

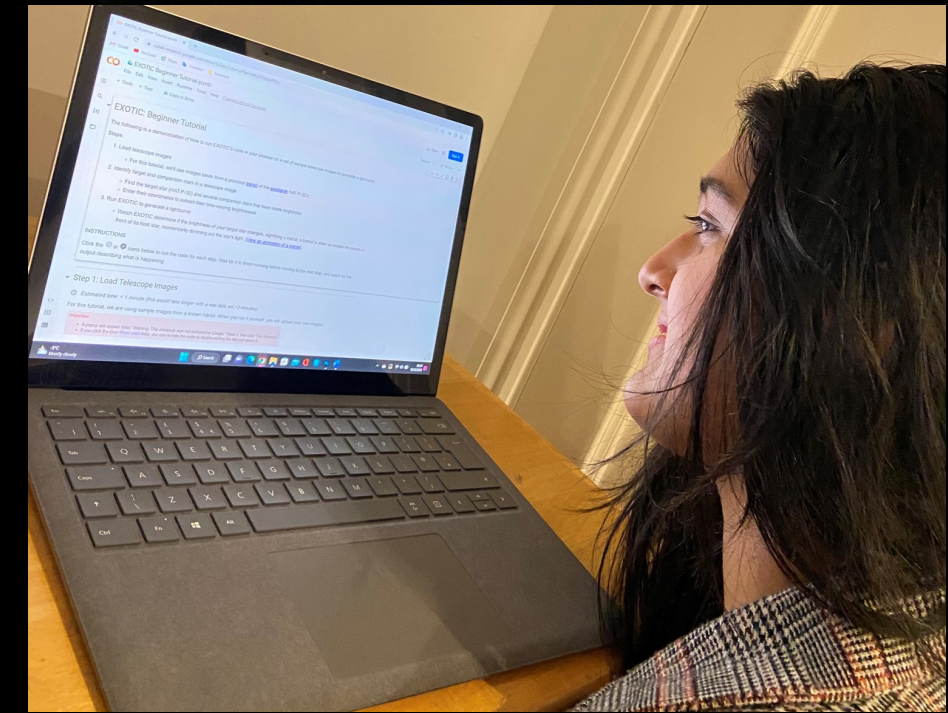
Dr. Rob Zellem (he/him)

# EXOPLANET WATCH

Inviting Citizen Scientists to  
Observe Transiting Exoplanets

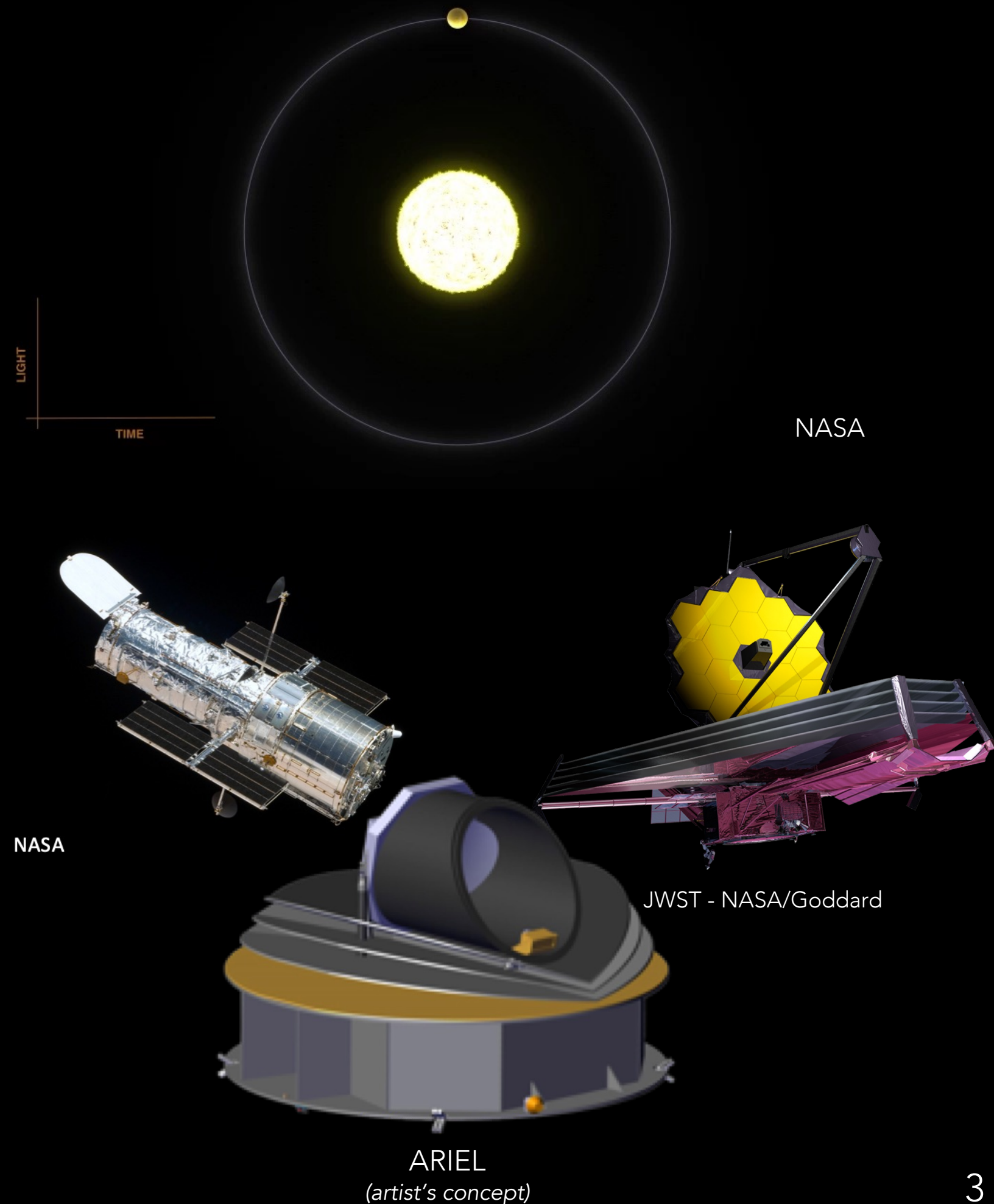
# OVERVIEW

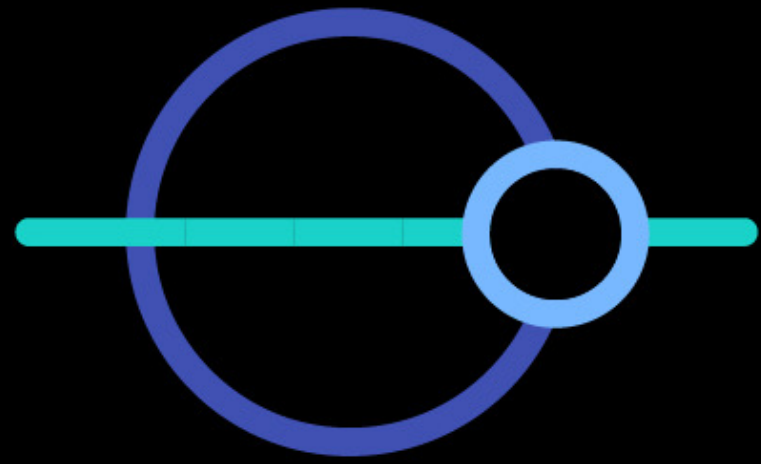
- Announcing the general audience launch of Exoplanet Watch: a citizen science project to monitor transiting exoplanets
  - Limited launch with amateur and professional astronomers since 2021
- Anyone and everyone can participate!
  - Learn how exoplanet science is really done!



# TRANSITS

- Measures the change in brightness as the planet passes in front of or behind its host star
- Also allow us to study a planet's atmosphere
  - Exoplanet Watch refines transit times
  - You can help!

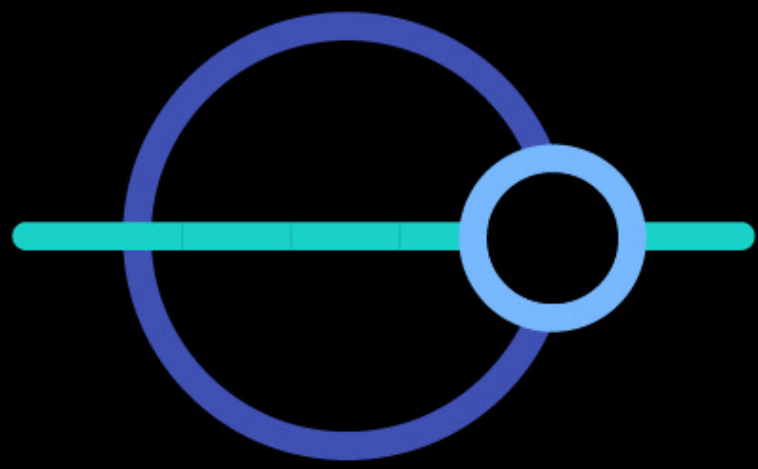




# EXOPLANET WATCH

CITIZEN SCIENTISTS MONITORING  
TRANSITING EXOPLANETS

- Citizen science project to routinely observe transiting exoplanets to keep their transit times precise
  - You will help enable NASA science!



# EXOPLANET WATCH

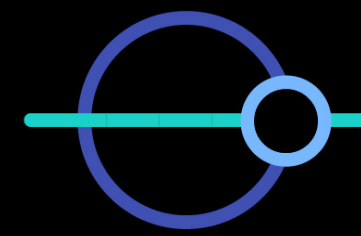
- Collaborative effort to complement existing surveys
- Data is immediately public
- Target requests by professional astronomers
- Observers are listed as co-authors
- Part of NASA's Universe of Learning



# GOALS

- **Education goals:** to engage and teach the public about exoplanets and enable them to do science
- **Science goals:** to ensure efficient use of large telescopes; discover and confirm new exoplanets; monitor stellar variability

# USER EXPERIENCE



# EXOPLANET WATCH

**What to Observe**

No matter where you are on Earth, it's likely that at least a few transiting exoplanets will be visible tonight. You can look up upcoming transits so that you know when and where to look for them. Transits can last anywhere from an hour to five or six hours, and some are even longer. When observing an exoplanet transit, it's important to capture the star's baseline brightness before the exoplanet starts passing in front of it, then capture the transit as well as an hour or two after the transit ends, so that the baseline brightness of the star can be measured again.

Name	RA	Dec	RA (h:m:s)	Dec (d:m:s)	RA (h:m:s)	Dec (d:m:s)	RA (h:m:s)	Dec (d:m:s)	RA (h:m:s)	Dec (d:m:s)
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Kepler-90d	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03
Kepler-90e	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03
Kepler-90f	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03
Kepler-90g	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03
Kepler-90h	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03
Kepler-90i	19h 59m 01s	+35d 08m 03s	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03	19:59:01	+35:08:03



Observe



AstrolmageJ

Analyze

Upload

Publish

**AAVSO**  
American Association of Variable Star Observers

Exoplanet Database: Submit Observation

Upload Here

Select Site \*

Select Equipment Package \*

Report form: \*

GDPR:  I accept the GDPR (see below)

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Exoplanet Watch partners with the MicroObservatory's DIY Planet Search to obtain robotic telescope observations of transiting exoplanets for Exoplanet Watch participants who do not have their own telescope. MicroObservatory is generously sharing ten years of archived transiting exoplanet observations with us so that you can participate in Exoplanet Watch.

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Once submitted, your data will be shared with the professional astronomers who study exoplanets and your light curve will be included on Exoplanet Watch's Results webpage. If your observations or light curves are used in a scientific paper, your name will be listed as a co-author on the paper, and you will get credit for participating in scientific research!

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The exoplanet you will be studying is randomly selected for you, so you can't request data of a specific exoplanet.

As with any astronomical observation, some nights are clear and some nights are cloudy. We can't guarantee that the data set you get will be from a clear night. If you get a cloudy data set, you can try to process it anyway and see if it works. If the sky is completely clouded over, come back in two weeks and request another data set. Hopefully it will be from a clearer night.

