

A SECOND EARTH-SIZED PLANET IN THE HABITABLE ZONE OF M DWARF, TOI-700

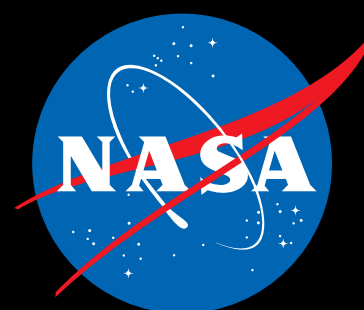
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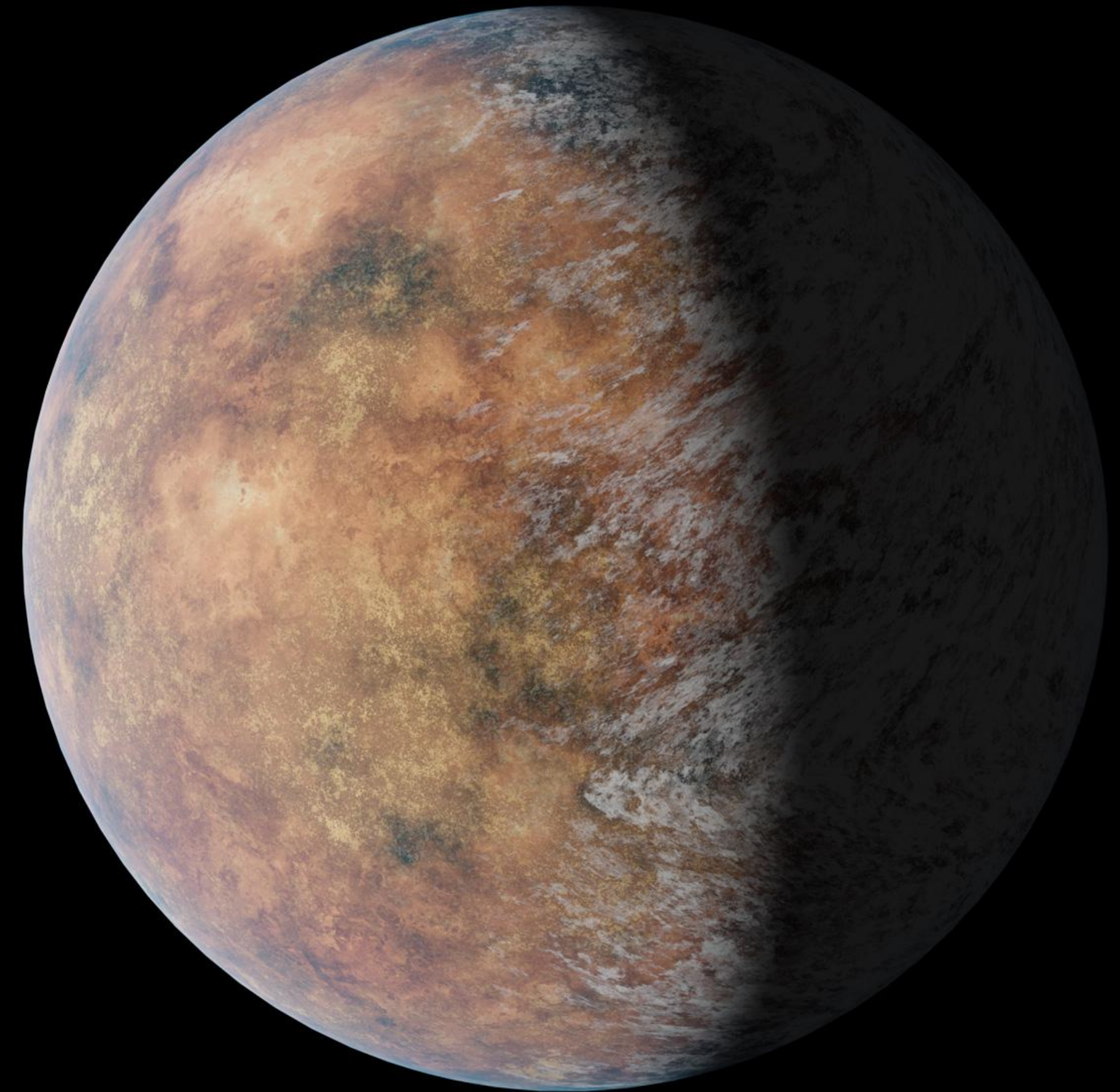
[@emdwarf](#)



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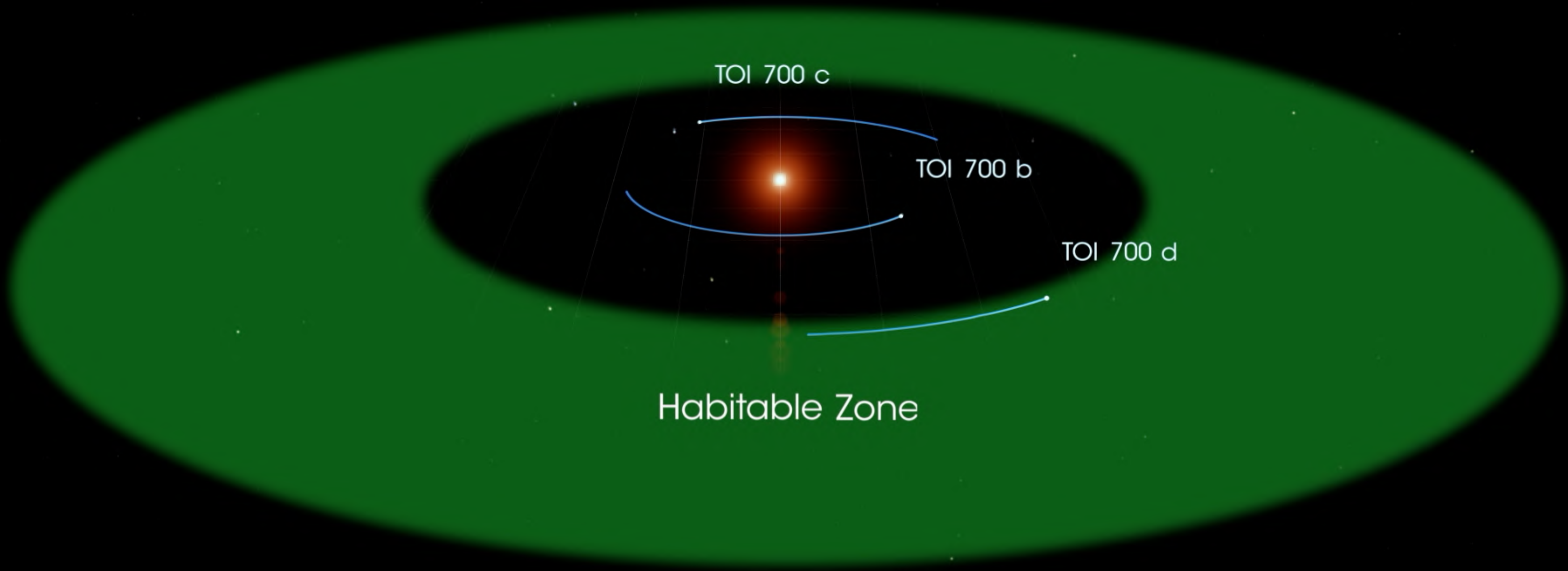
TALK OVERVIEW

- TOI-700 system parameters
- Updates to transit fits with TESS Year 3 data
- Discovery of a new habitable zone planet in the TOI-700 system



A brief refresher...

