Unlocking cool transiting planets across the sky:

A temperate sub-Neptune discovered using K2, TESS & CHEOPS

Hugh Osborn, Solène Ulmer-Moll, David Degen, Amy Tuson, Luisa Maria Serrano, Thomas Wilson, Davide Gandolfi, Yann Alibert, Willy Benz, Didier Queloz, +CHEOPS GTO

ETH zürich

UNIVERSITÄT BERN

PlanetS
National Centre of Competence in Research

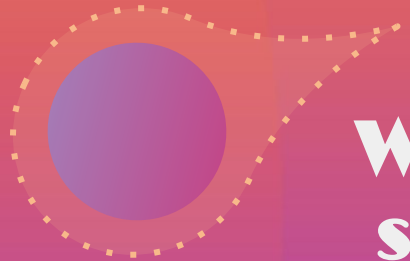
Not dominated by their host stars

Low photo-evaporation means primordial atmospheres maintained

Uncertain formation pathway

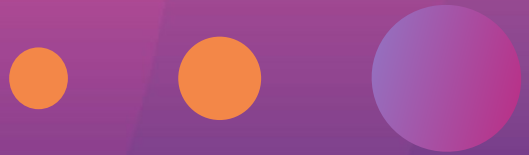
Water-poor inside the ice-line?

Or **water-rich** followed by migration?



Why are warm & temperate sub-Neptunes important?

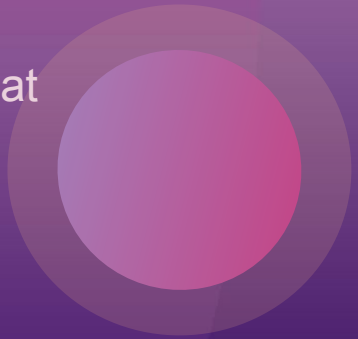
Allows for interplanetary comparison



Often in multi systems

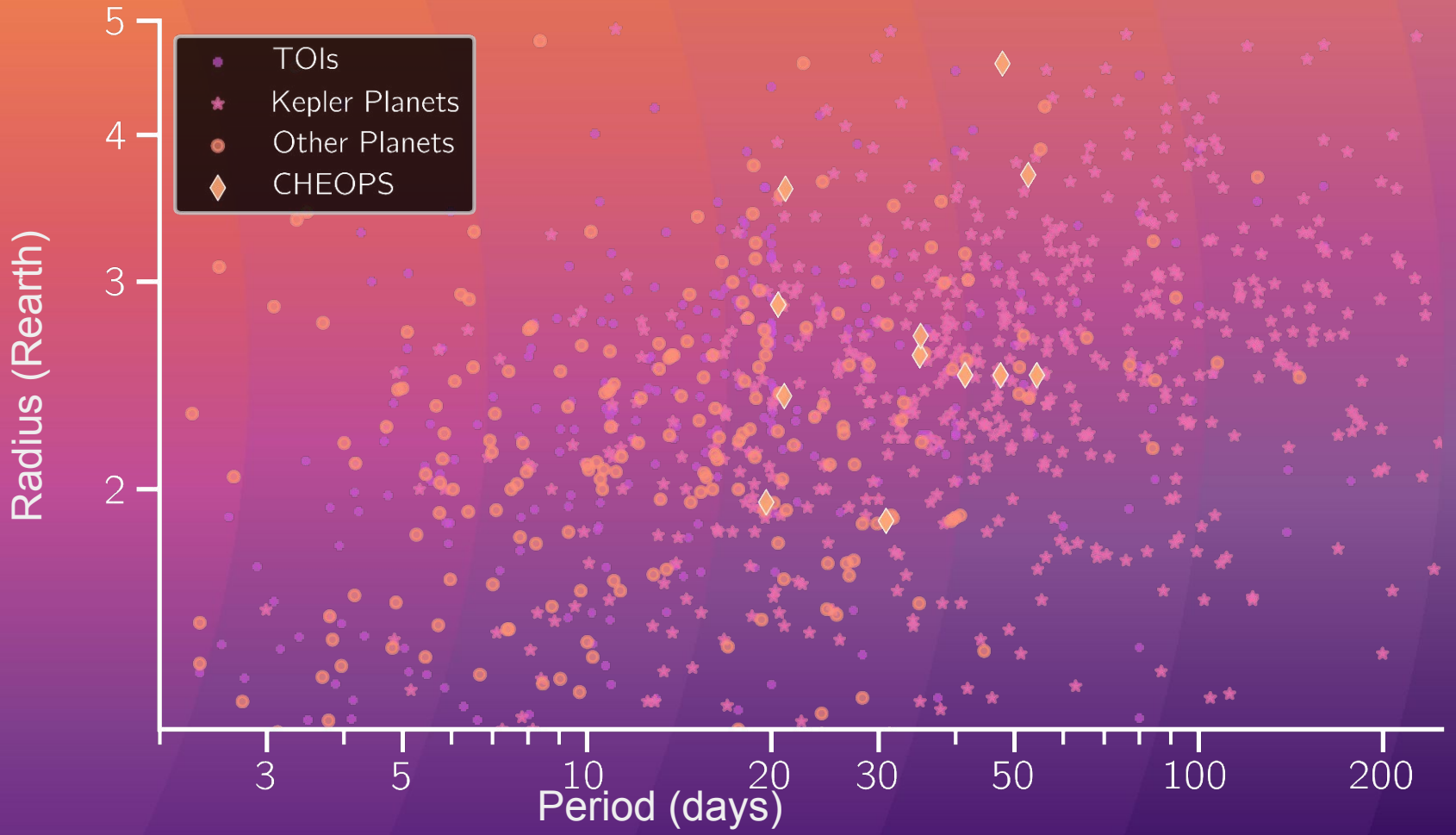
Clearer atmospheres at low Teq (TOI-270d, K2-18b, etc)