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Yes, Sign me up for monthly email updates from Exoplanet Watch, including nightly target identifications, software updates, and other news.

I'm not a robot



Request Data

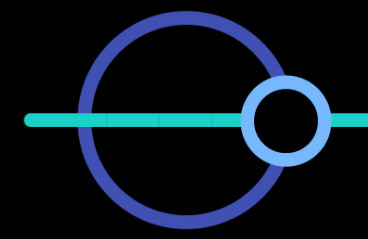
Utilizing Small Telescopes Operated by Citizen Scientists for Transiting Exoplanet Follow-up

Robert T. Zellem<sup>1</sup>, Kyle A. Pearson<sup>1,2</sup>, Ethan Blaser<sup>1,3</sup>, Martin Fowler<sup>1</sup>, David R. Ciardi<sup>4</sup>, Anya Biferno<sup>1</sup>, Bob Massey<sup>5</sup>, Franck Marchis<sup>6</sup>, Robert Baer<sup>7,8</sup>, Conley Ball<sup>9</sup>, Mike Chasin<sup>10,11</sup>, Mike Conley<sup>12</sup>, Scott Dixon<sup>13,14</sup>, Elizabeth Flecker<sup>15</sup>, Sanyela Hernandez<sup>16</sup>, Saiy Nair<sup>17</sup>, Quinn Peran<sup>18</sup>, Frank Sienkiewicz<sup>19</sup>, Kalle Toek<sup>20</sup>, Vivek Vijayakumar<sup>21</sup>, Mark R. Swain<sup>22</sup>, Gad M. Roudier<sup>23</sup>, Geoffrey Bryden<sup>24</sup>, Dennis M. CoRoT<sup>25</sup>, Doreen H. Hill<sup>26</sup>, Carl W. Hergeimboer<sup>27</sup>, Mary Drossart<sup>28</sup>, Stephen R. Kane<sup>29</sup>, Michael Fitzgerald<sup>30</sup>, Pat Boyce<sup>31</sup>, Laura Petroska<sup>32</sup>, Wilfred Ge<sup>33</sup>, Lynn Cominsky<sup>34</sup>, Rachel Zimmerman-Brachman<sup>35</sup>, Denise Smith<sup>36</sup>, Michelle J. Creech-Eakman<sup>37</sup>, John Engleke<sup>38</sup>, Alexandra Burradell<sup>39</sup>, Diana Dragomir<sup>40,41,42</sup>, Nemanja Jovanovic<sup>43</sup>, Brandon Lawton<sup>44</sup>, Emmanuel Arbouche<sup>45</sup>, Marc Kuchner<sup>46</sup>, and Armand Michard<sup>47</sup>

**Abstract**

Due to the efforts by numerous ground-based surveys and NASA's Kepler and Transiting Exoplanet Survey Satellite (TESS), there will be hundreds, if not thousands, of transiting exoplanets ideal for atmospheric characterization via spectroscopy with large platforms such as James Webb Space Telescope and ARIEL. However their next predicted mid-transit time could become so increasingly uncertain over time that significant overhead would be required to ensure the detection of the entire transit. As a result, follow-up observations to characterize these exoplanetary atmospheres would require less-efficient use of an observer's time—which is an issue for large platforms where minimizing observing overheads is a necessity. Here we demonstrate the power of citizen scientists operating smaller observatories (<1 m) to keep ephemerides "fresh," defined here as when the 1 $\sigma$  uncertainty in the mid-transit time is less than half the transit duration. We advocate for the creation of a community-wide effort to perform ephemeris maintenance on transiting exoplanets by citizen scientists. Such observations can be conducted with even a 6 inch telescope, which has the potential to save up to ~10,000 days for a 1000-planet survey. Based on a preliminary analysis of 14 transits from a single 6 inch MicroObservatory telescope, we empirically estimate the ability of small telescopes to benefit the community. Observations with a

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Name	Host Star	Distance (ly)	Transit Depth (%)
Kepler-90c	Kepler-90	1050	0.84
Kepler-11f	Kepler-11	1050	0.84
Kepler-16b	Kepler-16	1024	0.84
Kepler-18f	Kepler-18	124	0.84
Kepler-22b	Kepler-22	124	0.84
Kepler-37d	Kepler-37	495	0.84
Kepler-41b	Kepler-41	538	0.84
Kepler-43b	Kepler-43	4700	0.84
Kepler-43c	Kepler-43	4700	0.84
Kepler-43d	Kepler-43	4700	0.84
Kepler-43e	Kepler-43	4700	0.84
Kepler-43f	Kepler-43	4700	0.84
Kepler-43g	Kepler-43	4700	0.84
Kepler-43h	Kepler-43	4700	0.84
Kepler-43i	Kepler-43	4700	0.84
Kepler-43j	Kepler-43	4700	0.84
Kepler-43k	Kepler-43	4700	0.84
Kepler-43l	Kepler-43	4700	0.84
Kepler-43m	Kepler-43	4700	0.84
Kepler-43n	Kepler-43	4700	0.84
Kepler-43o	Kepler-43	4700	0.84
Kepler-43p	Kepler-43	4700	0.84
Kepler-43q	Kepler-43	4700	0.84
Kepler-43r	Kepler-43	4700	0.84
Kepler-43s	Kepler-43	4700	0.84
Kepler-43t	Kepler-43	4700	0.84
Kepler-43u	Kepler-43	4700	0.84
Kepler-43v	Kepler-43	4700	0.84
Kepler-43w	Kepler-43	4700	0.84
Kepler-43x	Kepler-43	4700	0.84
Kepler-43y	Kepler-43	4700	0.84
Kepler-43z	Kepler-43	4700	0.84

1. You can prioritize the Exoplanet Watch targets by selecting the "Exoplanet Watch targets" radio button at the top of the form.

2. Select an observatory near your location or choose "manual coordinate entry" at the end of the list.

3. Under "Date window" select the "base date" that you would like to begin scheduling and fill in the appropriate number of days before and/or after this base date. In addition, you can optionally include constraints on the target's elevation during the transit if your horizon has limited visibility.

4. Once you hit the "Submit" button, the service might take a few seconds to minutes to load, depending on the number of days you have requested.

5. On the page that does open, you can sort the planets according to their "Exoplanet Watch rank" where a low number (e.g., 1) is higher priority than a larger number (e.g., 1000). You can also filter your targets based upon the host star's "Magnitude (V, 'mag') and the expected transit depth ("Depth, 'mm") in units of parts per thousand (ppm). You can sort the list by the date, by the name of the exoplanet, or by the Exoplanet Watch rank, as well as by the magnitude of the star.



## Observe



**AAVSO**  
American Association of Variable Star Observers

Exoplanet Database: Submit Observation

Upload Here

Select Site \*

Select Equipment Package \*

Report form: \*

Choose File: No files selected

Image(s): \*

Choose File(s): No files selected

Submit

I accept the OEPH (see below)

\* This field is required  
\* Cannot find your site and/or equipment? Add it here: Site & Equipment  
\* You must check the OEPH box to confirm that you understand that the personal information contained in the Site and/or Equipment selection is part of the data shared with others when they download your data.

Publications of the Astronomical Society of the Pacific, 132:054-011 (2pp), 2020 May  
https://doi.org/10.1088/1538-3873/ab70c7

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<sup>1</sup>Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA; rzellem@jpl.nasa.gov  
<sup>2</sup>Lunar and Planetary Laboratory, University of Arizona, 629 E. University Blvd, Tucson, AZ 85721, USA  
<sup>3</sup>University of Virginia, Charlottesville, VA 22904, USA  
<sup>4</sup>Citizen Scientist, Leix Riogardes, Orford Road, South Wootton, Wiltshire SO21 1EX, UK  
<sup>5</sup>NASA Exoplanet Science Institute, California Institute of Technology, MC 114-6, 1201 E. California Blvd, Pasadena, CA 91125, USA  
<sup>6</sup>American Association of Variable Star Observers, 49 Bay State Rd, Cambridge, MA 02138, USA  
<sup>7</sup>SETI Institute, 1515 Bernardo Ave, Suite 200, Mountain View, CA 94043, USA  
<sup>8</sup>Unalaska, 19 rue Vaum, F-10011 Marville, France  
<sup>9</sup>Southern Illinois University Carbondale, MC 4001, 1245 Lincoln Dr, Carbondale, IL 62901, USA  
<sup>10</sup>Citizen CATE, Equipment, USA  
<sup>11</sup>Laguna Blanca School, 4125 Paloma Dr, Santa Barbara, CA 93110, USA  
<sup>12</sup>Boyce Research Institute and Education Foundation, USA  
<sup>13</sup>San Diego Astronomers Association, USA  
<sup>14</sup>Towson University, 800 York Rd, Towson, MD 21286, USA  
<sup>15</sup>Stanford Online High School, 415 Broadway Academy Hall, Floor 2, 885, Redwood City, CA 94063, USA  
<sup>16</sup>The Center for Astrophysics, Harvard & Smithsonian, 60 Garden Street, Cambridge, MA 02138, USA  
<sup>17</sup>Department of Earth and Planetary Sciences, University of California, Riverside, CA 92521, USA  
<sup>18</sup>Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027, Australia  
<sup>19</sup>Southern State University, 1801 East Costa Ave, Robert Park, CA 94928, USA  
<sup>20</sup>Macquarie University, Sydney, New South Wales 2109, Australia  
<sup>21</sup>Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA  
<sup>22</sup>Department of Physics, New Mexico Institute of Mining and Technology, 801 Leroy Place, Socorro, NM 87801, USA  
<sup>23</sup>Raytheon Intelligence, Information, and Services, 100 N Lake Ave, Suite 1120, Pasadena, CA 91101, USA  
<sup>24</sup>The University of New Mexico, Albuquerque, NM 87131, USA  
<sup>25</sup>Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, USA  
<sup>26</sup>Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM, USA  
<sup>27</sup>California Institute of Technology, 1200 East California Boulevard, Pasadena, CA 91125, USA  
<sup>28</sup>NASA Goddard Space Flight Center, 800 Greenbelt Rd, Greenbelt, MD 20771, USA  
<sup>29</sup>Received 2019 September 26, accepted 2020 March 11, published 2020 April 8

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<sup>30</sup> NASA Hubble Fellow.

## Plan

## AstrolmageJ

## Analyze

## Upload

## Publish

**How to Participate**

Get Involved | How to Observe | How to Analyze Your Data | How to Submit Your Data | Request an Exoplanet Observation

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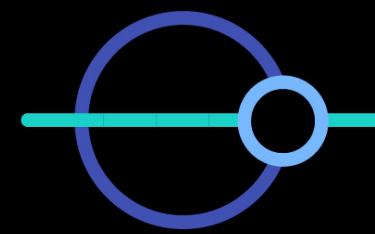
Submit



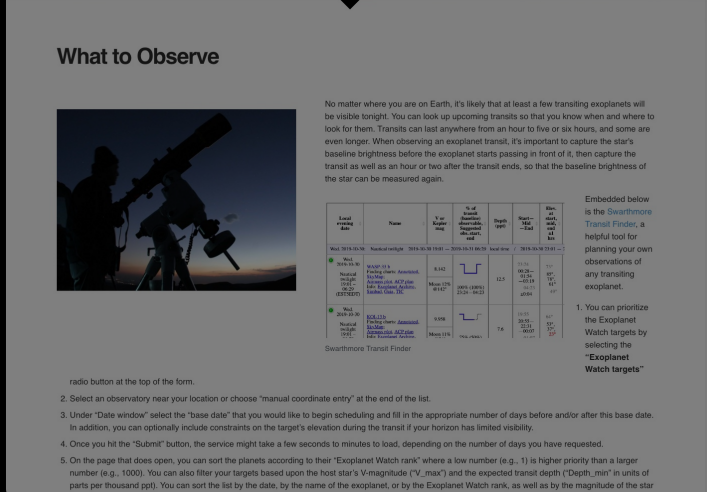
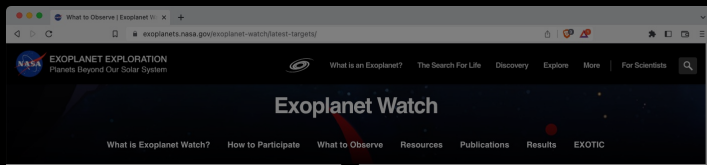
## Request Data