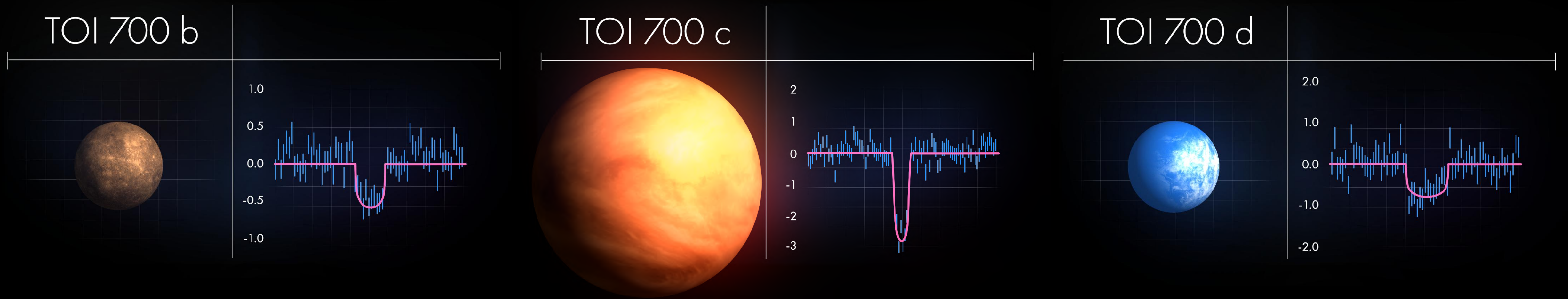
TOI-700 SYSTEM OVERVIEW



THE HOST STAR, TOI-700

- M2.5 dwarf, 3460 K
- 0.415 solar masses
- 0.421 solar radii
- Age = >1.5 billion years
- Distance = 101.4 light-years





