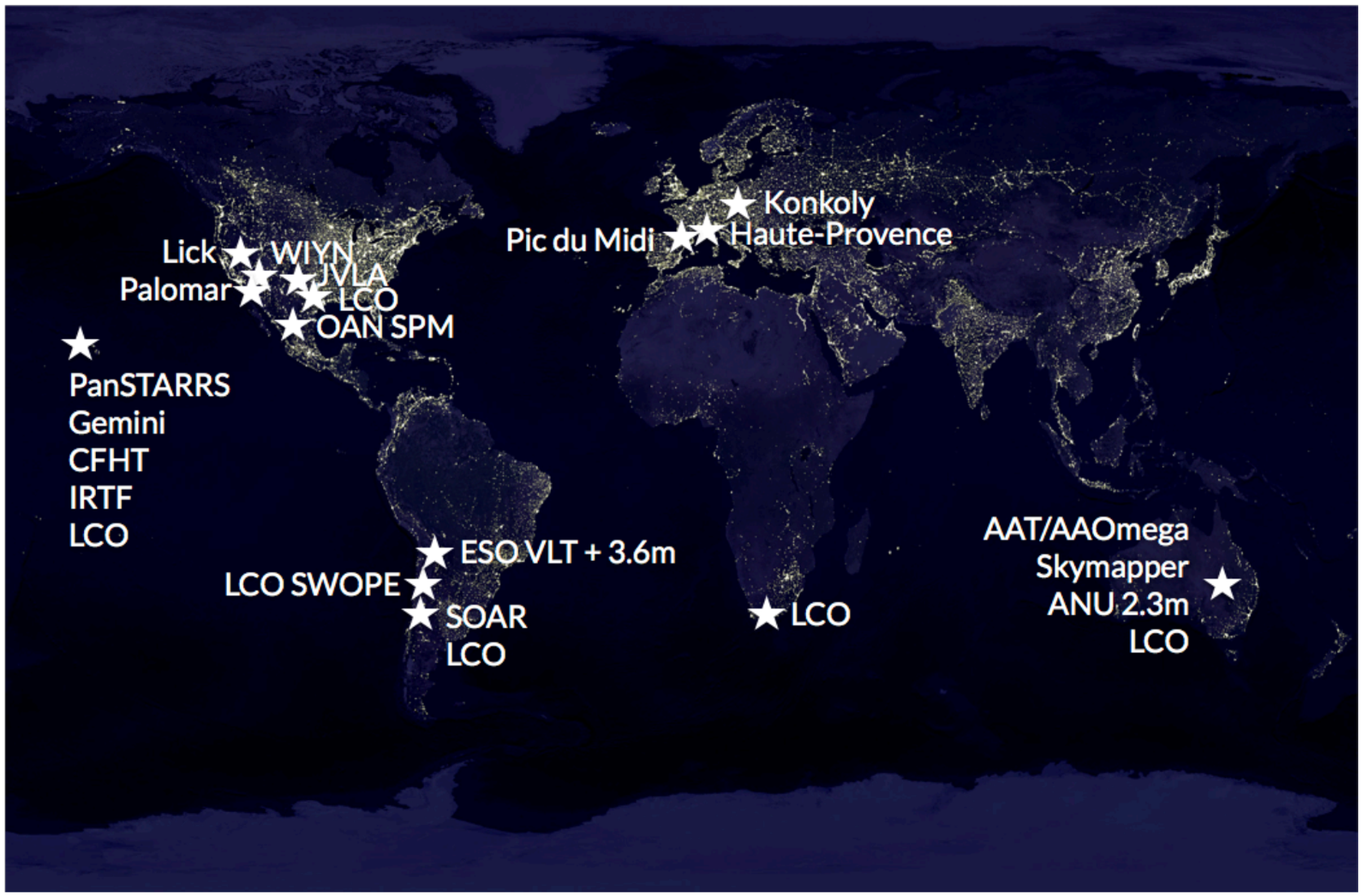
K2's scientific exploitation is only just getting started



K2's Campaigns 16 & 17 will enable new science

The community has secured **>24 ground-based facilities** to support the forward-facing Campaigns 16 & 17:

- Enables spectroscopic characterization of **supernovae**.
- Enables **simultaneous measurements of RV jitter and photometric stability** to Kepler precision.
- Observe **dozens of unconfirmed Earth-sized planet candidates** seen in previous Campaigns.