Condensed species?



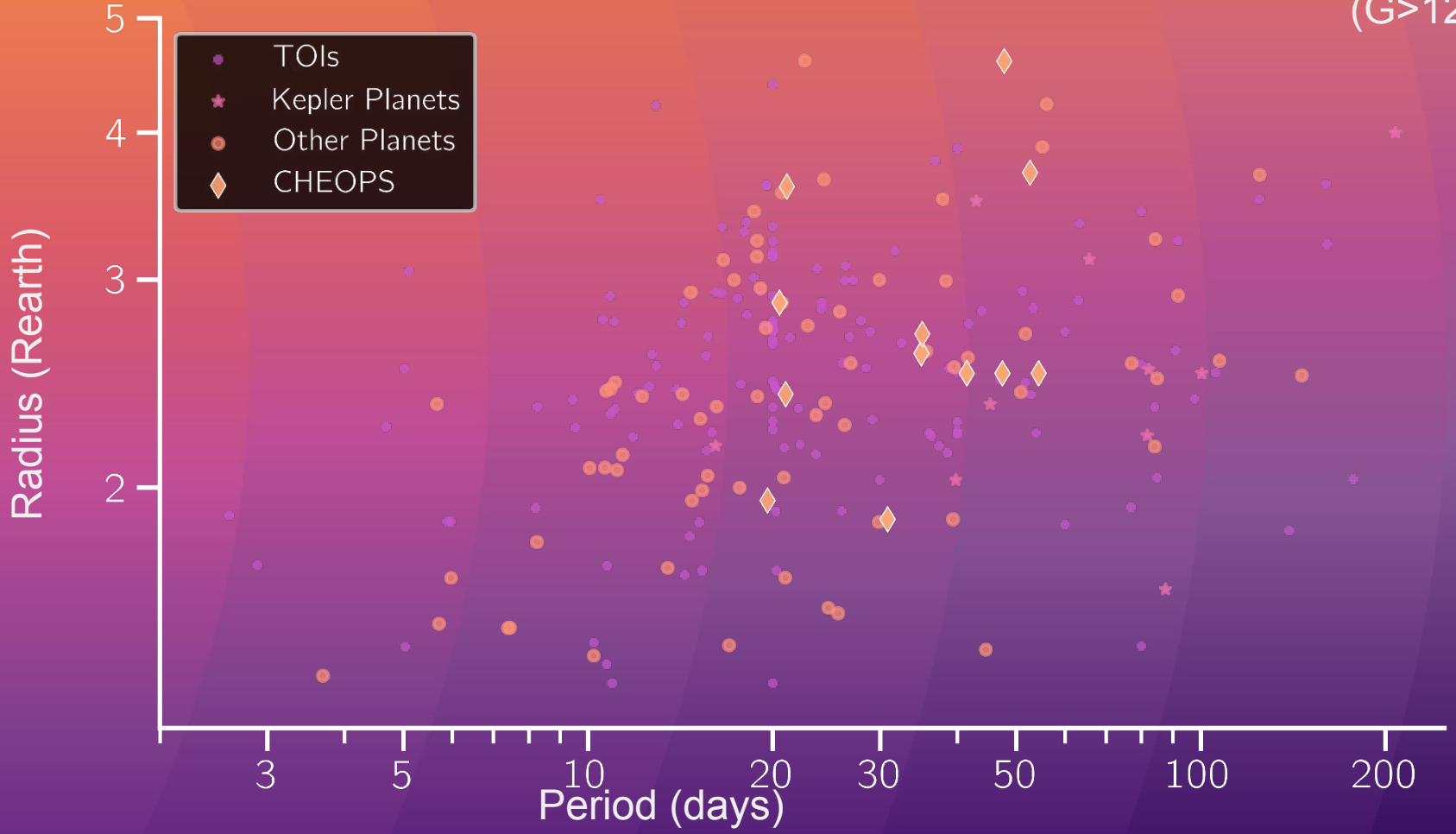
Characterisable atmospheres

Cool (T<600K) sub-Neptunes