10 days

1.01 Earth radii

16 days

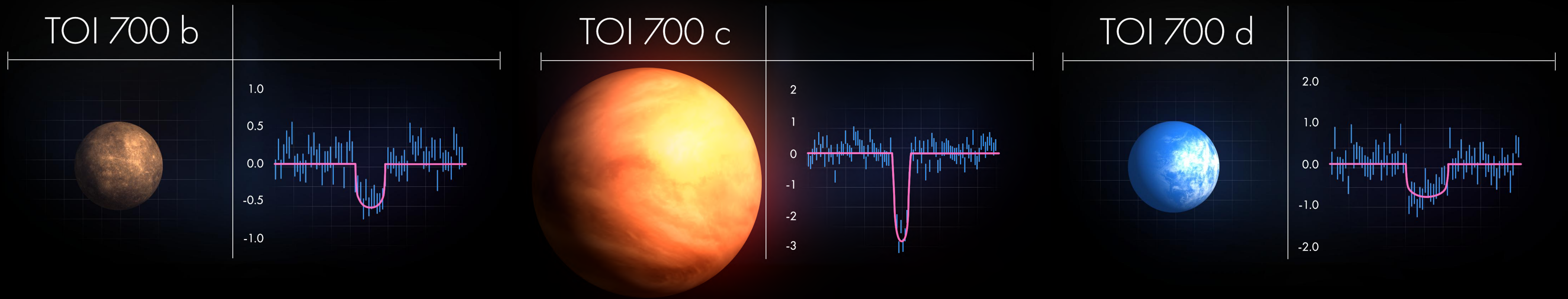
2.63 Earth radii

37 days

1.19 Earth radii



Ethan Kruse / NASA GSFC / UMD



10 days

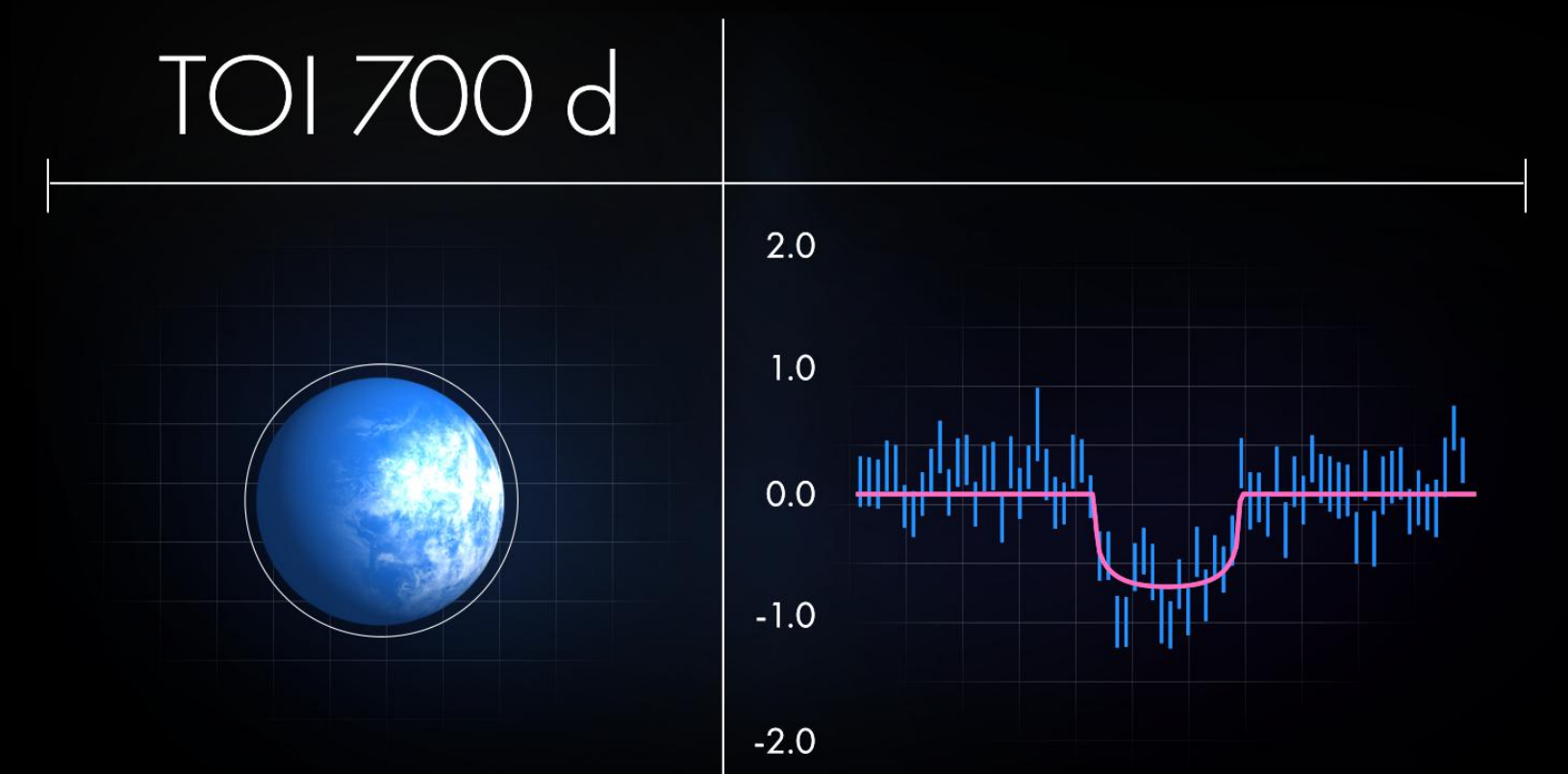
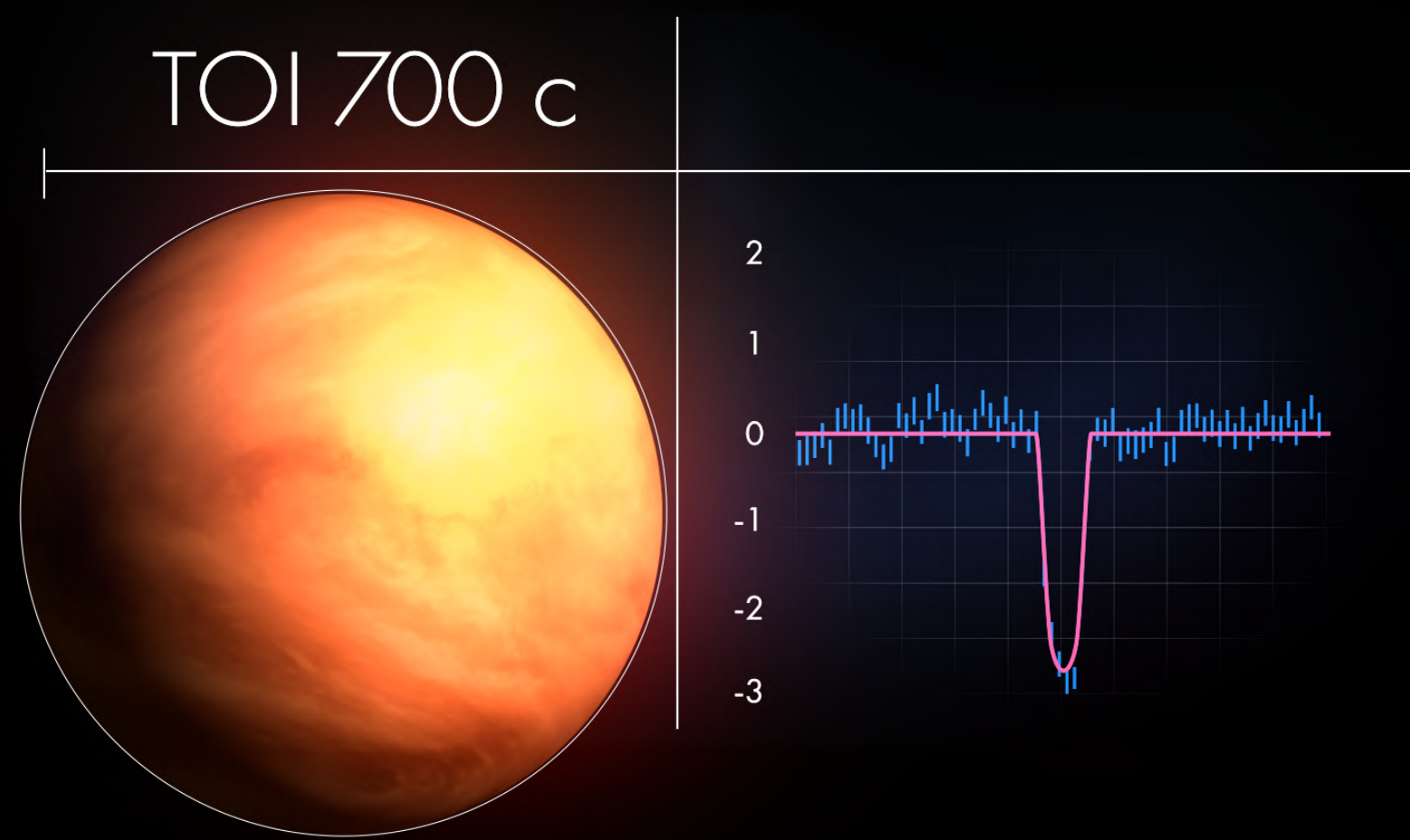
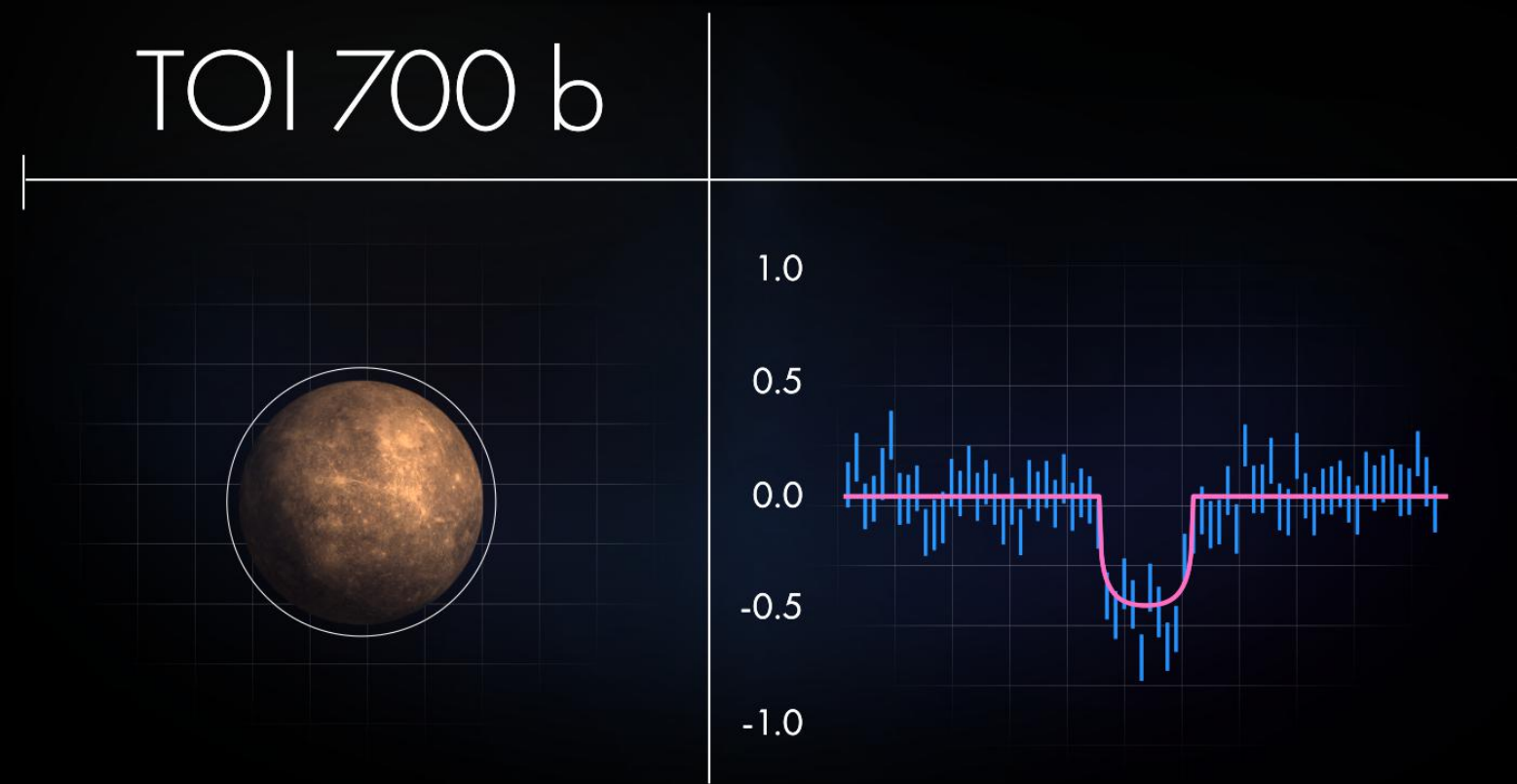
1.01 Earth radii