# USER EXPERIENCE



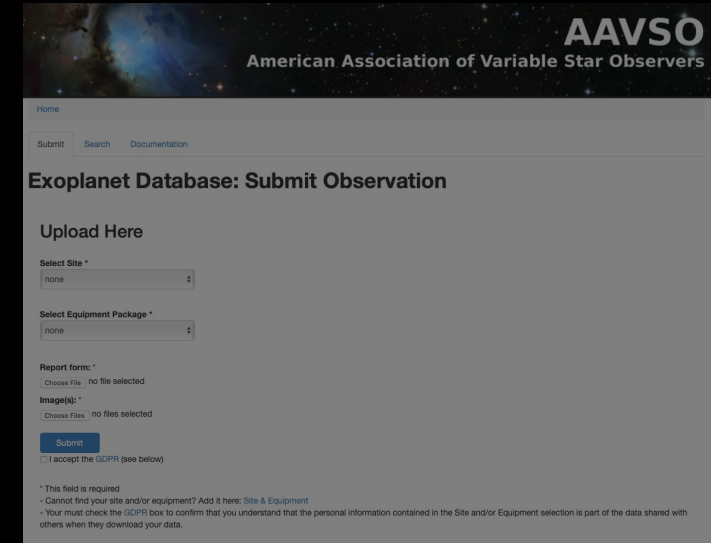
# EXOPLANET WATCH



Plan

Observe

EXOTIC

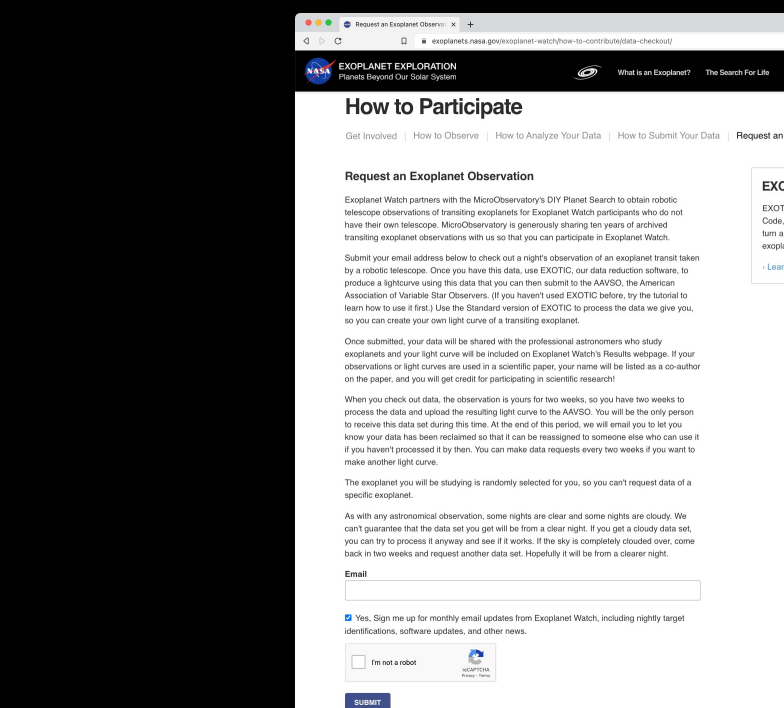


AstroImageJ

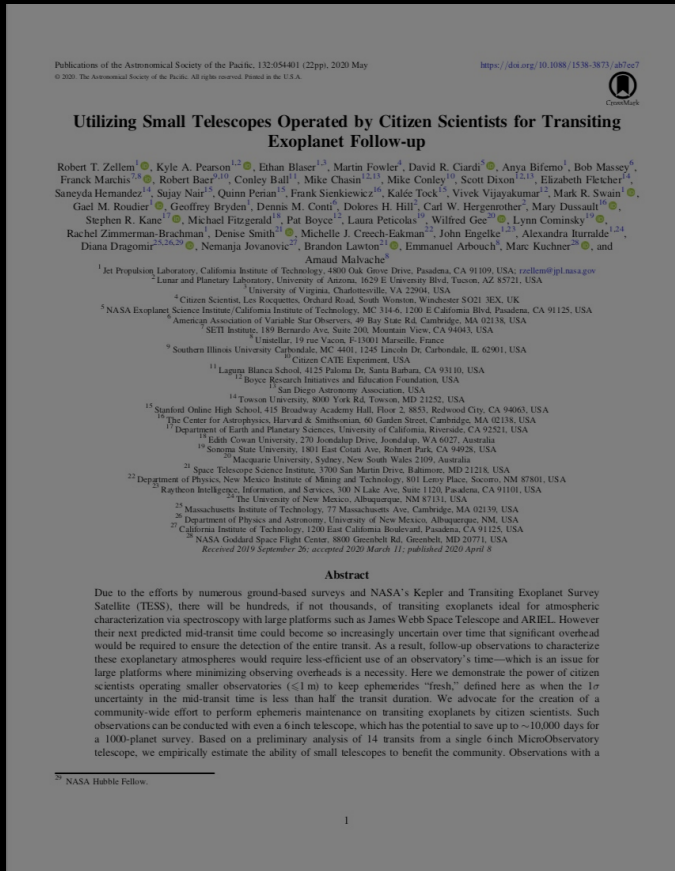
Analyze

Upload

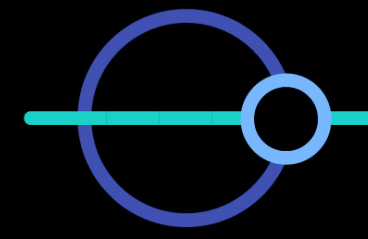
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Name	RA	Dec	Mag	Duration	Start	End
Kepler-90b	19h 08m 47s	+35° 10' 26"	12.7	1.2h	2023-09-01 00:00	2023-09-01 01:20
Kepler-90c	19h 08m 47s	+35° 10' 26"	12.7	1.2h	2023-09-01 00:00	2023-09-01 01:20
Kepler-90d	19h 08m 47s	+35° 10' 26"	12.7	1.2h	2023-09-01 00:00	2023-09-01 01:20



Observe



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American Association of Variable Star Observers

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Upload Here

Select Site \*

Select Equipment Package \*

Report form: \*

Image(s): \*

Submit

Utilizing Small Telescopes Operated by Citizen Scientists for Transiting Exoplanet Follow-up

Robert T. Zellem<sup>1</sup>, Kyle A. Pearson<sup>2,3</sup>, Ethan Blaser<sup>3,4</sup>, Martin Fowler<sup>5</sup>, David R. Ciardi<sup>6</sup>, Anya Biferno<sup>7</sup>, Bob Massey<sup>8</sup>, Franck Marchis<sup>9</sup>, Robert Baer<sup>10</sup>, Conley Ball<sup>11</sup>, Mike Chasin<sup>12,13</sup>, Mike Conley<sup>14</sup>, Scott Dixon<sup>15,16</sup>, Elizabeth Flecker<sup>17</sup>, Sanyela Hernandez<sup>18</sup>, Saiy Nair<sup>19</sup>, Quinn Perian<sup>20</sup>, Frank Sienkiewicz<sup>21</sup>, Kalle Toal<sup>22</sup>, Virek Vijayakumar<sup>23</sup>, Mark R. Swain<sup>24</sup>, Gad M. Roudier<sup>25</sup>, Geoffrey Bryden<sup>26</sup>, Dennis M. CoRoT<sup>27</sup>, Doreen H. Hill<sup>28</sup>, Carl W. Hergenrother<sup>29</sup>, Mary Doussall<sup>30</sup>, Stephen R. Kane<sup>31</sup>, Michael Fitzgerald<sup>32</sup>, Pat Boyce<sup>33</sup>, Laura Petricola<sup>34</sup>, Wilfred Ge<sup>35</sup>, Lynn Cominsky<sup>36</sup>, Rachel Zimmerman-Brachman<sup>37</sup>, Denise Smith<sup>38</sup>, Michelle J. Creech-Eakman<sup>39</sup>, John Engelke<sup>40</sup>, Alexandra Burnald<sup>41</sup>, Diana Dragomir<sup>42,43,44</sup>, Nemanja Jovanovic<sup>45</sup>, Brandon Lawton<sup>46</sup>, Emmanuel Abouch<sup>47</sup>, Marc Kuchner<sup>48</sup>, and Armand Michard<sup>49</sup>

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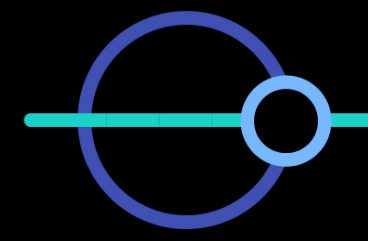
Yes, Sign me up for monthly email updates from Exoplanet Watch, including nightly target identifications, software updates, and other news.

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# EXOPLANET WATCH

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Name	Date	Duration	Magnitude
Kepler-90b	2019-09-09	1.5h	12.7
Kepler-90c	2019-09-09	1.5h	12.7
Kepler-90d	2019-09-09	1.5h	12.7
Kepler-90e	2019-09-09	1.5h	12.7
Kepler-90f	2019-09-09	1.5h	12.7
Kepler-90g	2019-09-09	1.5h	12.7
Kepler-90h	2019-09-09	1.5h	12.7
Kepler-90i	2019-09-09	1.5h	12.7
Kepler-90j	2019-09-09	1.5h	12.7



Observe



**AAVSO**  
American Association of Variable Star Observers

**Exoplanet Database: Submit Observation**

Upload Here

Select Site \*

Select Equipment Package \*

Report form: \*

Images: \*

Submit

I accept the GDPR (see below)

\* This field is required  
- Cannot find your site and/or equipment? Add it here: Site & Equipment  
- You must check the GDPR box to confirm that you understand that the personal information contained in the Site and/or Equipment selection is part of the data shared with others when they download your data.

Publications of the Astronomical Society of the Pacific, 132:054-011 (22pp), 2020 May  
https://doi.org/10.1088/1538-3873/ab70c7

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<sup>1</sup>Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA; rzellem@jpl.nasa.gov  
<sup>2</sup>Lunar and Planetary Laboratory, University of Arizona, 629 E. University Blvd, Tucson, AZ 85721, USA  
<sup>3</sup>University of Virginia, Charlottesville, VA 22904, USA  
<sup>4</sup>Citizen Scientist, Leix Ricqurtes, Orchard Road, South Wootton, Winchester SO21 1EX, UK  
<sup>5</sup>NASA Exoplanet Science Institute, California Institute of Technology, MC 114-6, 1201 E. California Blvd, Pasadena, CA 91125, USA  
<sup>6</sup>American Association of Variable Star Observers, 49 Bay State Rd, Cambridge, MA 02138, USA  
<sup>7</sup>SETI Institute, 1515 Bennett Ave, Suite 200, Mountain View, CA 94043, USA  
<sup>8</sup>Univallée, 19 rue Vacon, F-13001 Marseille, France  
<sup>9</sup>Southern Illinois University Carbondale, MC 4001, 1245 Lincoln Dr, Carbondale, IL 62901, USA  
<sup>10</sup>Citizen CATE, Equipment, USA  
<sup>11</sup>Laguna Blanca School, 4125 Paloma Dr, Santa Barbara, CA 93110, USA  
<sup>12</sup>Boyce Research Institute and Education Foundation, USA  
<sup>13</sup>San Diego Astronomy Association, USA  
<sup>14</sup>Towson University, 800 York Rd, Towson, MD 21286, USA  
<sup>15</sup>Stanford Online High School, 415 Broadway Academy Hall, Floor 2, 885, Redwood City, CA 94063, USA  
<sup>16</sup>The Center for Astrophysics, Harvard & Smithsonian, 60 Garden Street, Cambridge, MA 02138, USA  
<sup>17</sup>Department of Earth and Planetary Sciences, University of California, Riverside, CA 92521, USA  
<sup>18</sup>Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027, Australia  
<sup>19</sup>Southern State University, 1801 East Costa Ave, Robert Park, CA 94928, USA  
<sup>20</sup>Macquarie University, Sydney, New South Wales 2109, Australia  
<sup>21</sup>Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA  
<sup>22</sup>Department of Physics, New Mexico Institute of Mining and Technology, 801 Leroy Place, Socorro, NM 87801, USA  
<sup>23</sup>Raytheon Intelligence, Information, and Services, 100 N Lake Ave, Suite 1120, Pasadena, CA 91101, USA  
<sup>24</sup>The University of New Mexico, Albuquerque, NM 87131, USA  
<sup>25</sup>Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, USA  
<sup>26</sup>Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM, USA  
<sup>27</sup>California Institute of Technology, 1201 East California Boulevard, Pasadena, CA 91125, USA  
<sup>28</sup>NASA Goddard Space Flight Center, 800 Greenbelt Rd, Greenbelt, MD 20771, USA  
<sup>29</sup>Received 2019 September 26, accepted 2020 March 11, published 2020 April 8