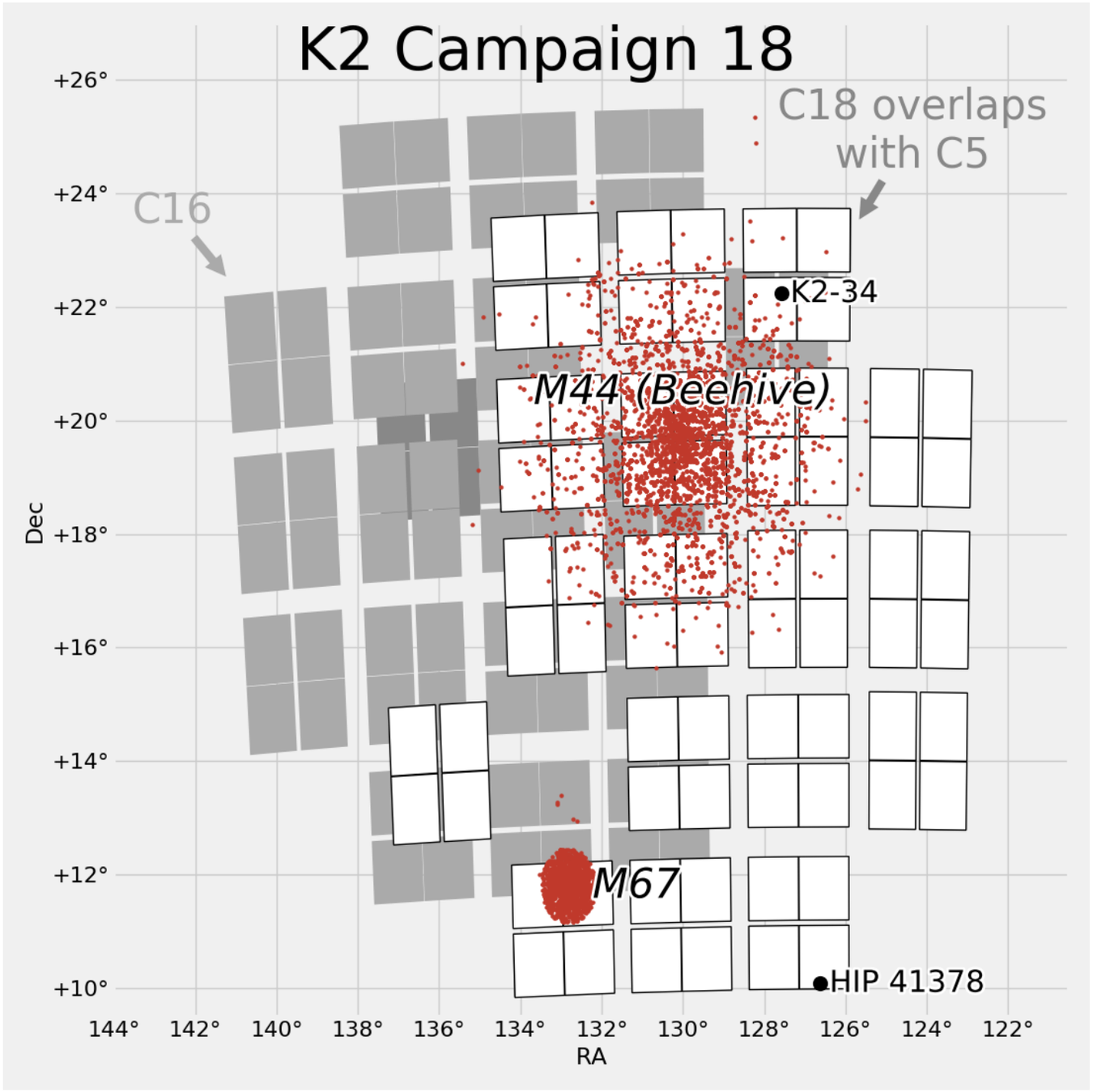
Campaign 18 revisits K2's legacy field

Campaign 18 will revisit the key part of the sky that includes **benchmark solar-like (M67) and young (M44) star clusters.**

This is **K2's legacy field**; it will benefit from a 3-year baseline and 8-month duty cycle.

Enables prime-mission-like science at a different Galactic sight line from the original mission:

- Exoplanet TTVs;
- Long-term stellar activity;
- Asteroseismology.



Proposal opportunities

DDT deadlines for exceptional targets:

C17: Nov 30, 2017 (any new planets from C6?)
C18: Jan 19, 2018 (any new planets from C5?)
C19: Apr 12, 2018 (any new planets from C12?)