16 days

2.63 Earth radii

37 days

1.19 Earth radii



10 days

~~1.01 Earth radii~~

0.914 Earth radii

16 days

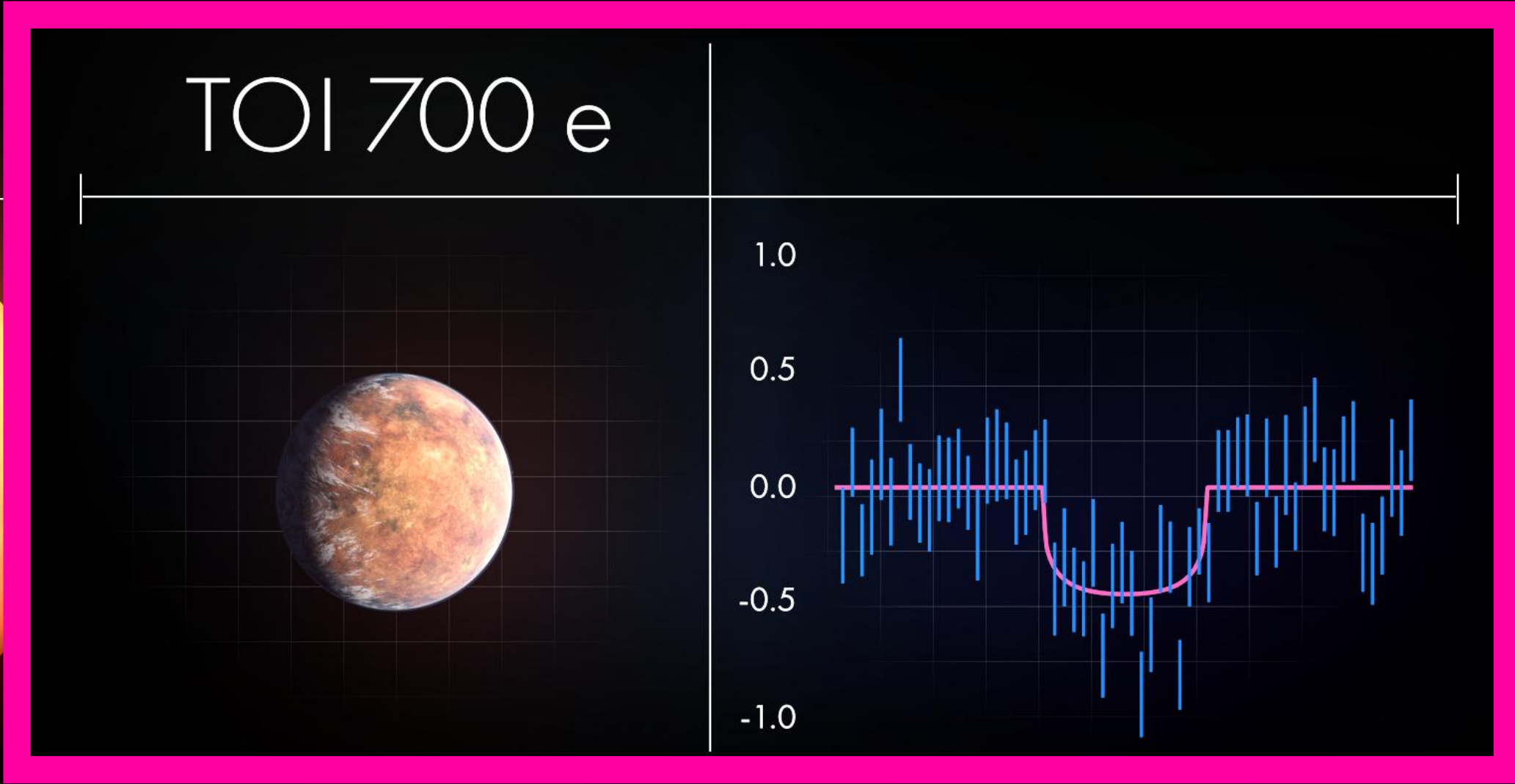
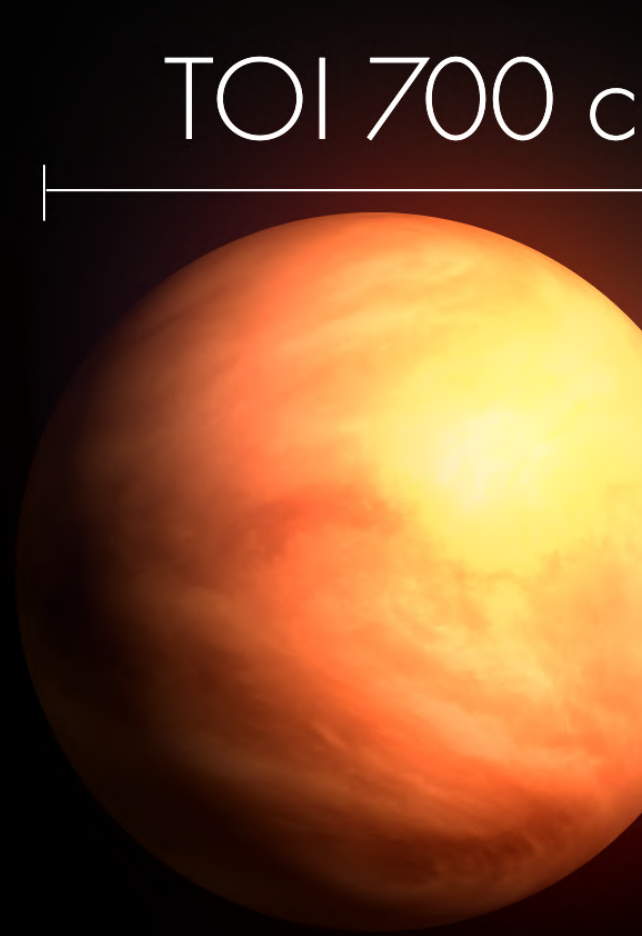
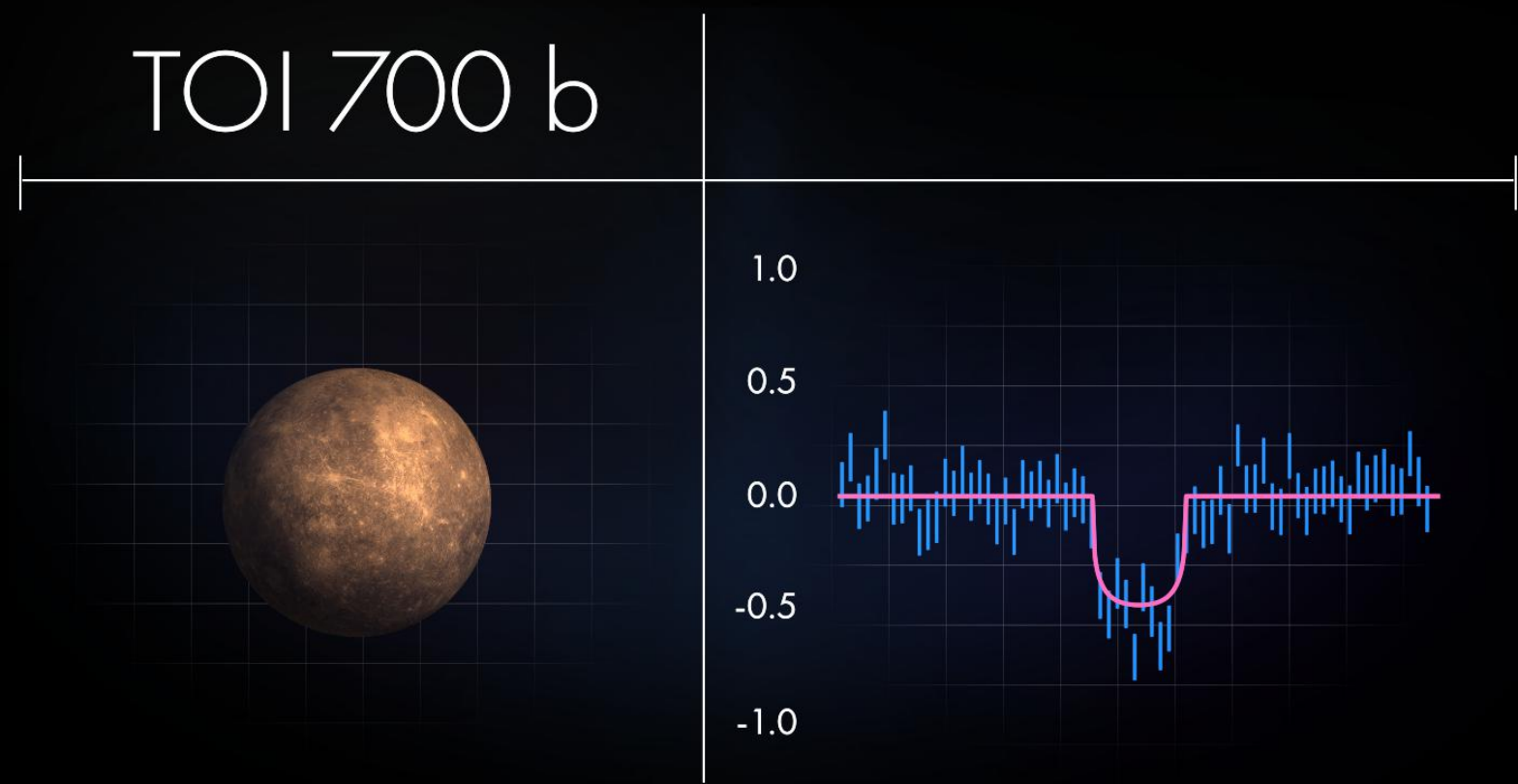
~~2.63 Earth radii~~