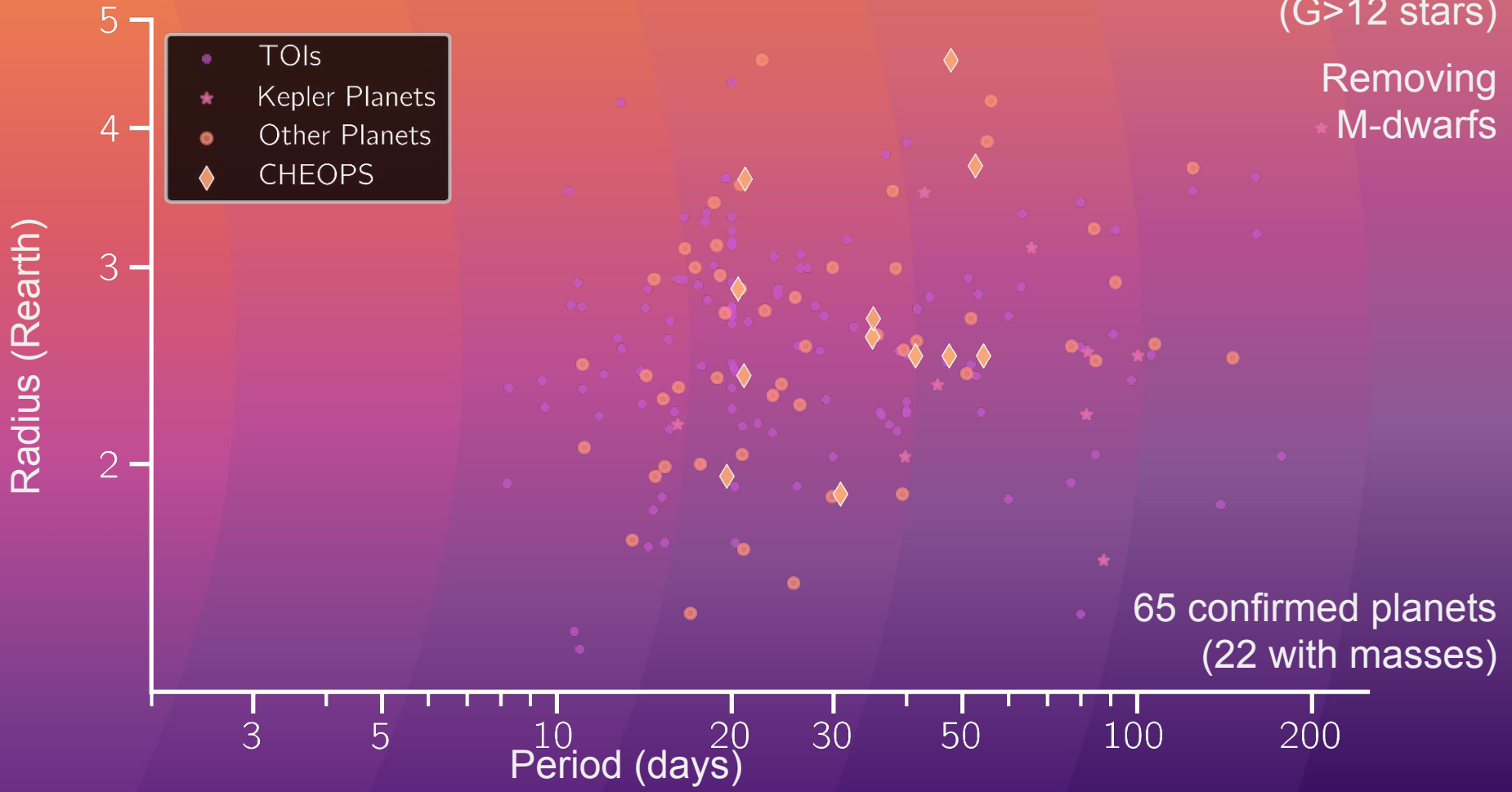


Cool (T<600K) sub-Neptunes

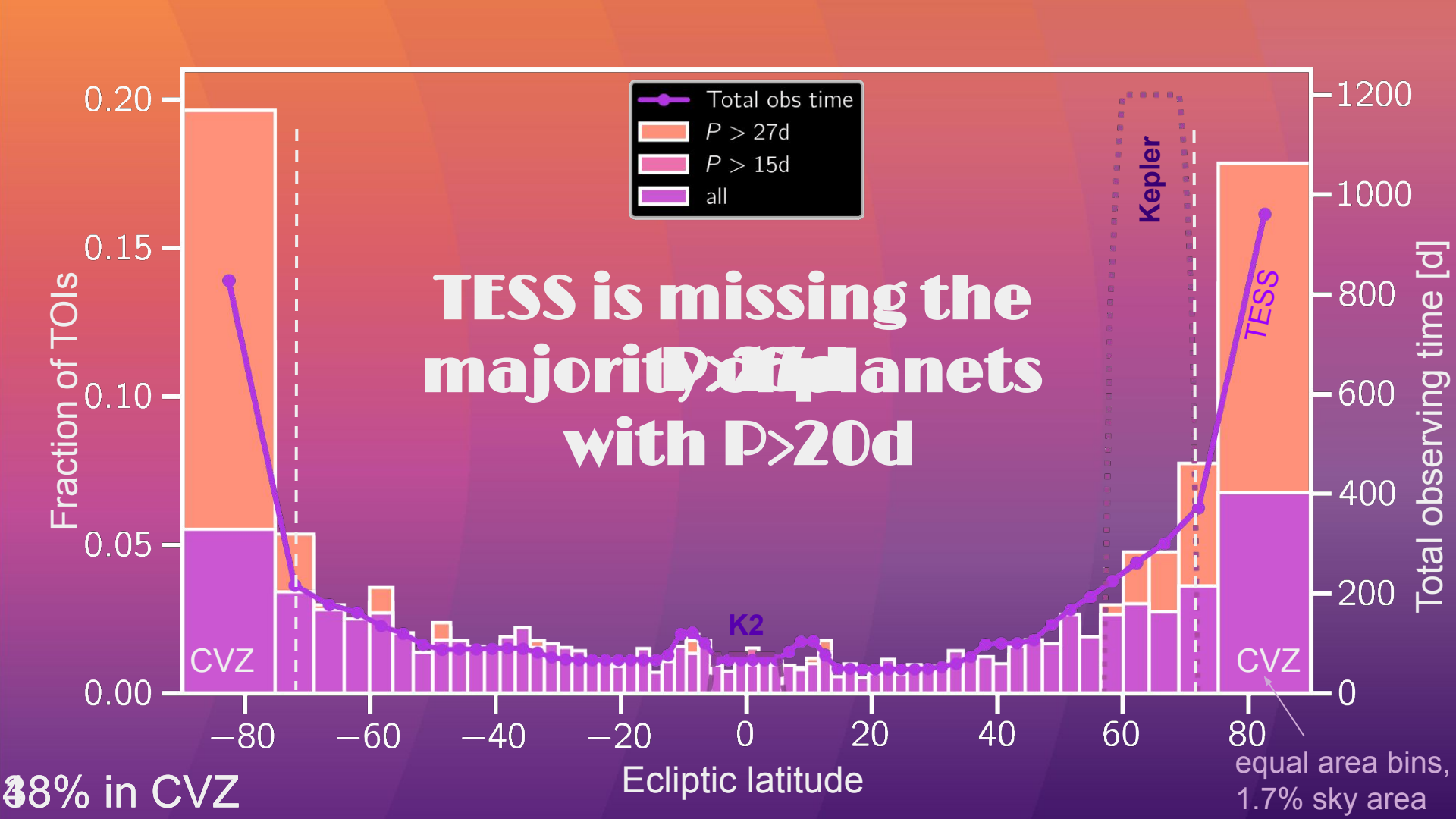
Removing faint
(G>12 stars)