K2 Cycle 6 Phase-2 deadline for funding (~$20-$150k grants):

Apr 19, 2018

Proposals may only use C17-18-19 targets selected in Phase-1 (target lists to be published in February). See ROSES D.7 for details.

Also: propose to ADAP and XRP!

We can help! Introducing the new K2 GO team:

Dr Michael Gully-Santiago

Supernova experiment support
Low-fuel science simulations
Systematics removal tutorials

Dr Ann Marie Cody

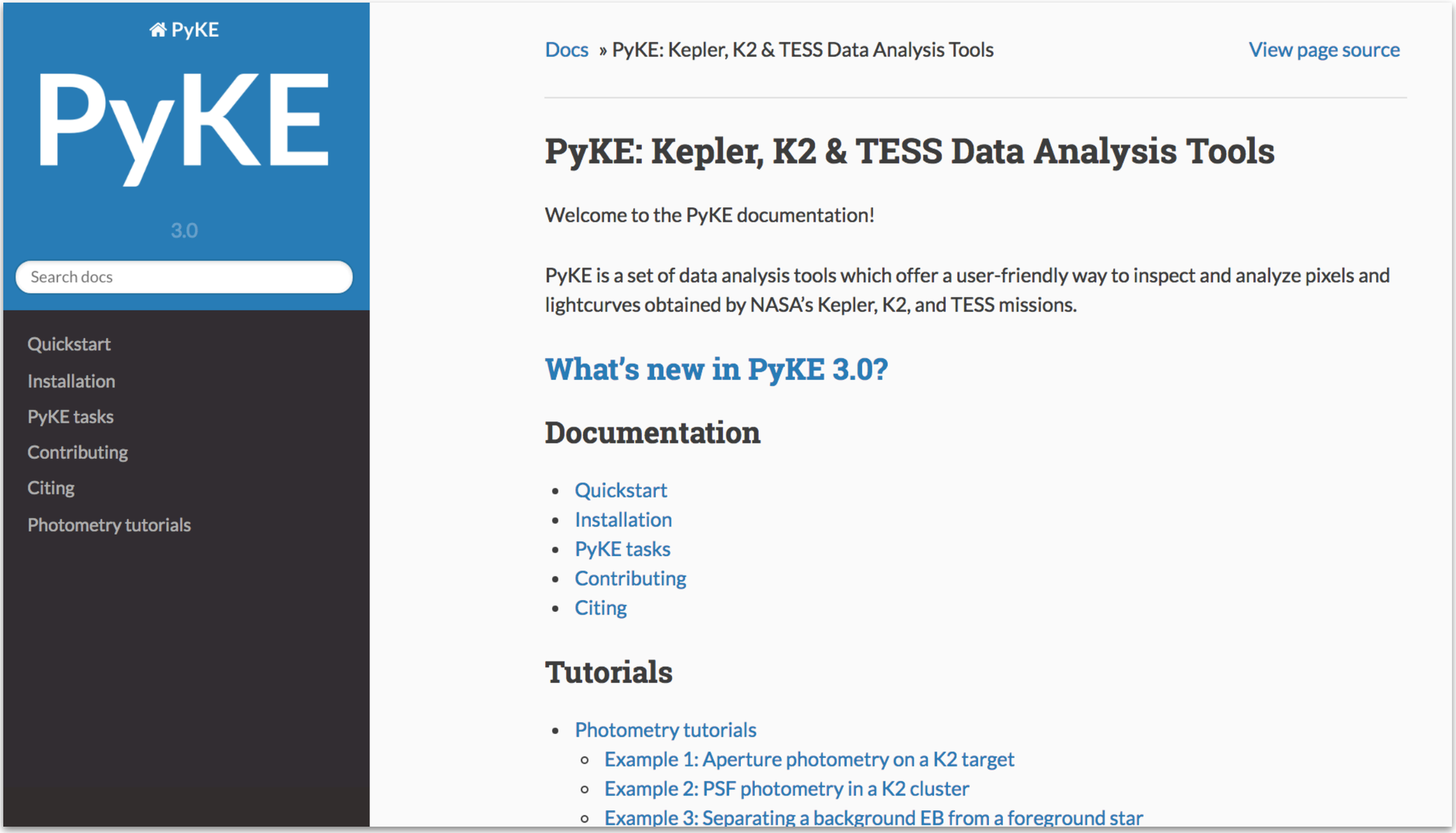
Crowded field photometry support
High Level Science Product manager
Workshop organizer

Dr Christina Hedges

Science tutorials
Solar System light curves
Chromatic abberation expert

Zé Vinícius (intern)

PyKE community tools
PSF photometry expert
Probabilistic inference



http://pyke.keplerscience.org

QuickTime Player File Edit View Window Help
55% Tue 3:36 PM
PyKE: Kepler, K2 & TESS Data
pyke.keplerscience.org/index.html

PyKE: Kepler, K2 & TESS Data Analysis Tools

Welcome to the PyKE documentation!