2.60 Earth radii

37 days

~~1.19 Earth radii~~

1.073 Earth radii



10 days
0.914 Earth radii

16 days
2.60 Earth radii

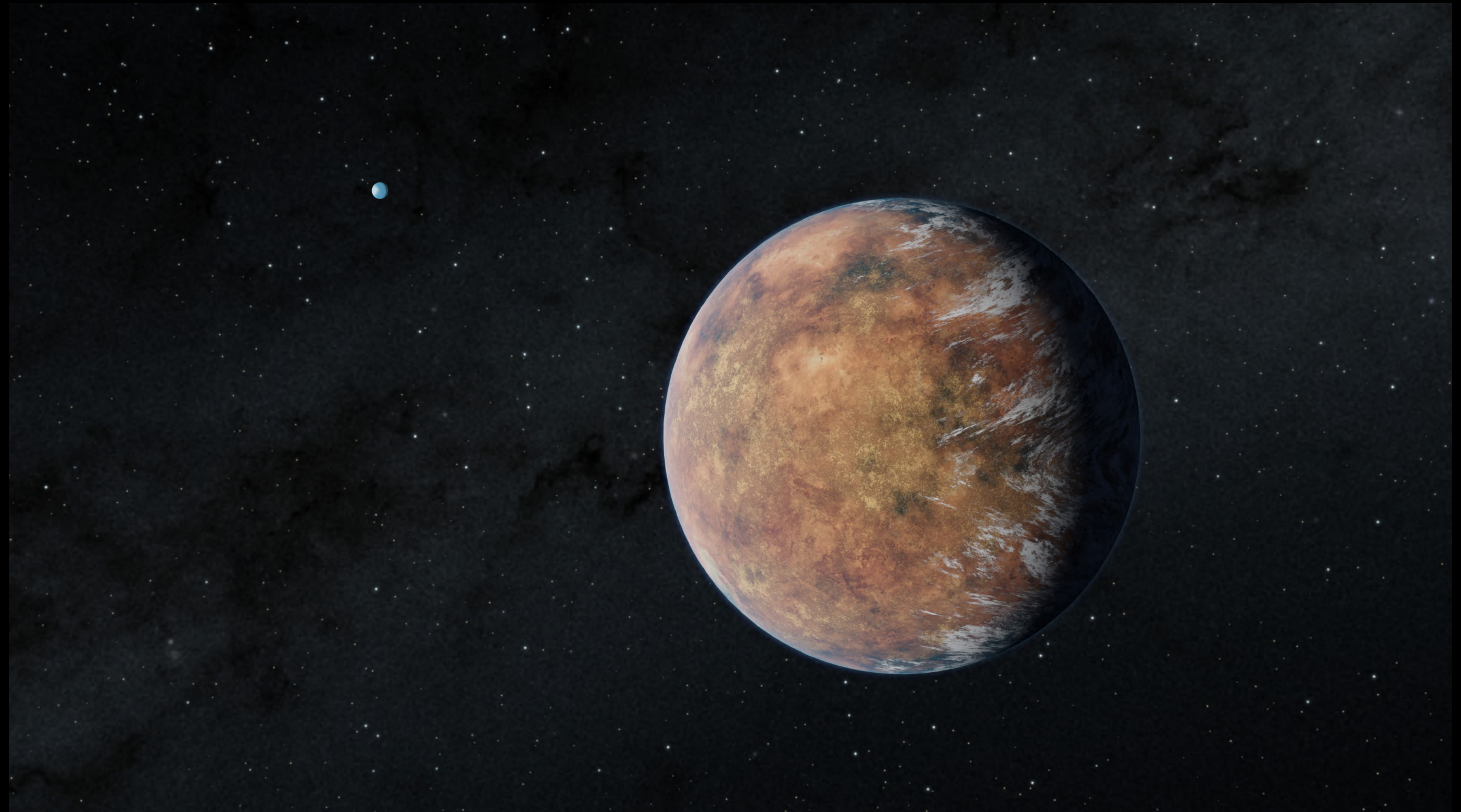
28 days
0.95 Earth radii

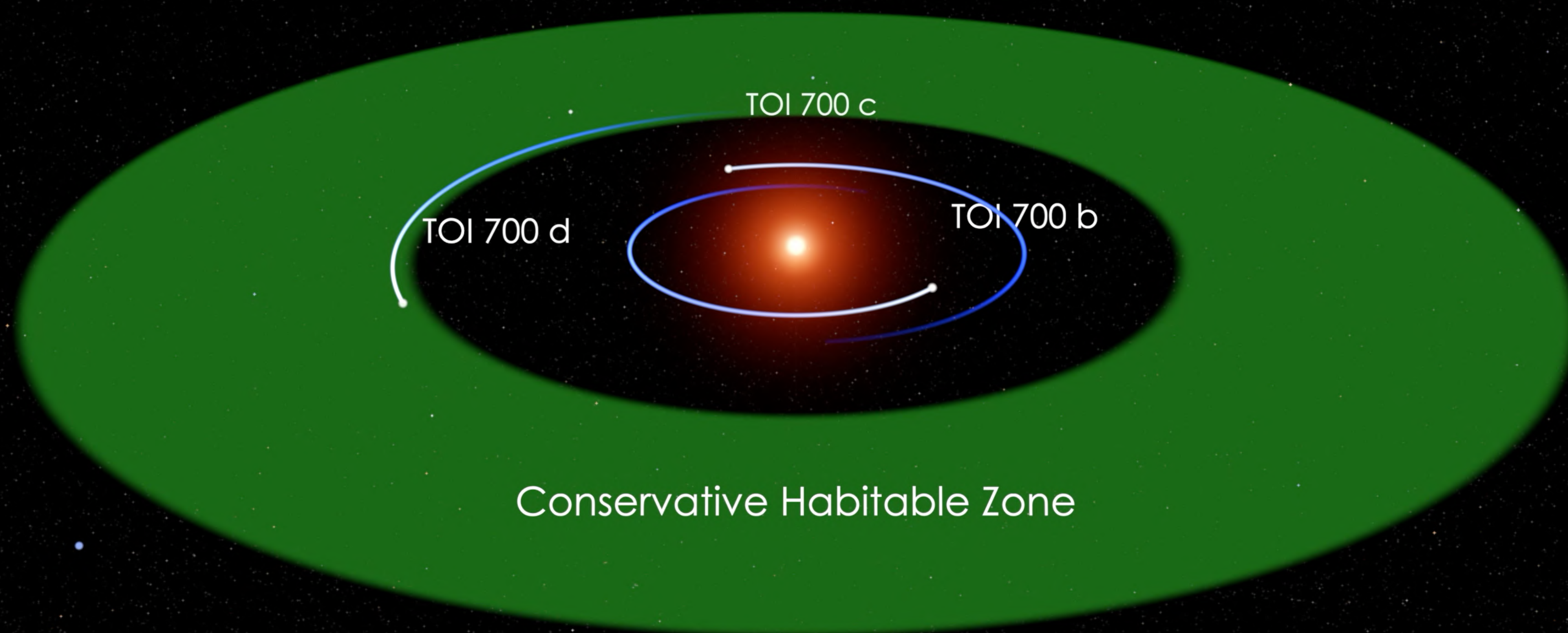
37 days
1.073 Earth radii

TOI-700 e, TESS's second Earth-sized planet in
the habitable zone

TOI-700 e

- 27.8 days
- 0.95 Earth radii
- Likely rocky
- 1.3x Earth's solar flux
- Optimistic habitable zone