**Abstract**

Due to the efforts by numerous ground-based surveys and NASA's Kepler and Transiting Exoplanet Survey Satellite (TESS), there will be hundreds, if not thousands, of transiting exoplanets ideal for atmospheric characterization via spectroscopy with large platforms such as James Webb Space Telescope and ARIEL. However their next predicted mid-transit time could become so increasingly uncertain over time that significant overhead would be required to ensure the detection of the entire transit. As a result, follow-up observations to characterize these exoplanetary atmospheres would require less-efficient use of an observer's time—which is an issue for large platforms where minimizing observing overheads is a necessity. Here we demonstrate the power of citizen scientists operating smaller observatories (<1 m) to keep ephemerides "fresh," defined here as when the 1 $\sigma$  uncertainty in the mid-transit time is less than half the transit duration. We advocate for the creation of a community-wide effort to perform ephemeris maintenance on transiting exoplanets by citizen scientists. Such observations can be conducted with even a 6-inch telescope, which has the potential to save up to ~10,000 days for a 1000-planet survey. Based on a preliminary analysis of 14 transits from a single 6-inch MicroObservatory telescope, we empirically estimate the ability of small telescopes to benefit the community. Observations with a

<sup>30</sup> NASA Hubble Fellow.

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Get Involved | How to Observe | How to Analyze Your Data | How to Submit Your Data | Request an Exoplanet Observation

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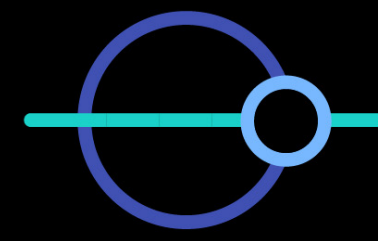
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I'm not a robot



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Name	Distance (ly)	Size (Earth radii)	Transit Depth (%)
Kepler-90c	1050	1.19	0.0084
Kepler-11f	1050	1.04	0.0084
Kepler-11g	1050	1.04	0.0084
Kepler-11h	1050	1.04	0.0084
Kepler-11i	1050	1.04	0.0084
Kepler-11j	1050	1.04	0.0084
Kepler-90d	1050	1.19	0.0084
Kepler-90e	1050	1.19	0.0084
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Kepler-90g	1050	1.19	0.0084
Kepler-90h	1050	1.19	0.0084
Kepler-90i	1050	1.19	0.0084
Kepler-90j	1050	1.19	0.0084
Kepler-90k	1050	1.19	0.0084
Kepler-90l	1050	1.19	0.0084
Kepler-90m	1050	1.19	0.0084
Kepler-90n	1050	1.19	0.0084
Kepler-90o	1050	1.19	0.0084
Kepler-90p	1050	1.19	0.0084
Kepler-90q	1050	1.19	0.0084
Kepler-90r	1050	1.19	0.0084
Kepler-90s	1050	1.19	0.0084
Kepler-90t	1050	1.19	0.0084
Kepler-90u	1050	1.19	0.0084
Kepler-90v	1050	1.19	0.0084
Kepler-90w	1050	1.19	0.0084
Kepler-90x	1050	1.19	0.0084
Kepler-90y	1050	1.19	0.0084
Kepler-90z	1050	1.19	0.0084

**Submit**



Observe

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Upload Here

Select Site \*

Select Equipment Package \*

Report Form: \*

I accept the CEPPH (see below)

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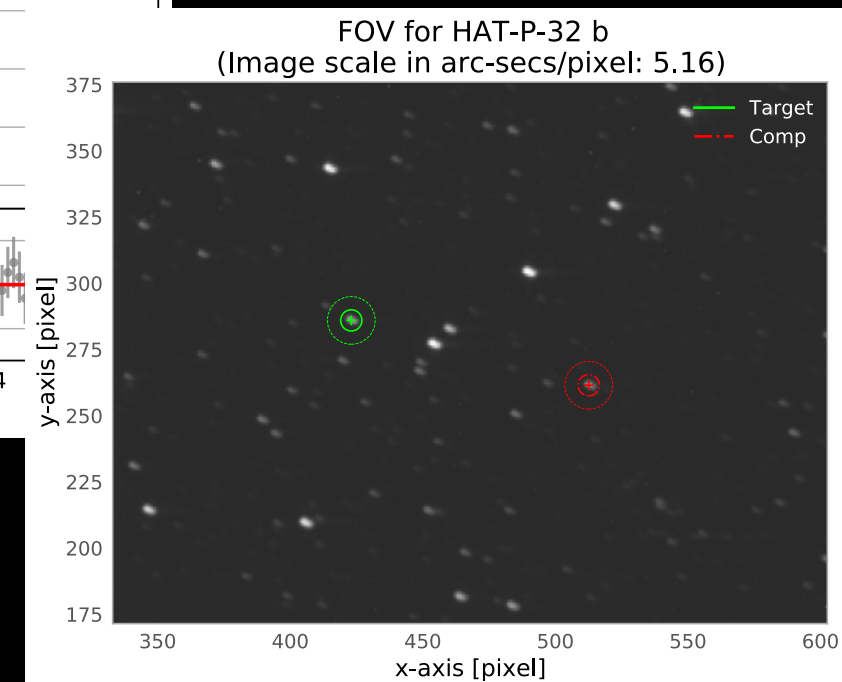
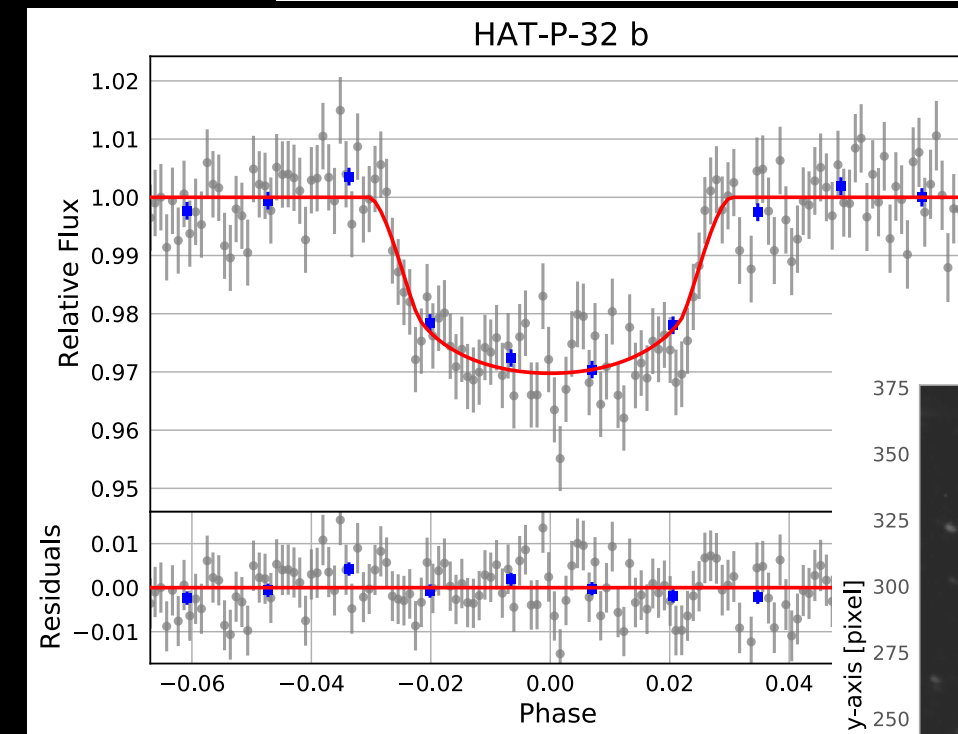
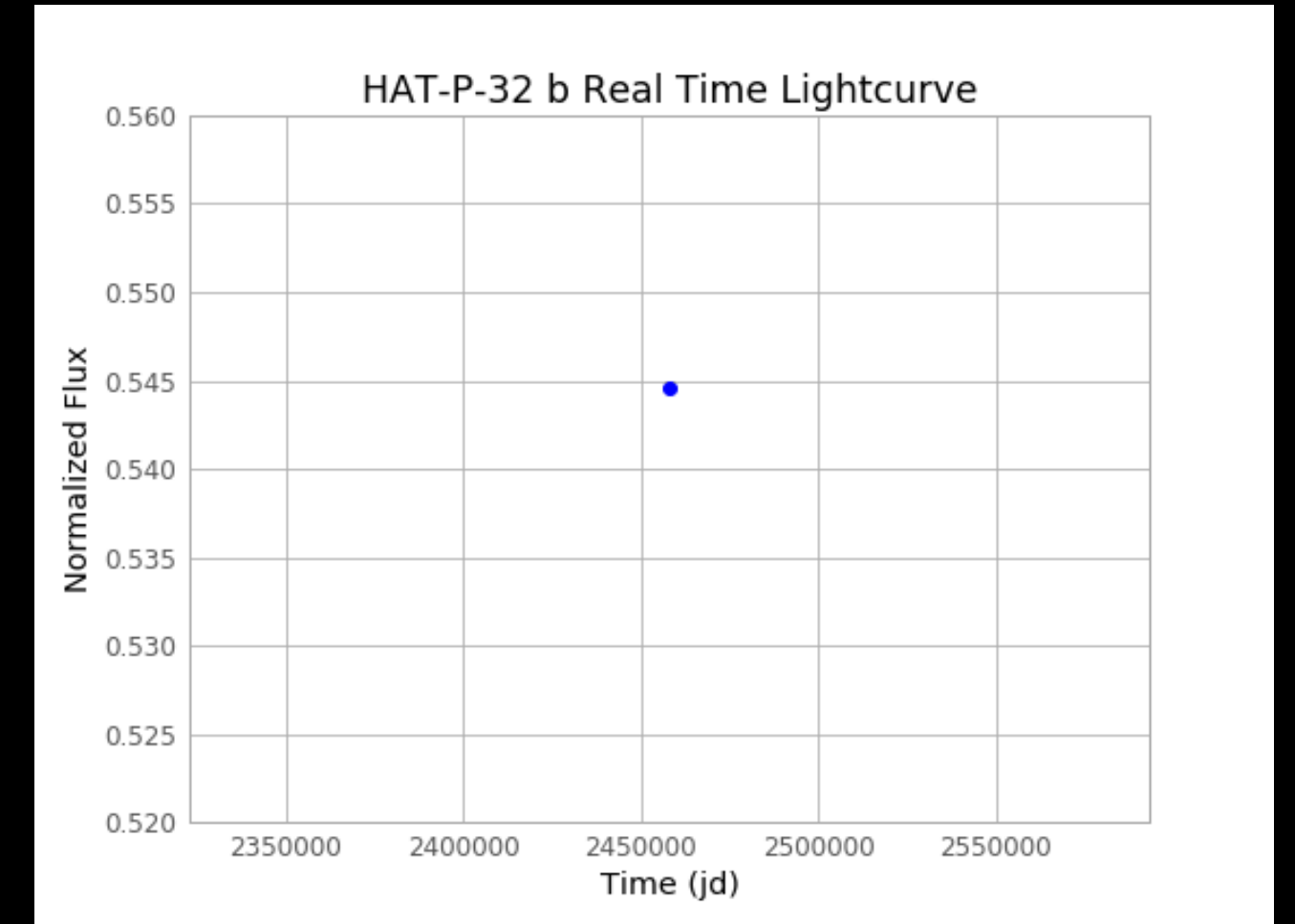
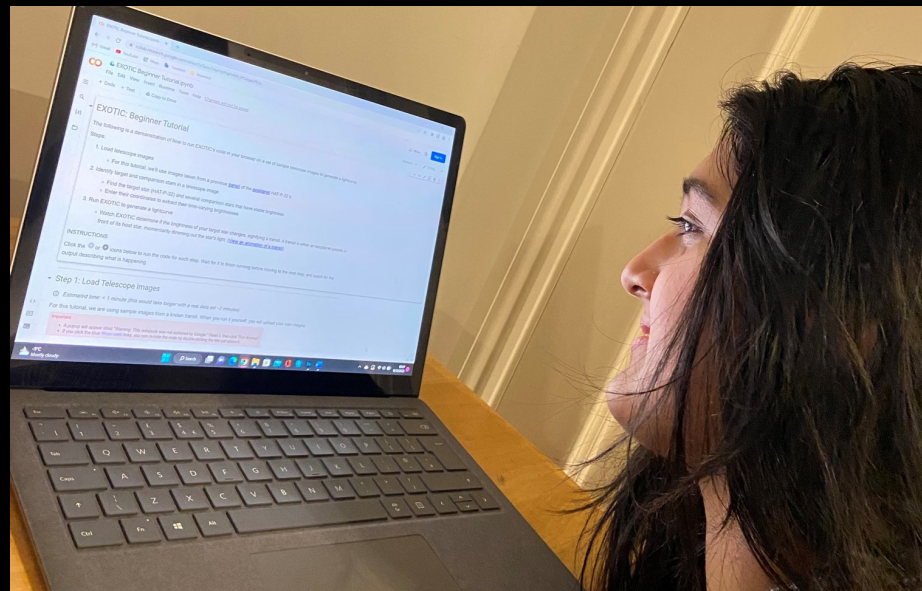
**REQUEST DATA**