PyKE is a set of data analysis tools which offer a user-friendly way to inspect and analyze pixels and lightcurves obtained by NASA's Kepler, K2, and TESS missions.

What's new in PyKE 3.0?

Documentation

- Quickstart
- Installation
- PyKE tasks
- Contributing
- Citing

Tutorials

- Photometry tutorials
  - Example 1: Aperture photometry on a K2 target
  - Example 2: PSF photometry in a K2 cluster
  - Example 3: Separating a background EB from a foreground star
  - Example 4: Removing Stellar Astrophysics and Quarter Stitching

Acknowledgment

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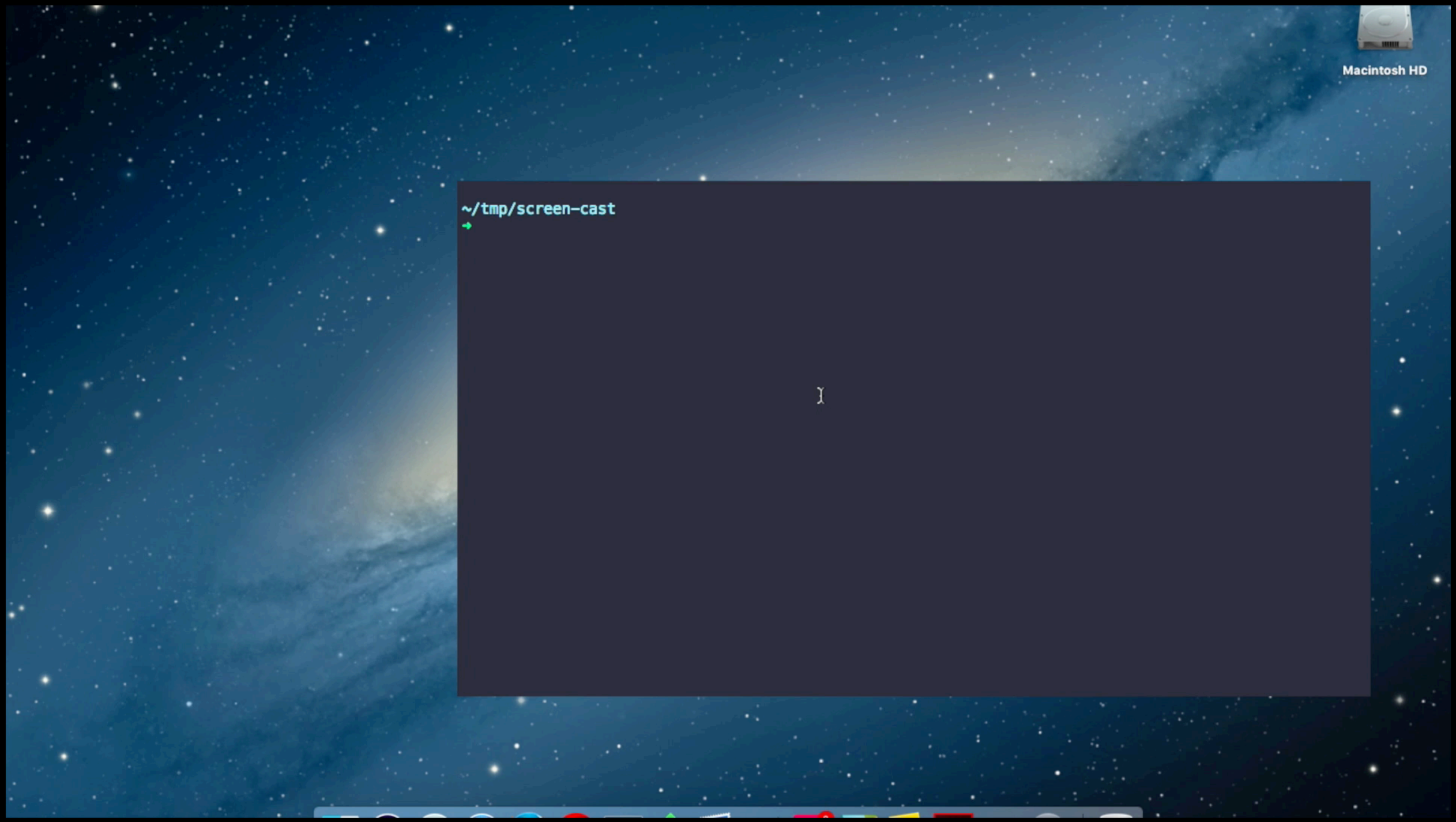
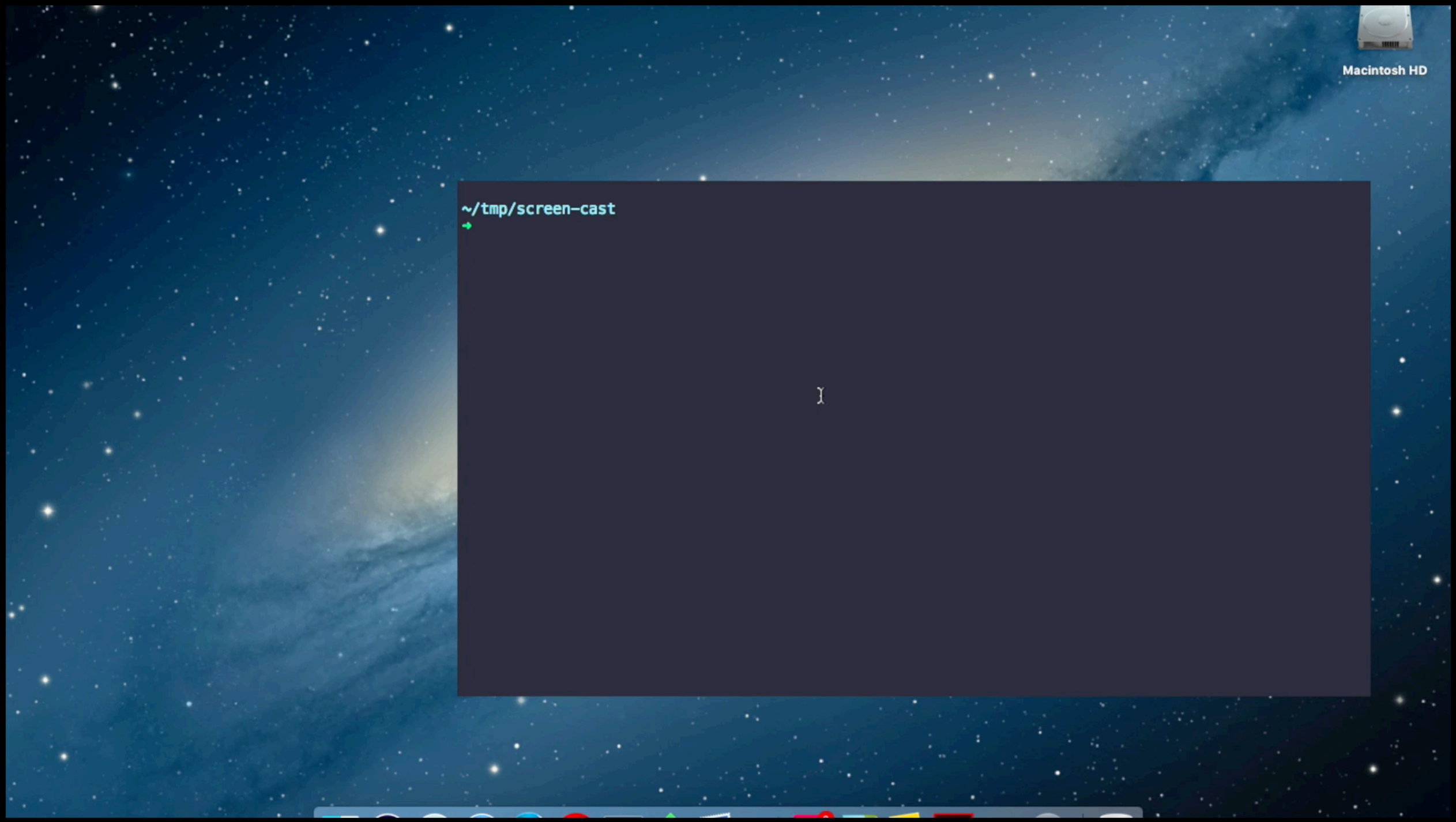