TOI 700 c

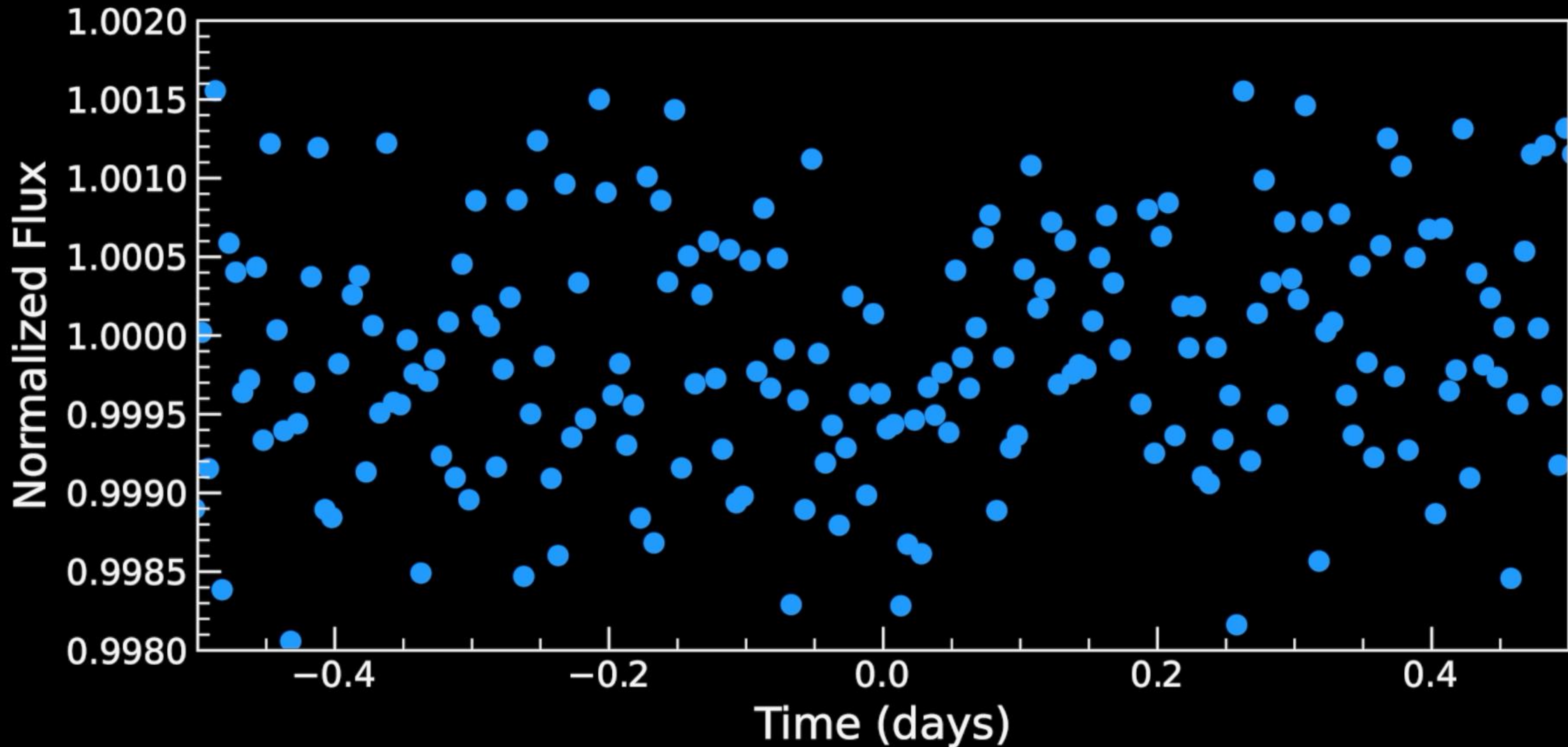
TOI 700 b

TOI 700 d

Conservative Habitable Zone

Year 1

Transits: 1



































SIGNIFICANCE OF THIS DISCOVERY

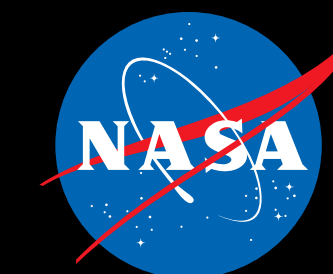
- Star is bright enough for follow up and does not flare
- Planets formed in same disk under similar stellar conditions
- Enables us to study how planet traits affect habitability
 - Boundaries of the habitable zone
 - Planet size