Request Data

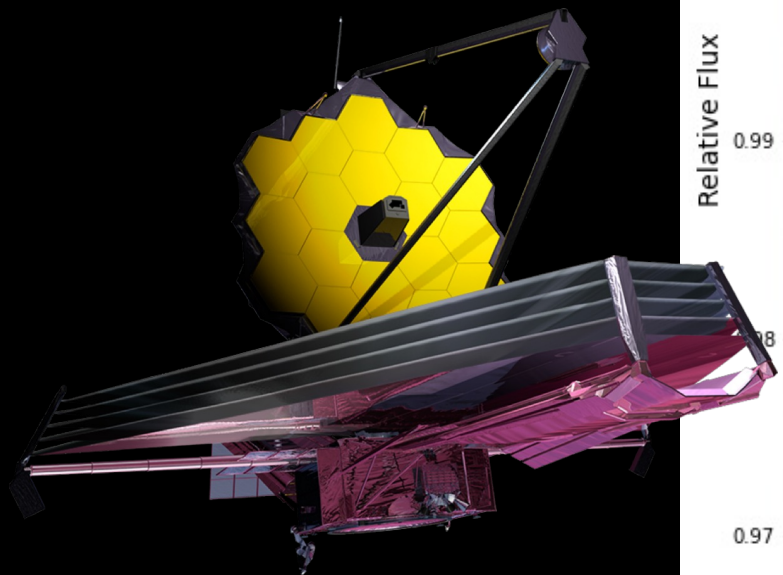
# EXOTIC

- EXOplanet Transit Interpretation Code
- Real astronomy analysis tool
- Teach you how science is done
- Have step-by-step tutorials on how to use

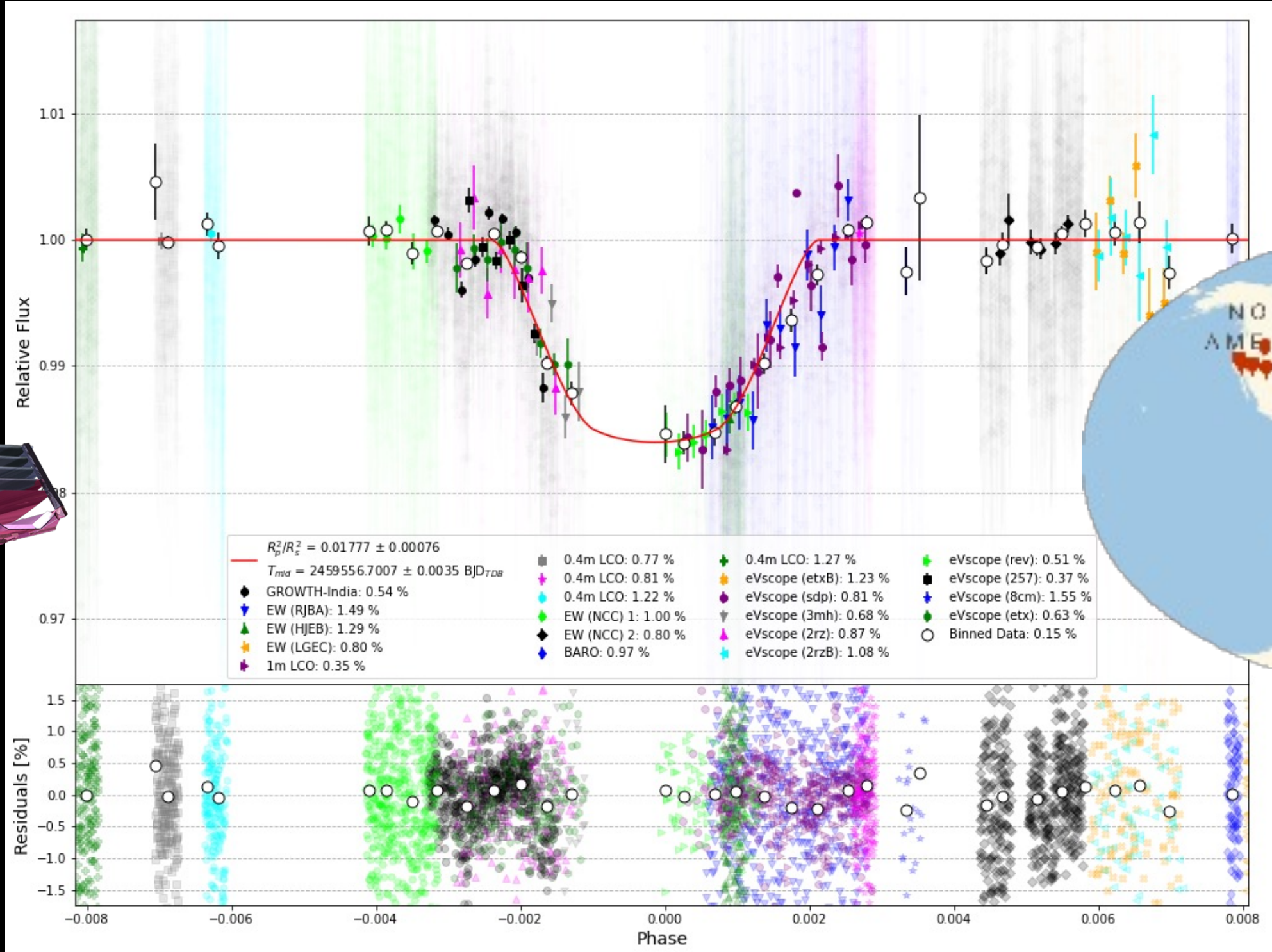


Zellem et al. 2020

# DEC 2021 OBSERVING CAMPAIGN

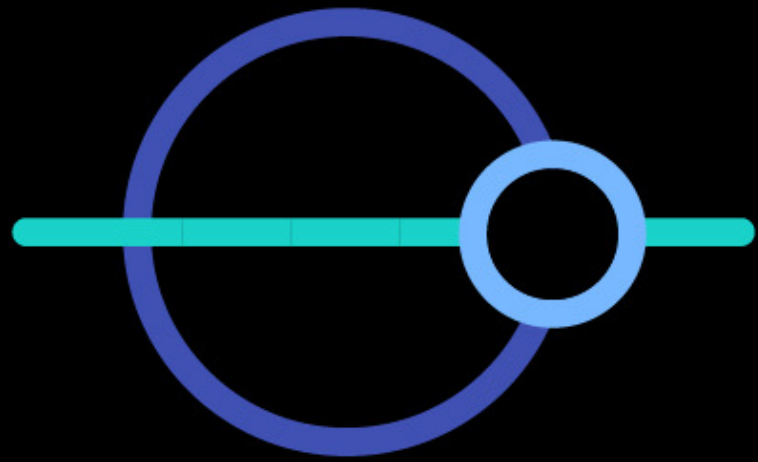


JWST - NASA/Goddard



24 facilities;  $\leq 0.7\text{-m}$  (30-in)

Pearson et al. (2022)



# EXOPLANET WATCH

Get started here:  
[exoplanets.nasa.gov/exoplanet-  
watch](https://exoplanets.nasa.gov/exoplanet-watch)



Exoplanet Watch  
Workshop  
Jan 18, 2023, 4 PM EST







# DEC 2021 OBSERVING CAMPAIGN

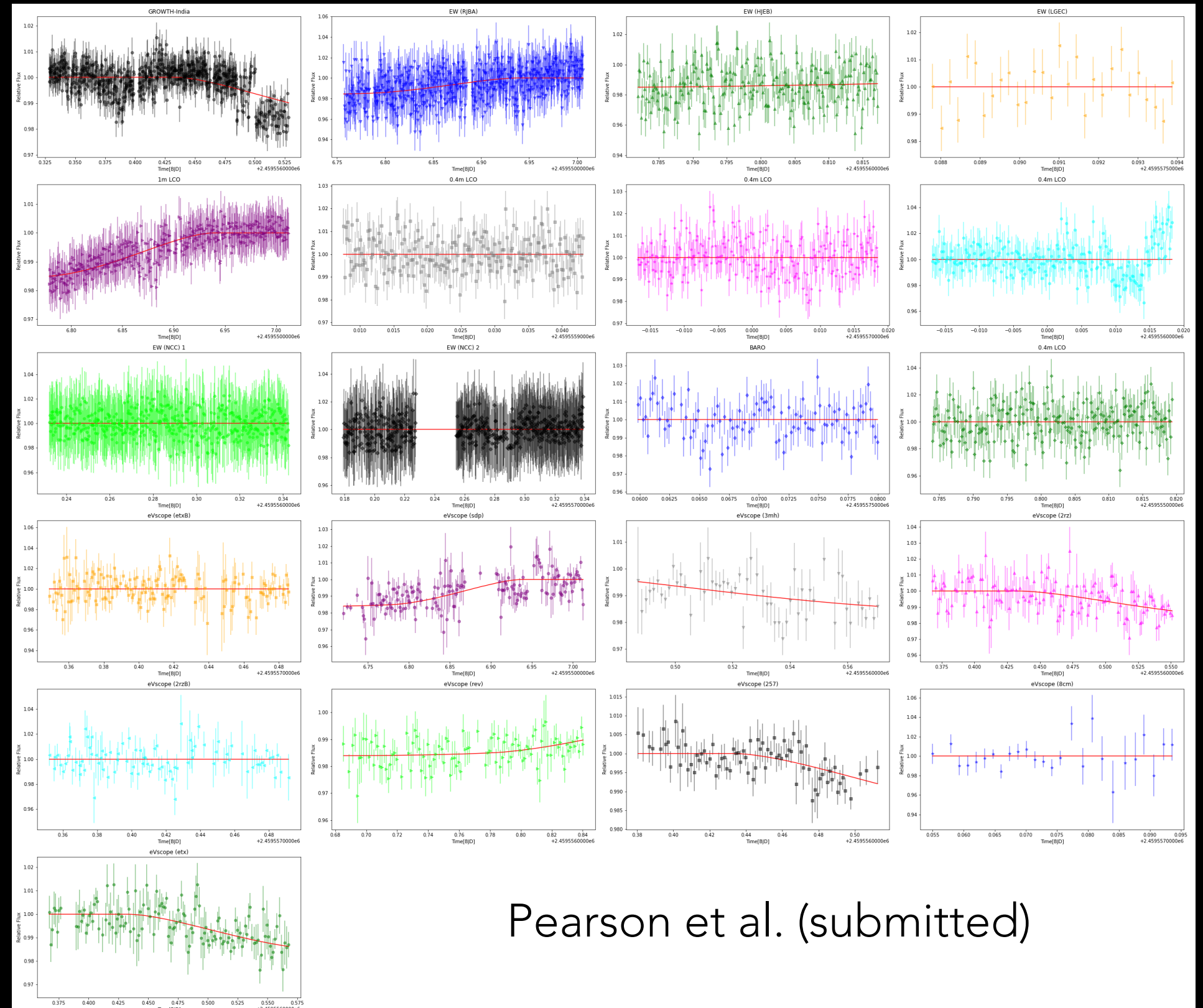
- World-wide observing campaign of HD 80606b
- In support of JWST observations this ~fall
- 12-hour long transit
- Requires multiple observers across the world