Macintosh HD
~/tmp/screen-cast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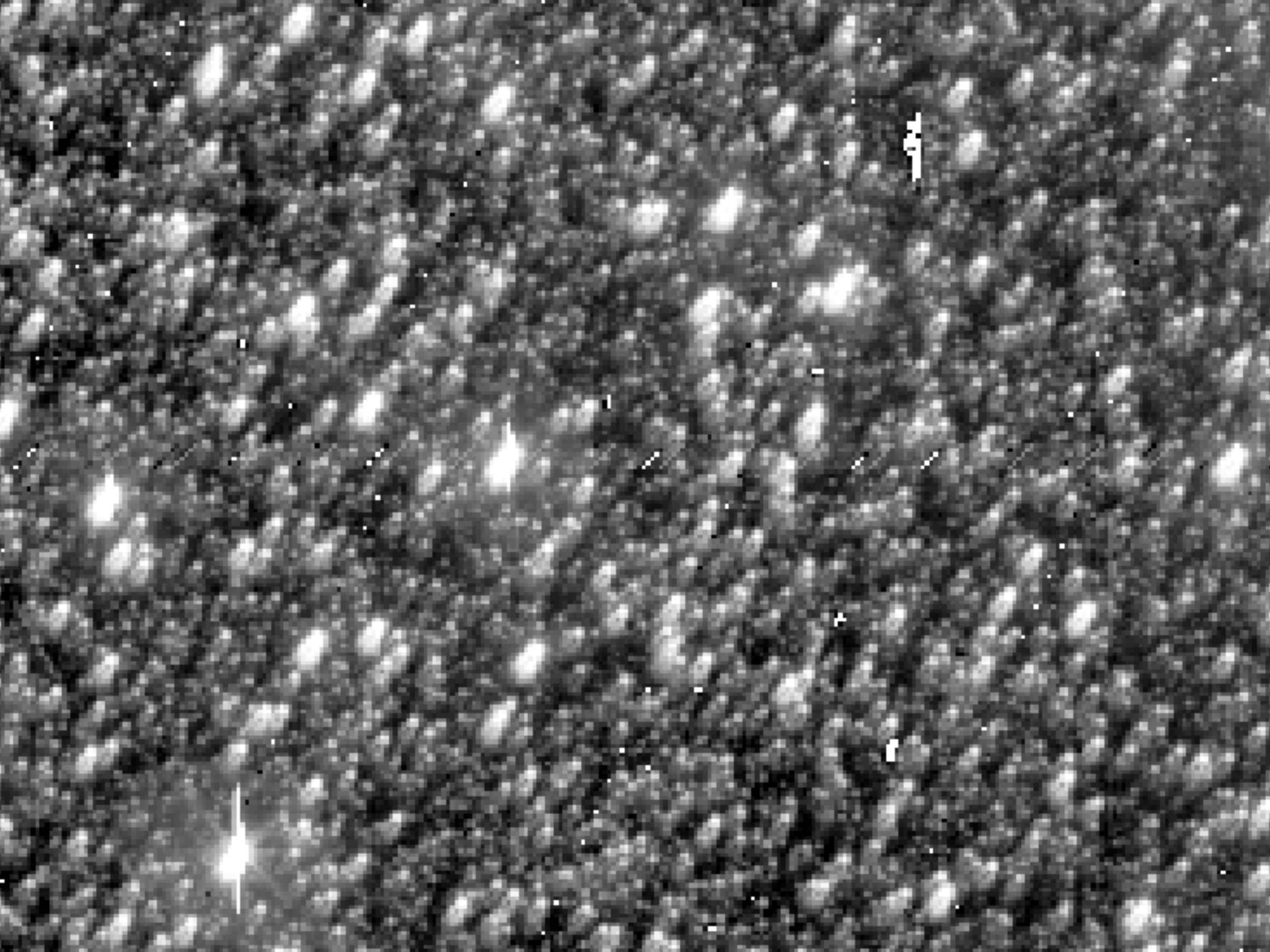
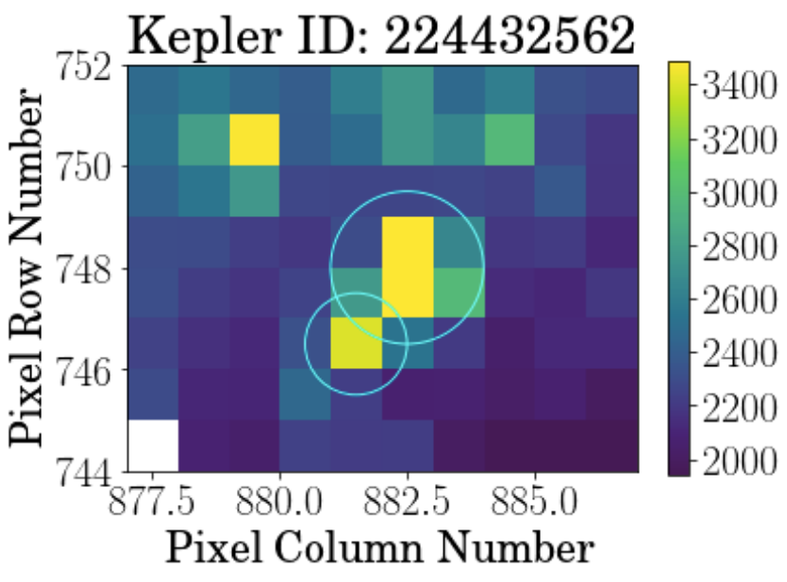
~/tmp/screen-cast