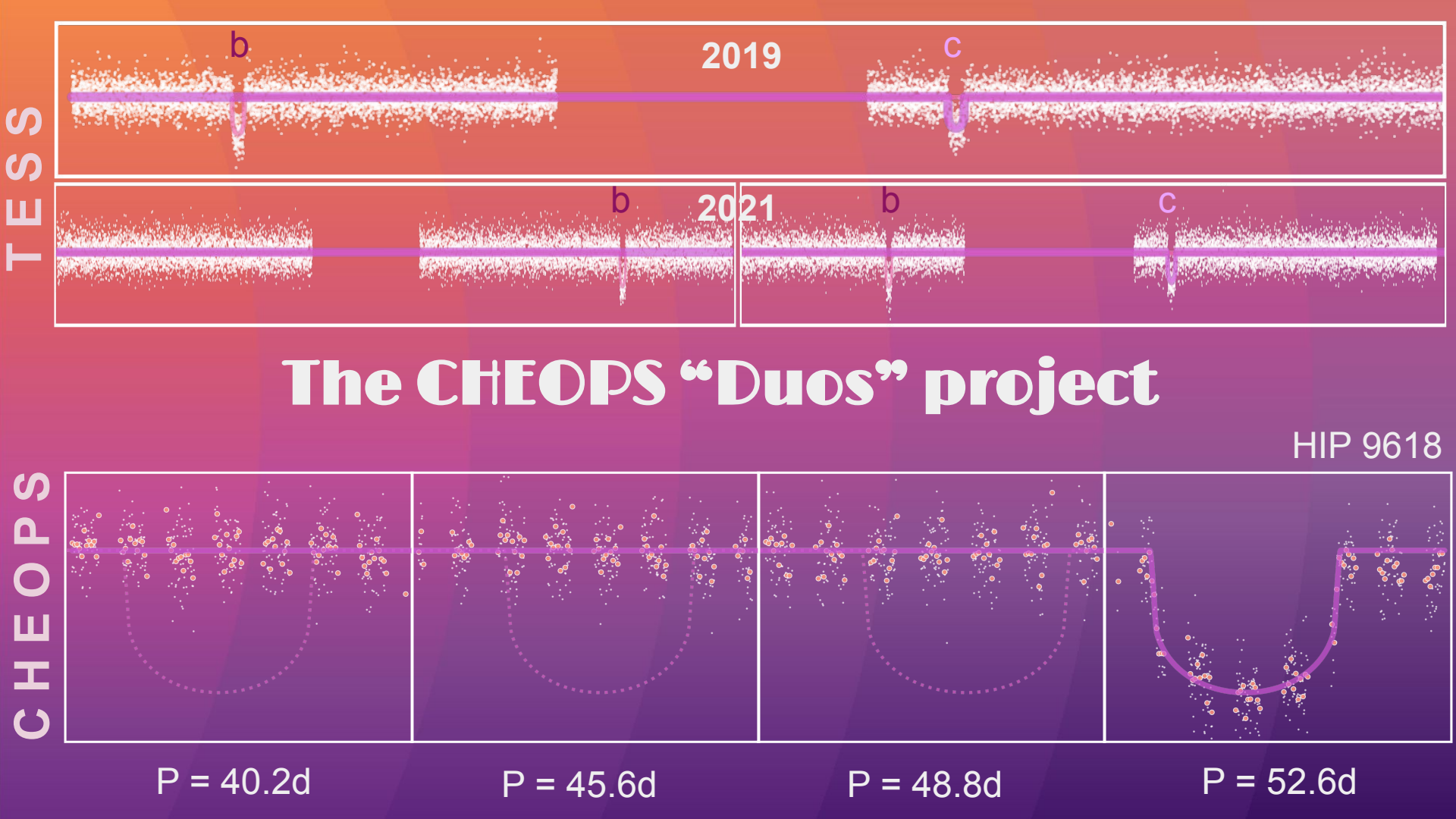


Cool (T<600K) sub-Neptunes