Pearson et al. (submitted)

# DEC 2021 OBSERVING CAMPAIGN

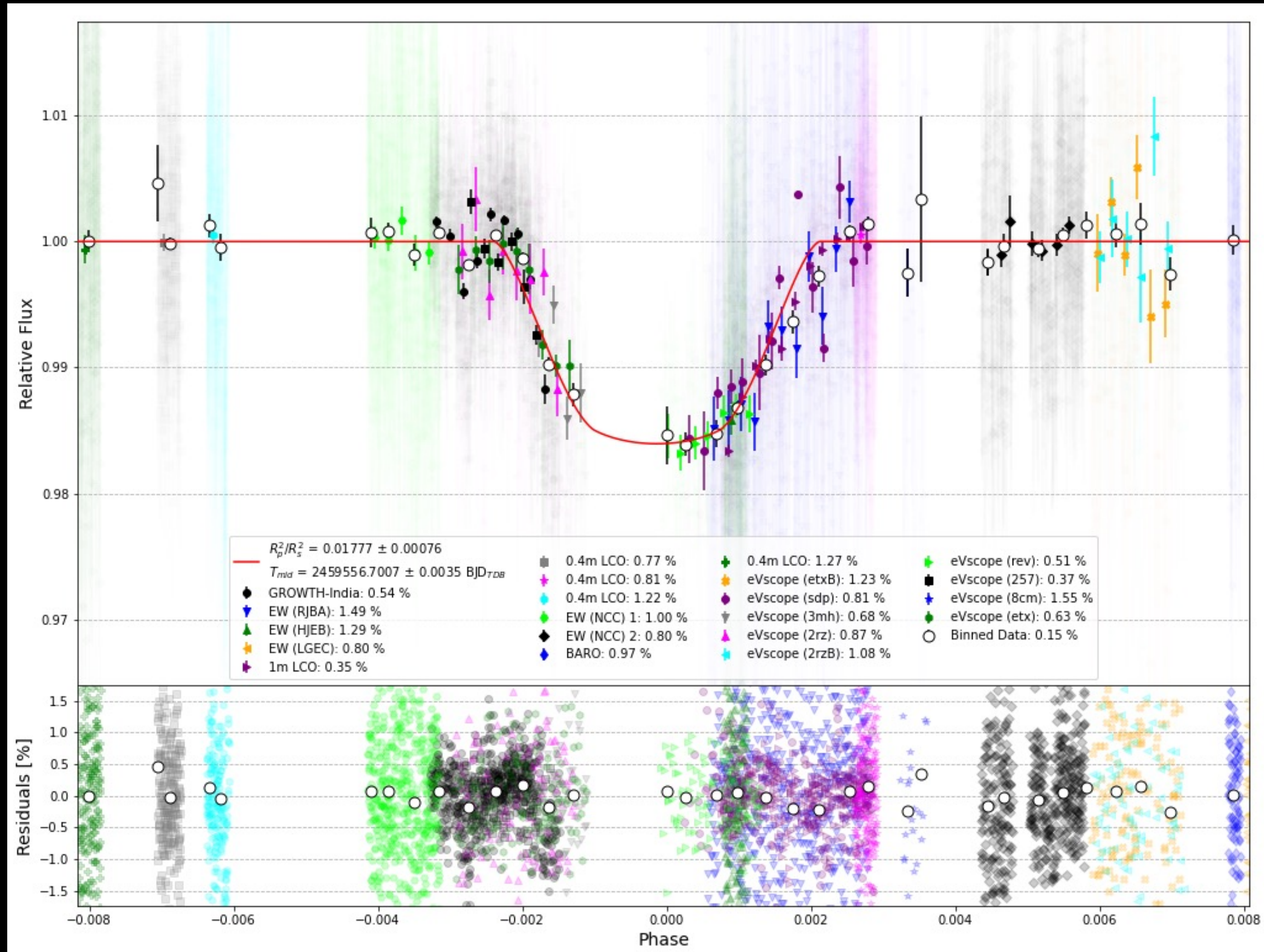
Facility	Location (N,E)	Size (m)
Transiting Exoplanet Survey Satellite (TESS)	Space	0.1
Exoplanet Watch [HJEB]	(30.7, -104.2)	0.4
Las Cumbres (LCO)	(30.7, -104.2)	0.4
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Exoplanet Watch [NCC]	(23.5, 120.9)	0.4
Unistellar eVscope 2 (2rz)	(49.2, -0.4)	0.11
Unistellar eVscope (etx)	(49.2, -0.4)	0.11
Unistellar eVscope (257)	(60.8, 24.4)	0.11
Unistellar eVscope (3mh)	(45.3, 11.1)	0.11
Exoplanet Watch [GDAI]	(39.0, -108.2)	0.4
Unistellar eVscope (rev)	(30.4, 97.8)	0.11
Unistellar eVscope (sdp)	(32.2, -111)	0.11
GROWTH-India	(32.8, 79.0)	0.7
Exoplanet Watch [RJBA]	(34.1, -118.1)	0.15
Las Cumbres (LCO)	(30.7, -104.2)	1
Exoplanet Watch [HJEB]	(30.7, -104.2)	0.4
Las Cumbres (LCO)	(30.7, -104.2)	0.4
Unistellar eVscope (8cm)	(35.1, 134.4)	0.11
Exoplanet Watch [NCC]	(23.5, 120.9)	0.4
Unistellar eVscope 2 (2rzB)	(49.2, -0.4)	0.11
Unistellar eVscope (etxB)	(49.2, -0.4)	0.11
Boyce-Astro Research Observatory (BARO)	(32.6, -116.3)	0.43
Exoplanet Watch [LGEC]	(28.3, -16.6)	0.4
Exoplanet Watch [FMAA]	(31.7, -111.1)	0.15



24 facilities;  $\leq 0.7$ -m (30-in)

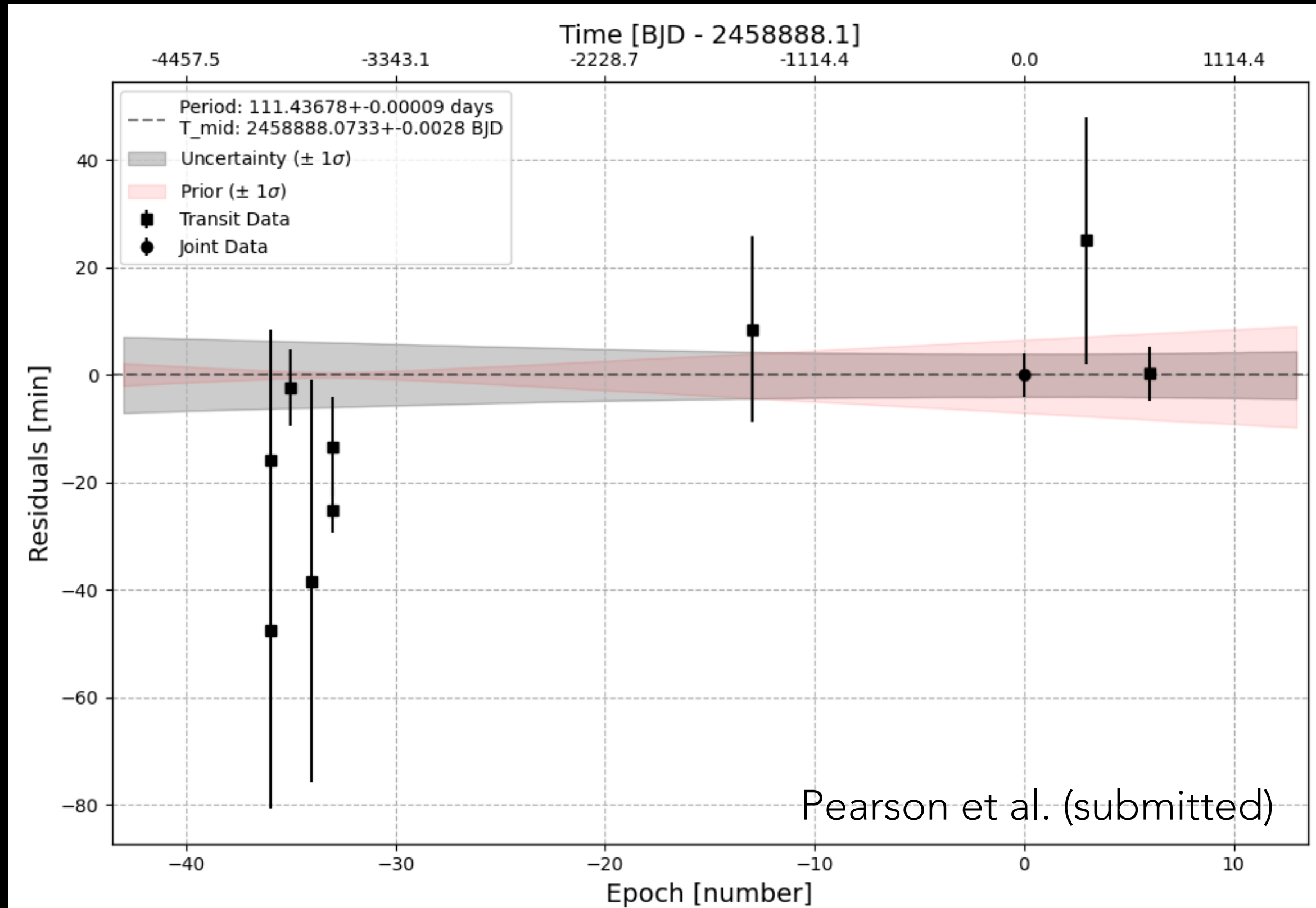
Pearson et al. (submitted)