A Second Earth-Sized Planet in the Habitable Zone of the M Dwarf, TOI-700

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THE FIRST HABITABLE ZONE EARTH-SIZED PLANET FROM TESS

I. Validation of the TOI-700 System (Gilbert et al., 2020)

II. *Spitzer* Confirms TOI-700 d (Rodriguez et al., 2020)

III. Climate States and Characterization Prospects for
TOI-700 d (Suissa et al., 2020)

arXiv: 2001.00952, 2001.00954, 2001.00955

SOLAR SYSTEM

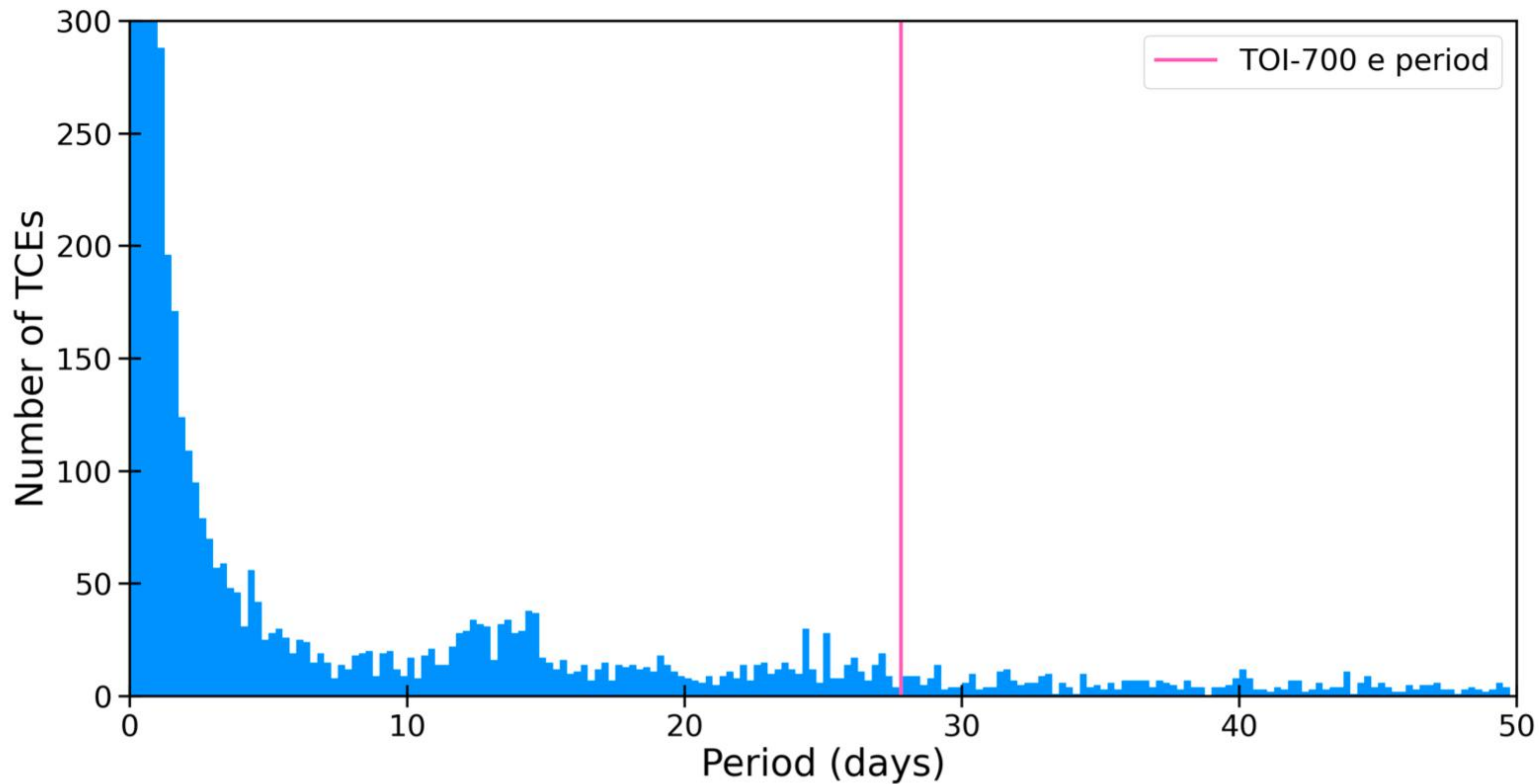
PLANET	INSOLATION FLUX
MERCURY	6.67
VENUS	1.91
EARTH	1
MARS	0.43

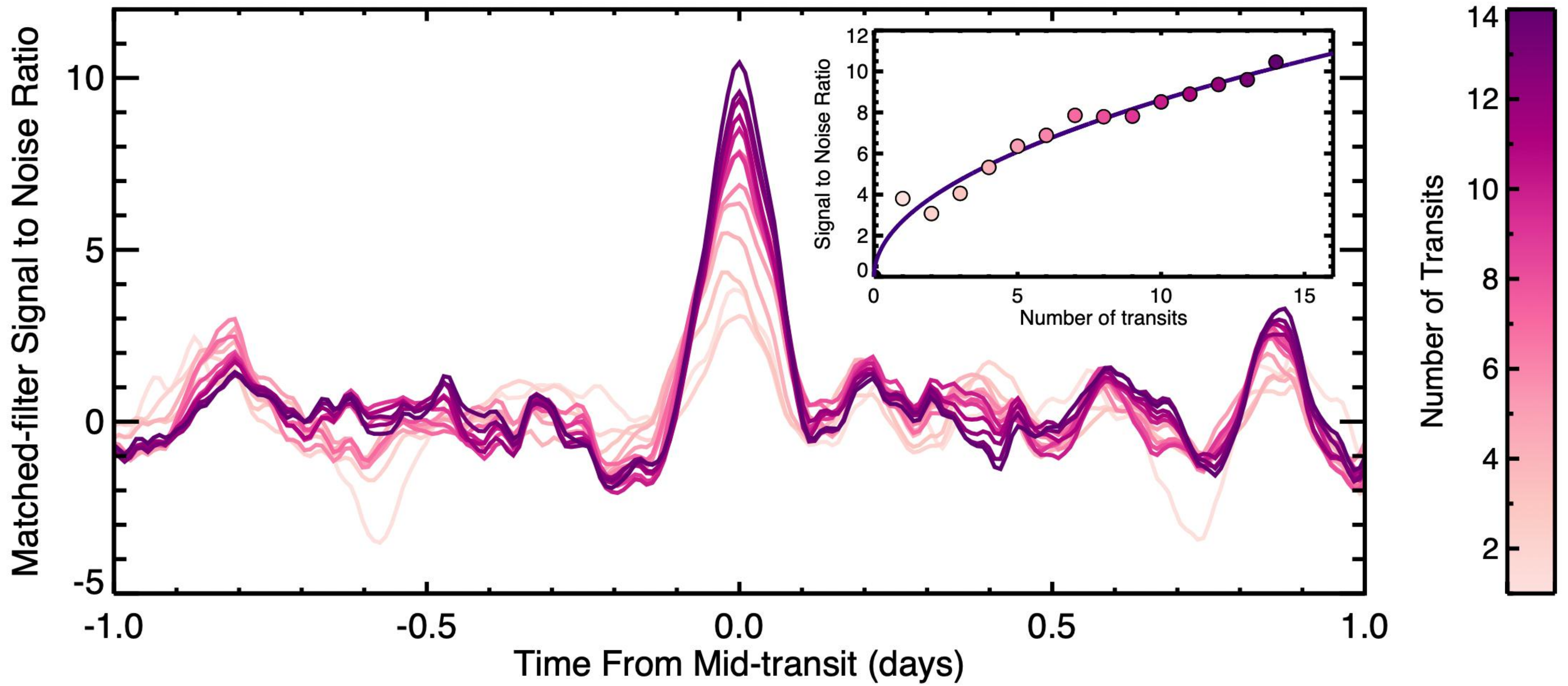
TOI-700

PLANET	INSOLATION FLUX
TOI-700 b	4.98
TOI-700 c	2.64
TOI-700 e	1.27
TOI-700 d	0.85

TOI-700 e

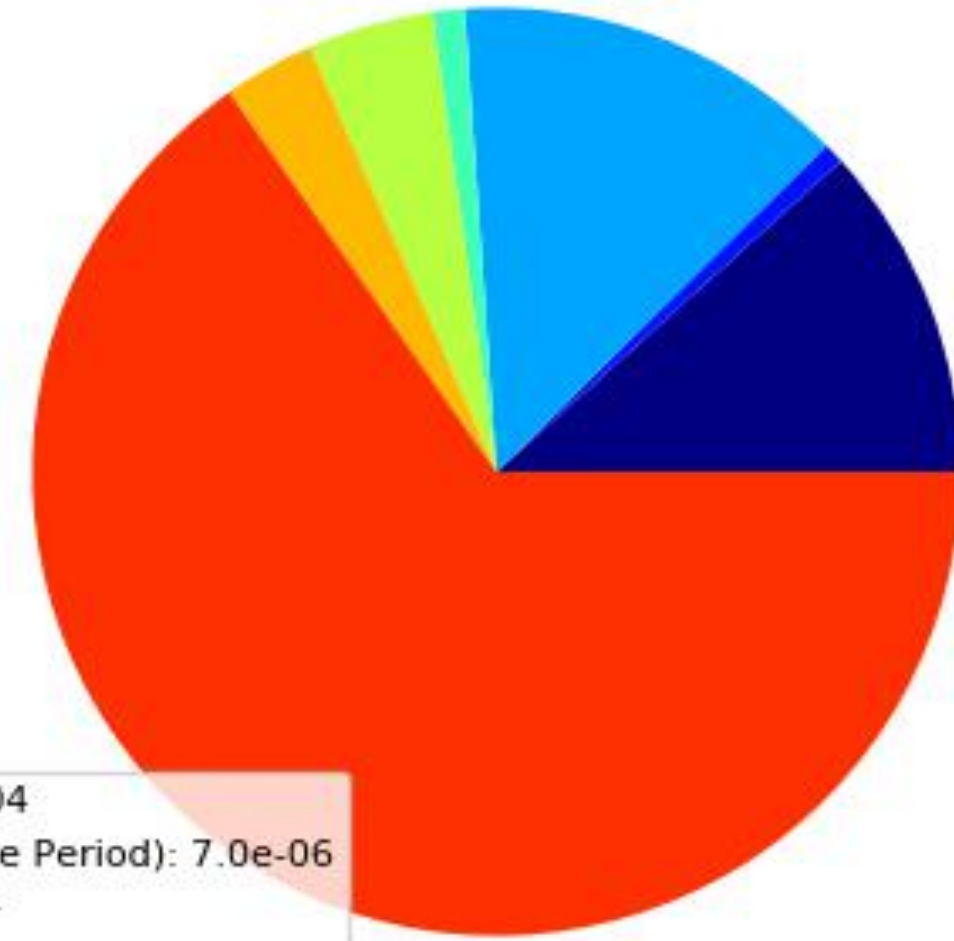
P	Period (days).....	27.80978	0.00046	0.00040
R_P	Radius (R_{\oplus})	0.953	0.089	0.075
T_0	Optimal conjunction Time (BJD _{TDB})	2458964.8112	0.0058	0.0045
a	Semi-major axis (AU)	0.1340	0.0022	0.0022
i.....	Inclination (Degrees)	89.60	0.21	0.16
e	Eccentricity	0.059	0.057	0.042
ω_*	Argument of Periastron (Degrees) ...	70	100	120
S	Insolation Flux (S_{\oplus}).....	1.27	0.13	0.15
R_P/R_*	Radius of planet in stellar radii	0.0208	0.0017	0.0014
T_{14}	Total transit duration (days)	0.1157	0.0087	0.016
b	Transit Impact parameter	0.47	0.19	0.25