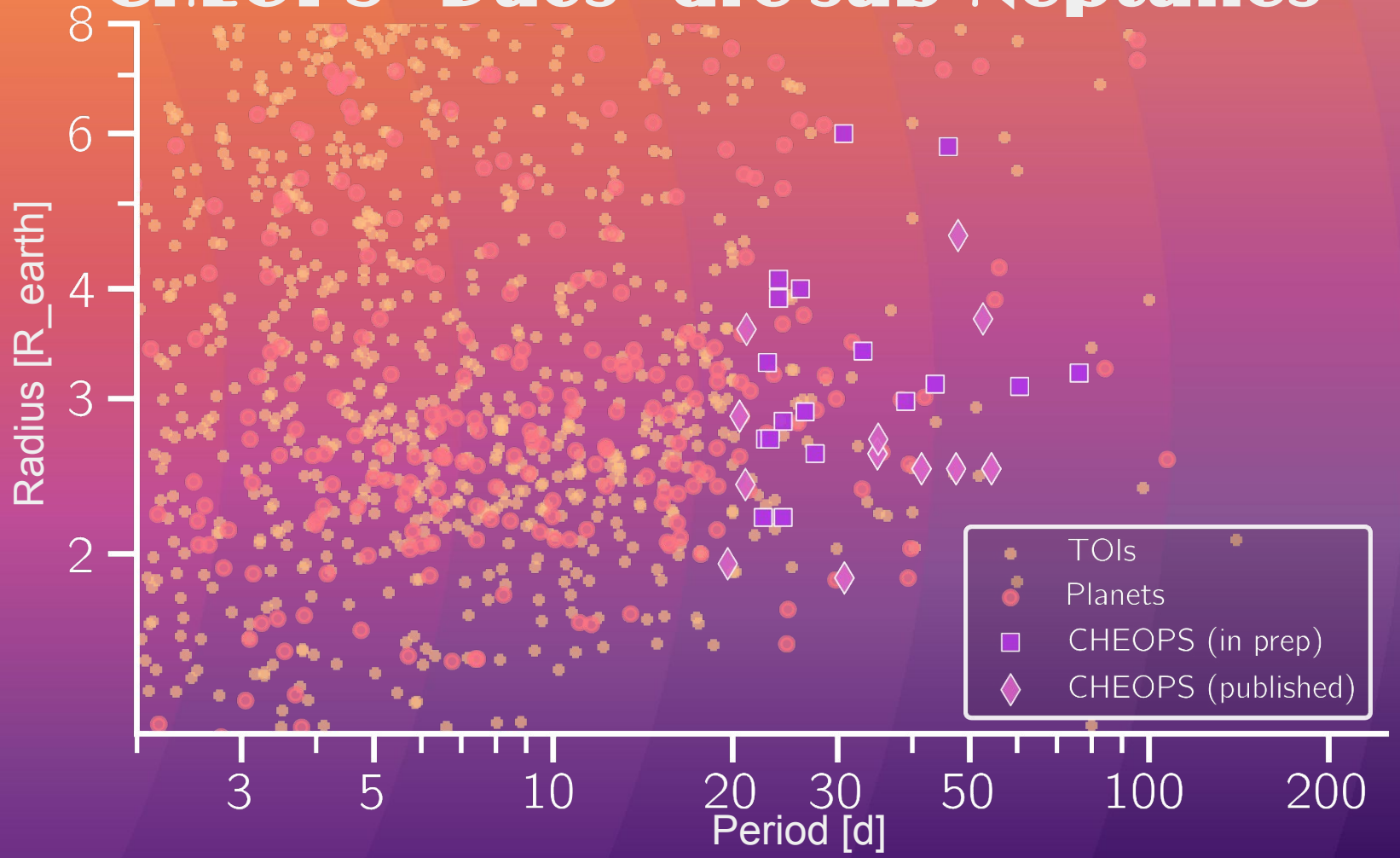
How are long-period sub-Neptunes distributed across the sky?