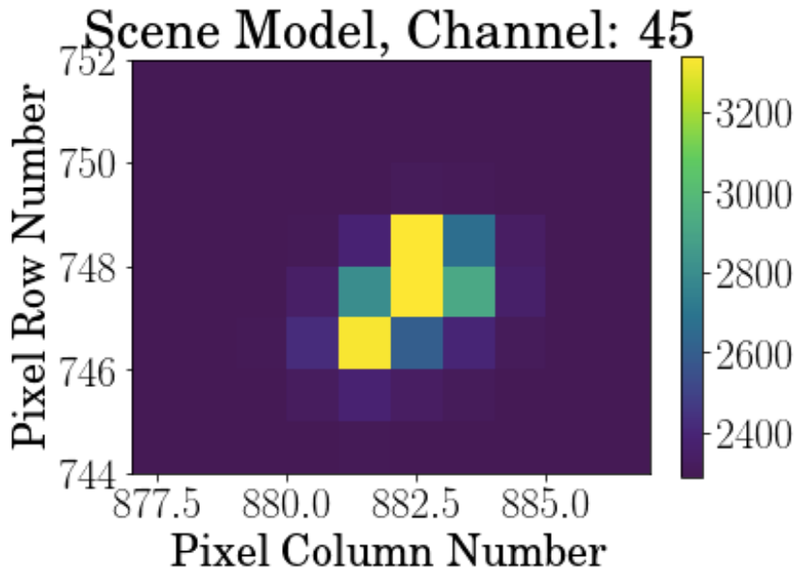
PyKE is turning into an AstroPy-quality library for building your custom pipelines and tools

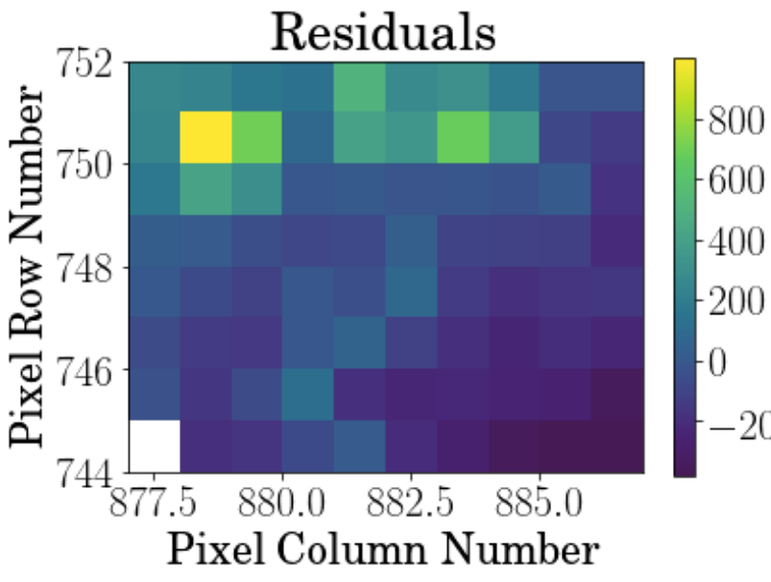
```
from pyke import KeplerTargetPixelFile

tpf = KeplerTargetPixelFile(“file.fits”)
tpf.show_movie()

lightcurve = tpf.to_lightcurve().detrend(method=“sff”)
lightcurve.fold(phase=274.1, period=31.4).plot()
```