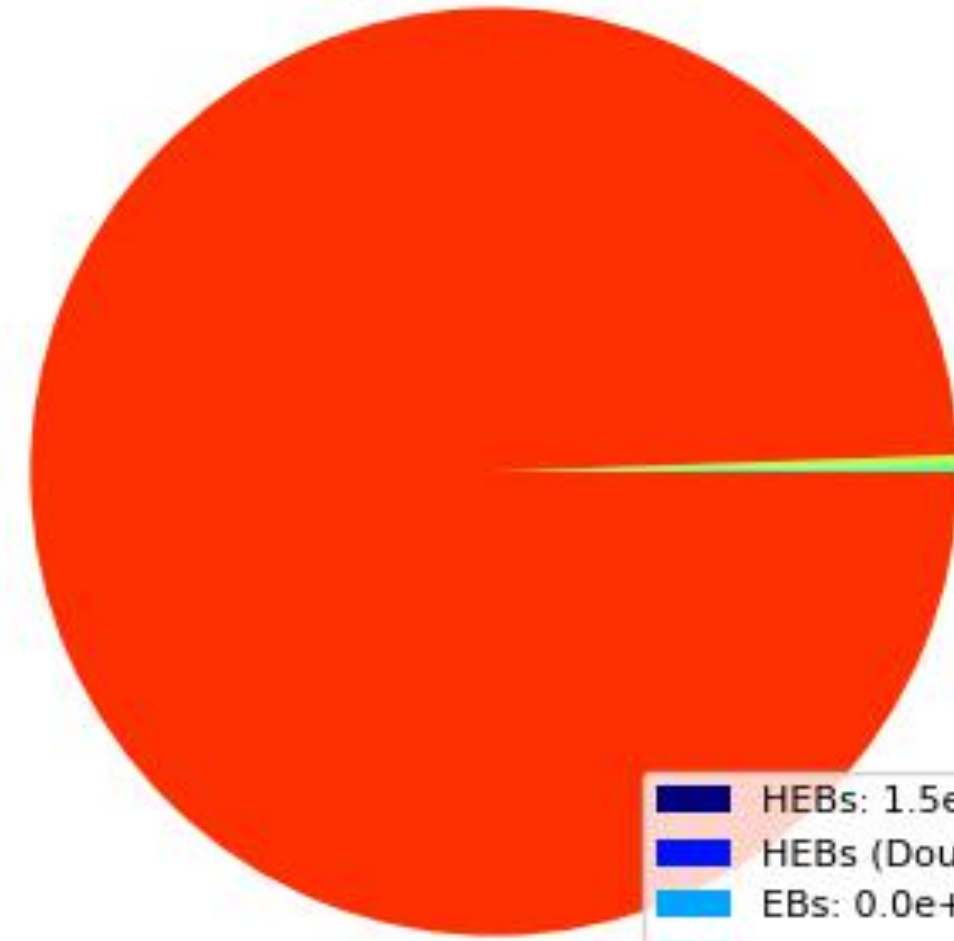
TOI_700

Priors



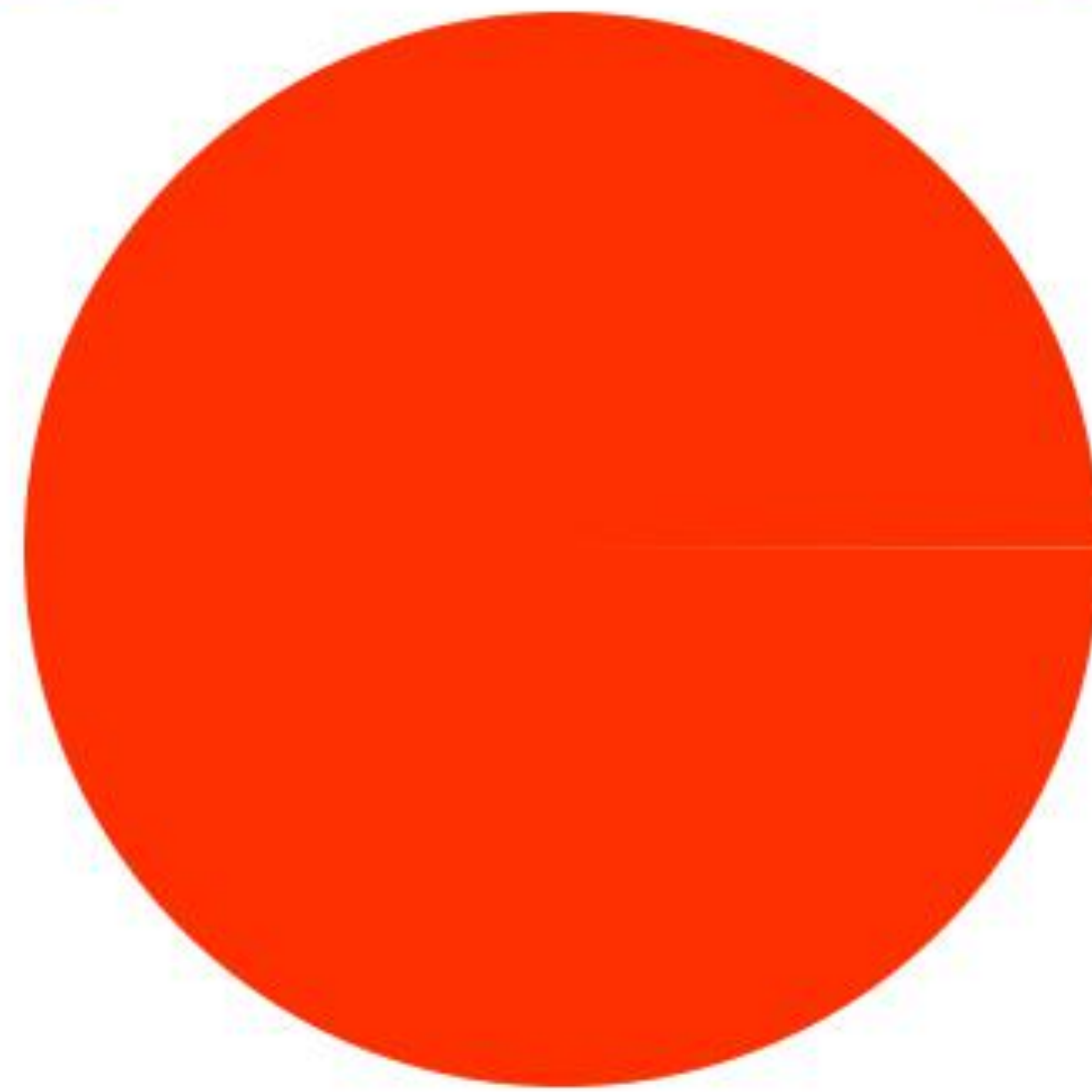
HEBs:	1.1e-04
HEBs (Double Period):	7.0e-06
EBs:	1.3e-04
EBs (Double Period):	1.1e-05
BEBs:	4.1e-05
BEBs (Double Period):	3.0e-05
Planets:	6.2e-04

Likelihoods



HEBs:	1.5e-89
HEBs (Double Period):	3.8e-05
EBs:	0.0e+00
EBs (Double Period):	1.7e-03
BEBs:	2.6e-03
BEBs (Double Period):	3.7e-15
Planets:	7.5e-01

Constraints:
secondary spectrum
odd-even < 0.000396
secondary depth < 0.0001
Zorro i-band contrast curve



HEBs:	0.000
HEBs (Double Period):	0.000
EBs:	0.000
EBs (Double Period):	0.000
BEBs:	0.000
BEBs (Double Period):	0.000
Planets:	1.000

Final Probability

$f_{pl, v} = 0.002$
FPP: 1 in 3649