# DEC 2021 OBSERVING CAMPAIGN

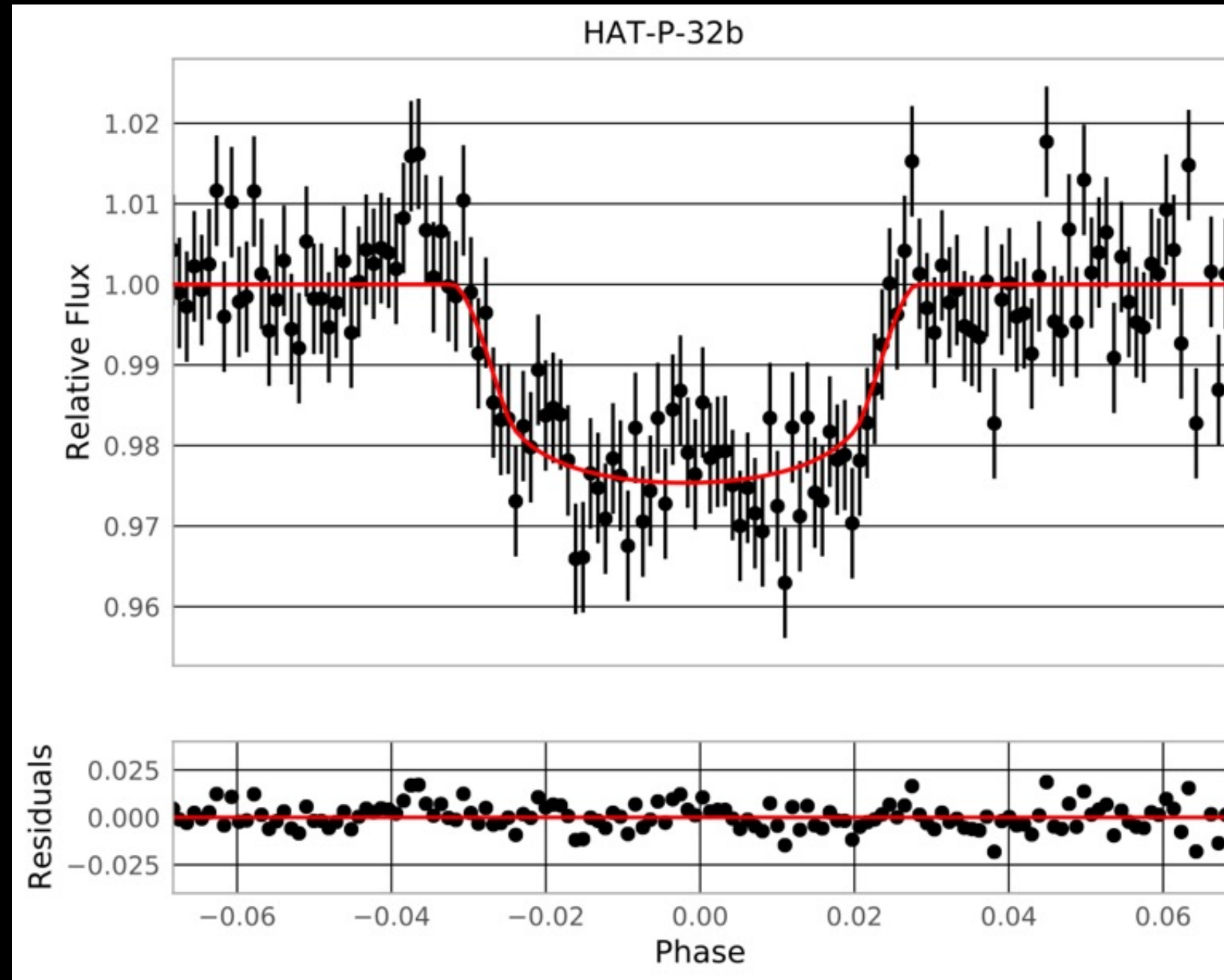


Pearson et al. (submitted)

# DEC 2021 OBSERVING CAMPAIGN



# MICROOBSERVATORY DATA



Zellem et al. (2020)

# CITISENS PIPELINE

1. Scrape

```
*****
Fitting a Light Curve Model to Your Data
*****
Sampling 2 chains, 0 divergences: 4% | ██████████
```

2. Process

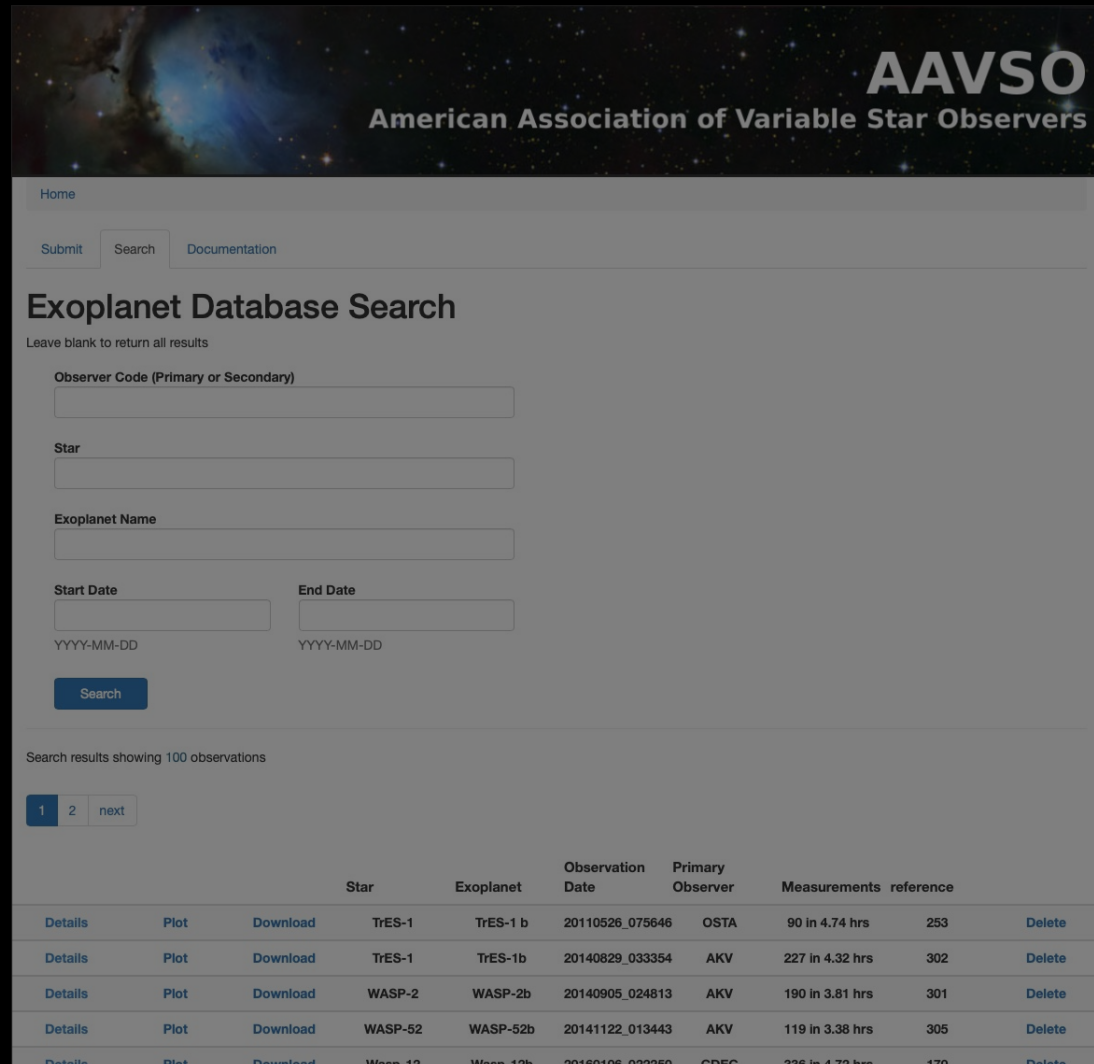


## EXOPLANET WATCH

Planet Name *	Host Star Metallicity	Host Star log(g)	Host Star Radius [R_Sun]	Host Star Effective Temperature [K]	a/R <sub>s</sub>	eccentricity	inclination [degrees]	omega [degrees]	orbital period [days]	R <sub>p</sub> [R_Earth]
CoRoT-2 b	0.03	4.42	0.9	5696.0	6.711	0.0	88.07	102.0	1.742997	15.85
CoRoT-7 b	0.03	4.54	0.84	5313.0	4.26	0.0	80.1	160.0	0.854	1.58
CoRoT-8 b	0.3	4.58	0.8	5080.0	13.7	0.19	88.18	0.0	6.212445	6.94
CoRoT-14 b	0.05	4.34	1.21	6040.0	4.854	0.036	79.6	0.0	1.51214	12.22
CoRoT-18 b	-0.1	4.4	1.0	5440.0	7.16	0.025	89.9	0.0	1.9000769	12.85
GJ 436 b	-0.03	4.84	0.46	3350.0	14.54	0.145	86.858	-25.0	2.64389751	4.19
GJ 1214 b	0.29	4.99	0.21	3026.0	14.85	0.063	88.7	0.0	1.58040454	2.746
GJ 3470 b	0.2	4.66	0.48	3652.0	12.92	0.114	89.13	-82.5	3.336649	3.88
HAT-P-1 b	0.13	4.38	1.14	5975.0	9.853	0.0	86.11	253.1	4.4652992	13.92
HAT-P-3 b	0.27	4.56	0.83	5185.0	10.05	0.0	86.31	107.7	2.89973826	10.21
HAT-P-5 b	0.24	4.37	1.12	5960.0	7.8	0.072	86.16	0.0	2.788491	13.57
HAT-P-6 b	-0.13	4.22	1.46	6570.0	7.73	0.044	85.51	94.1	3.8529962	14.91
HAT-P-7 b	0.233	3.97	1.84	6350.0	4.602	0.0	87.21	165.0	2.2047363	16.42
HAT-P-8 b	0.01	4.15	1.58	6200.0	6.13	0.006	87.5	116.0	3.0763433	16.81

3. Publish

# CITISENS PIPELINE



1. Scrape

```
*****
Fitting a Light Curve Model to Your Data
*****
Sampling 2 chains, 0 divergences: 4% | ██████████
```

2. Process



## EXOPLANET WATCH

Planet Name *	Host Star Metallicity	Host Star log(g)	Host Star Radius [R_Sun]	Host Star Effective Temperature [K]	a/R <sub>s</sub>	eccentricity	inclination [degrees]	omega [degrees]	orbital period [days]	R <sub>p</sub> [R_Earth]
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CoRoT-7 b	0.03	4.54	0.84	5313.0	4.26	0.0	80.1	160.0	0.854	1.58
CoRoT-8 b	0.3	4.58	0.8	5080.0	13.7	0.19	88.18	0.0	6.212445	6.94
CoRoT-14 b	0.05	4.34	1.21	6040.0	4.854	0.036	79.6	0.0	1.51214	12.22
CoRoT-18 b	-0.1	4.4	1.0	5440.0	7.16	0.025	89.9	0.0	1.9000769	12.85
GJ 436 b	-0.03	4.84	0.46	3350.0	14.54	0.145	86.858	-25.0	2.64389751	4.19
GJ 1214 b	0.29	4.99	0.21	3026.0	14.85	0.063	88.7	0.0	1.58040454	2.746
GJ 3470 b	0.2	4.66	0.48	3652.0	12.92	0.114	89.13	-82.5	3.336649	3.88
HAT-P-1 b	0.13	4.38	1.14	5975.0	9.853	0.0	86.11	253.1	4.4652992	13.92
HAT-P-3 b	0.27	4.56	0.83	5185.0	10.05	0.0	86.31	107.7	2.89973826	10.21
HAT-P-5 b	0.24	4.37	1.12	5960.0	7.8	0.072	86.16	0.0	2.788491	13.57
HAT-P-6 b	-0.13	4.22	1.46	6570.0	7.73	0.044	85.51	94.1	3.8529962	14.91
HAT-P-7 b	0.233	3.97	1.84	6350.0	4.602	0.0	87.21	165.0	2.2047363	16.42
HAT-P-8 b	0.01	4.15	1.58	6200.0	6.13	0.006	87.5	116.0	3.0763433	16.81

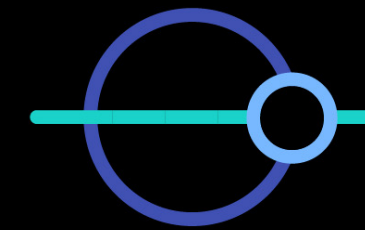
3. Publish

# CITISENS PIPELINE

1. Scrape

```
*****
Fitting a Light Curve Model to Your Data
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Sampling 2 chains, 0 divergences: 4% | ██████████
```