Total obs time
P > 27d
P > 15d
all
TESS is missing the majority of planets with P>20d
Kepler
TESS
K2
CVZ
CVZ
Fraction of TOIs
0.20
0.15
0.10
0.05
0.00
Total observing time [d]
1200
1000
800
600
400
200
0
−80
−60
−40
−20
0
20
40
60
80
Ecliptic latitude
equal area bins,
1.7% sky area
38% in CVZ

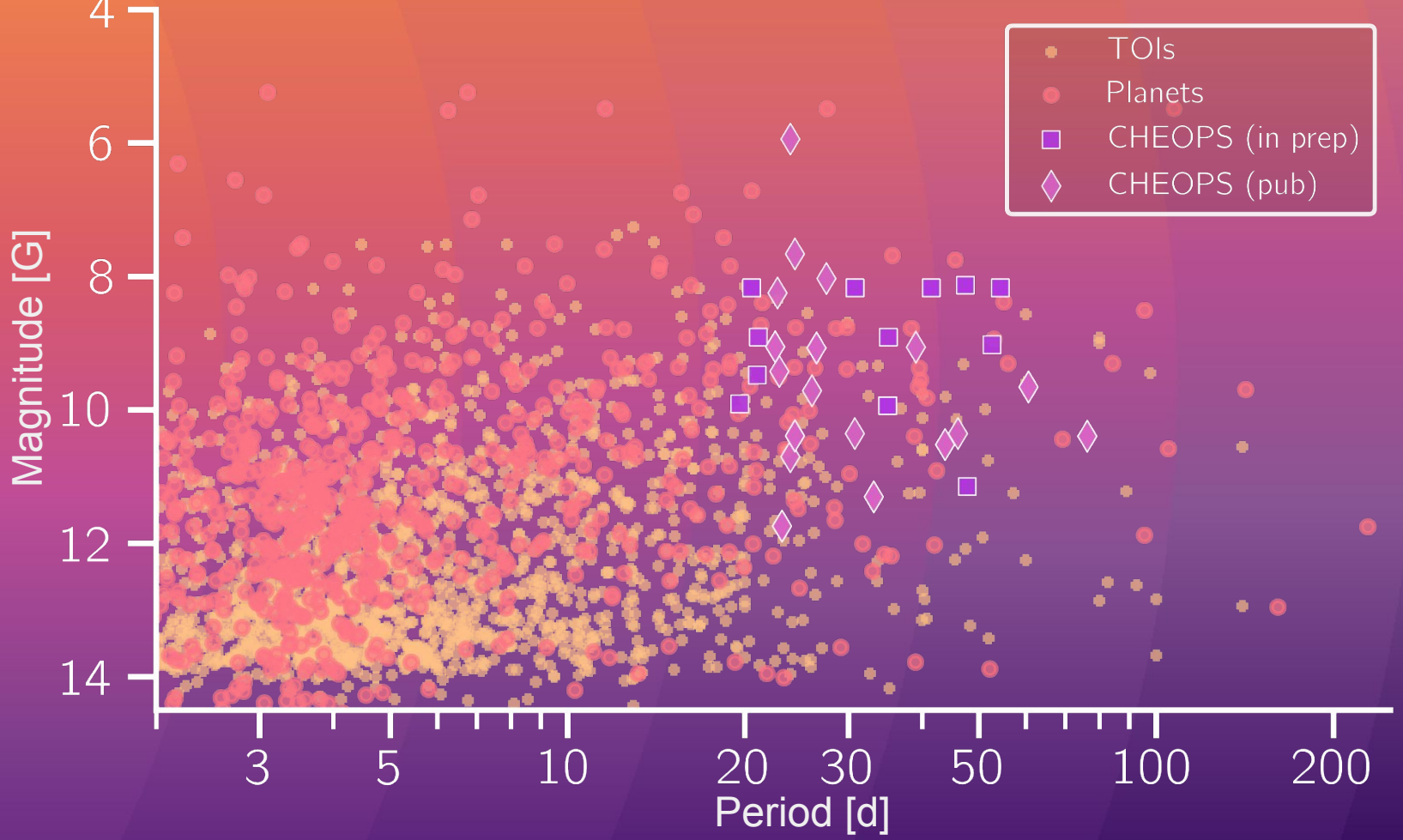

TESS
b
2019
c
b
2021
b
c
The CHEOPS "Duos" project
HIP 9618
CHEOPS
P = 40.2d
P = 45.6d
P = 48.8d
P = 52.6d