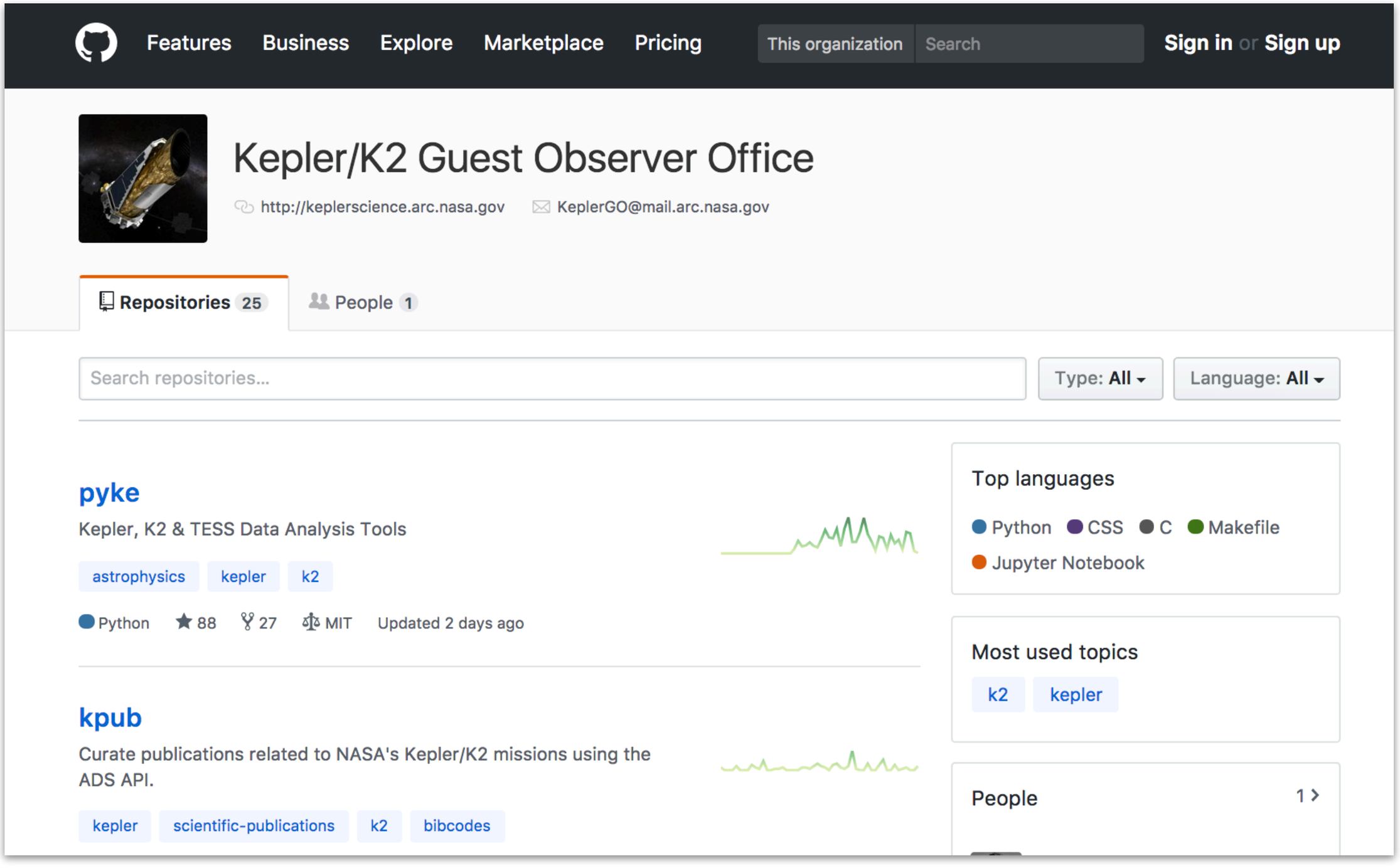
PyKE is turning into a powerful PSF photometry tool







All our tools and tutorials are on GitHub — we encourage pull requests!



Visit the K2 team at NASA Ames; we have visitor desks and coffee!

Visit the K2 team at NASA Ames; we have visitor desks and coffee!

Submit your talk by Nov 22!

Pointing Forward: Looking Back

Kepler takes a picture of Earth

2017-Dec-10 (1:30pm Pacific)

#WaveAtKepler

Image: Jim Davenport