2. Process



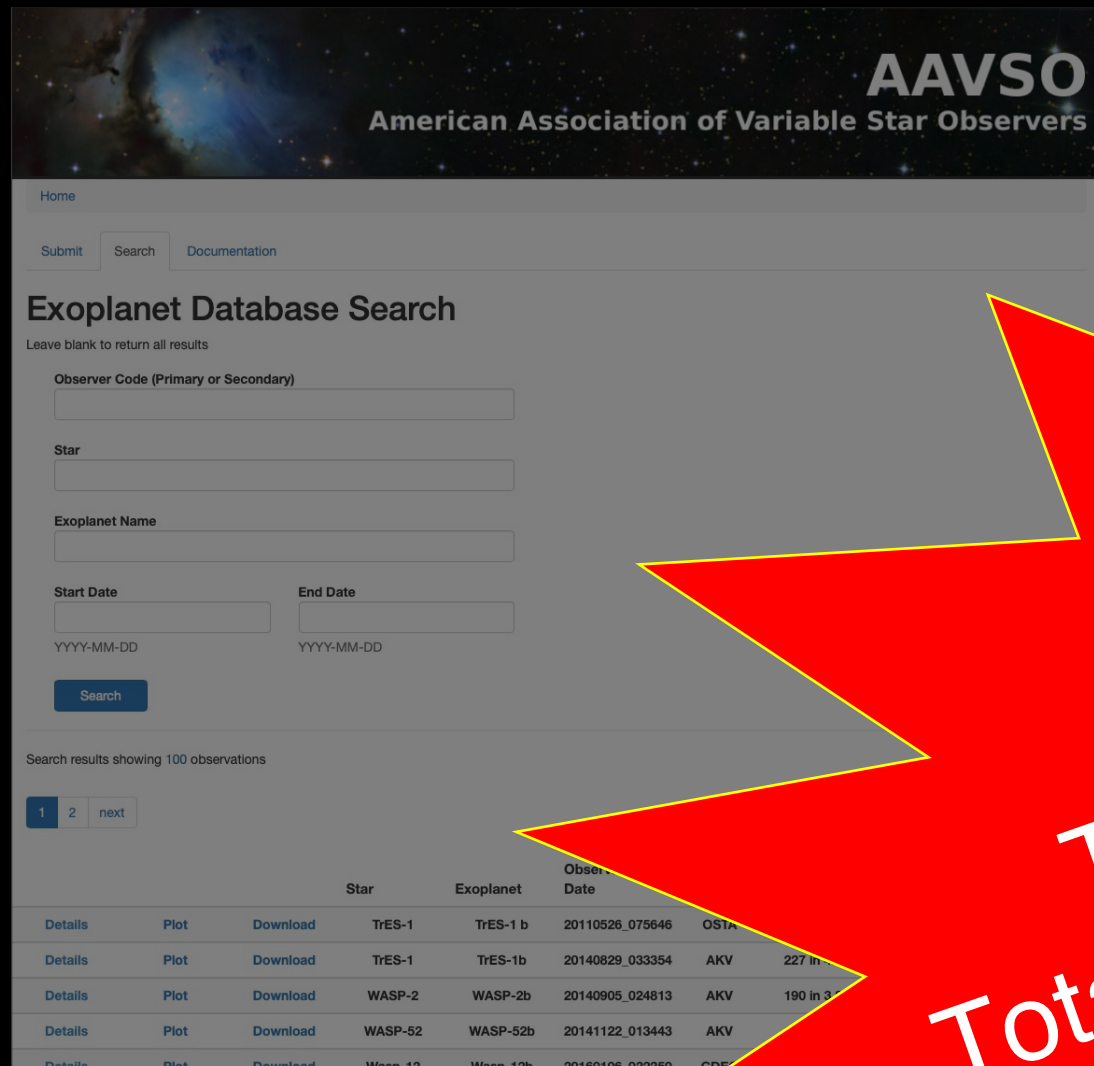
## EXOPLANET WATCH

Planet Name *	Host Star Metallicity	Host Star log(g)	Host Star Radius [R_Sun]	Host Star Effective Temperature [K]	a/R <sub>s</sub>	eccentricity	inclination [degrees]	omega [degrees]	orbital period [days]	R <sub>p</sub> [R_Earth]
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GJ 1214 b	0.29	4.99	0.21	3026.0	14.85	0.063	88.7	0.0	1.58040454	2.746
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HAT-P-7 b	0.233	3.97	1.84	6350.0	4.602	0.0	87.21	165.0	2.2047363	16.42
HAT-P-8 b	0.01	4.15	1.58	6200.0	6.13	0.006	87.5	116.0	3.0763433	16.81

3. Publish



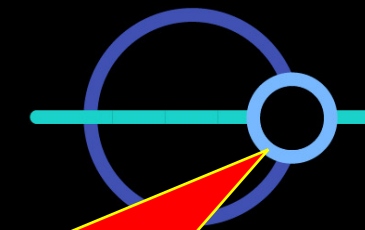
# CITISENS PIPELINE



1. Scrape

**Total Targets: 264**  
**Total Reductions: 1289**  
**Total Time Saved: 0.333 hours**

2. Process



## EXOPLANET WATCH

Star	Host Star Metallicity	Host Star log(g)	Host Star Radius [R_Sun]	Host Star Effective Temperature [K]	a/R <sub>s</sub>	eccentricity	inclination [degrees]	omega [degrees]	orbital period [days]	R <sub>p</sub> [R_Earth]
				5313.0	4.26	0.0	80.1	160.0	0.854	1.58
	4.58	0.8	5080.0	13.7	0.19	88.18	0.0	6.212445	6.94	
	0.05	4.34	1.21	6040.0	4.854	0.036	79.6	0.0	1.51214	12.22
	4.4	1.0	5440.0	7.16	0.025	89.9	0.0	1.9000769	12.85	
	4.84	0.46	3350.0	14.54	0.145	86.858	-25.0	2.64389751	4.19	
	0.29	4.99	0.21	3026.0	14.85	0.063	88.7	0.0	1.58040454	2.746
	0.2	4.66	0.48	3652.0	12.92	0.114	89.13	-82.5	3.336649	3.88
	13	4.38	1.14	5975.0	9.853	0.0	86.11	253.1	4.4652992	13.92
	4.56	0.83	5185.0	10.05	0.0	86.31	107.7	2.89973826	10.21	
HAT-P-5 b			1.12	5960.0	7.8	0.072	86.16	0.0	2.788491	13.57
HAT-P-6 b	-0.13	4.22	1.46	6570.0	7.73	0.044	85.51	94.1	3.8529962	14.91
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HAT-P-8 b	0.01	4.15	1.58	6200.0	6.13	0.006	87.5	116.0	3.0763433	16.81

3. Publish

# HOW TO GET INVOLVED?

- Website
- Monthly newsletter
- Slack channel

**EXOPLANET EXPLORATION**  
Planets Beyond Our Solar System

What is an Exoplanet? The Search For Life Discovery Explore More For Scientists

## Exoplanet Watch

What is Exoplanet Watch? How to Participate What to Observe Resources Publications Results

### What is Exoplanet Watch?

Overview | Team | Stay in Touch | Community

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NASA's [Universe of Learning's](#) Exoplanet Watch is a citizen science project, currently geared toward amateur astronomers and astronomy students at colleges and universities, to observe transiting [exoplanets](#) — planets outside our solar system — with small telescopes. A [transiting exoplanet](#) is a planet outside of our solar system that periodically passes in front of its host star, causing the star to appear to slightly dim (typically by ~1%). Observing exoplanet transits is important, as they provide direct measurement of a planet's radius and composition.

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Sign up for [email updates](#) from Exoplanet Watch, including nightly target identifications, software updates, and other news.

enter your email

**SIGN UP**

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*Exoplanet Watch*

*June 2022 Newsletter*

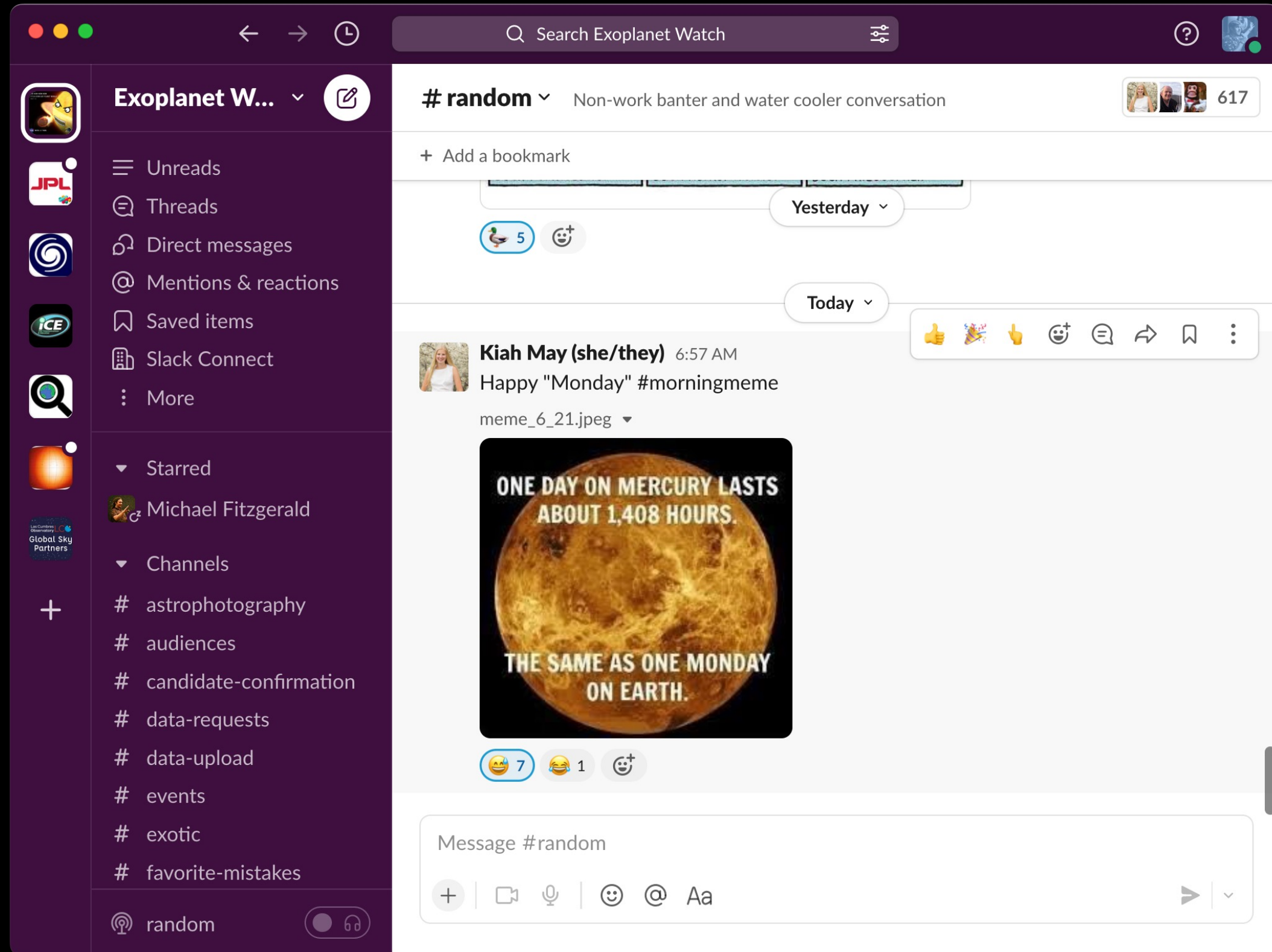


Explore Distant Worlds

• *Be a citizen scientist* •

# HOW TO GET INVOLVED?

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# HOW TO GET INVOLVED?

- Currently, launched to those who have their own telescope
- Or access to a robotic one
  - MicroObservatory, LCO
- By end of CY 2022, will be getting additional data to loan out people so that everyone and anyone can participate



Harvard/CfA

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NASA/JPL

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NASA/JPL

# EXOPLANET WATCH TEAM

Exoplanet Watch Interns



Izzy Huckabee (ASU)



Kiah May (UC Boulder)



Tamim Fatahi (CalPoly SLO)

JPL Team



Nora Bailey



John Engelke



Kyle Pearson



Rachel  
Zimmerman-Brachman



Rob Zellem