New planets from the CHEOPS “Duos” project

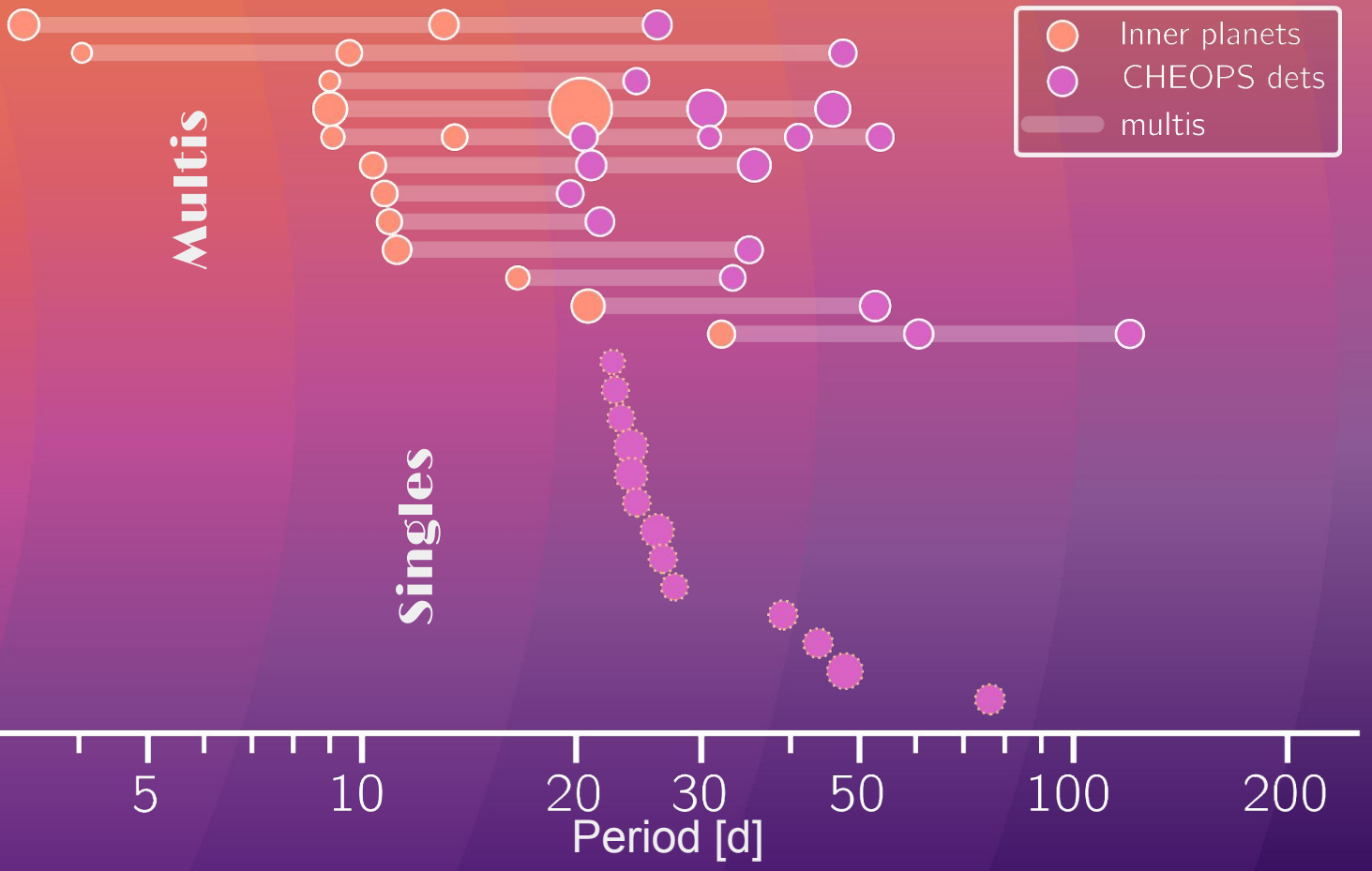
CHEOPS "Duos" are sub-Neptunes



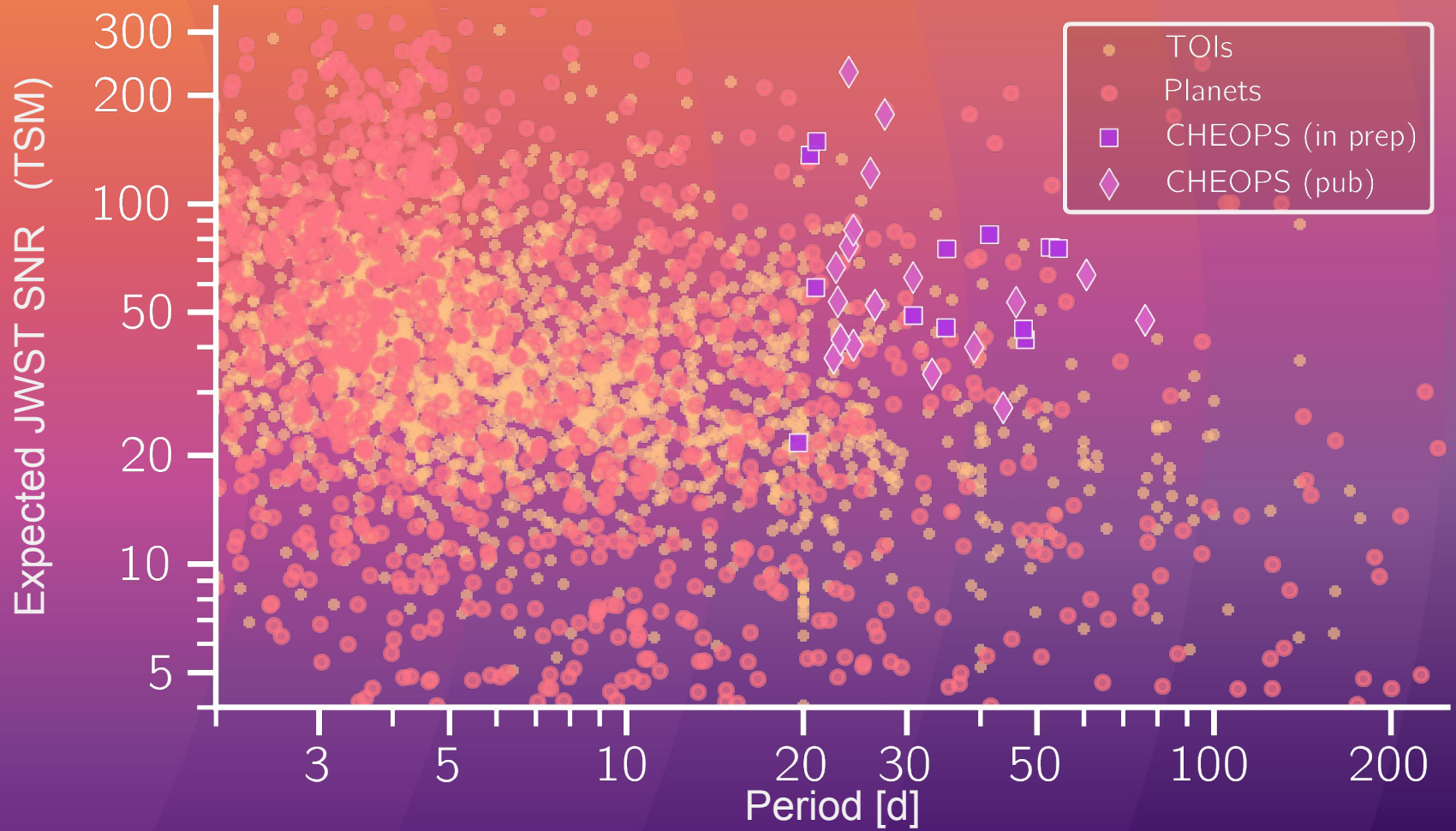
CHEOPS "Duos" are bright



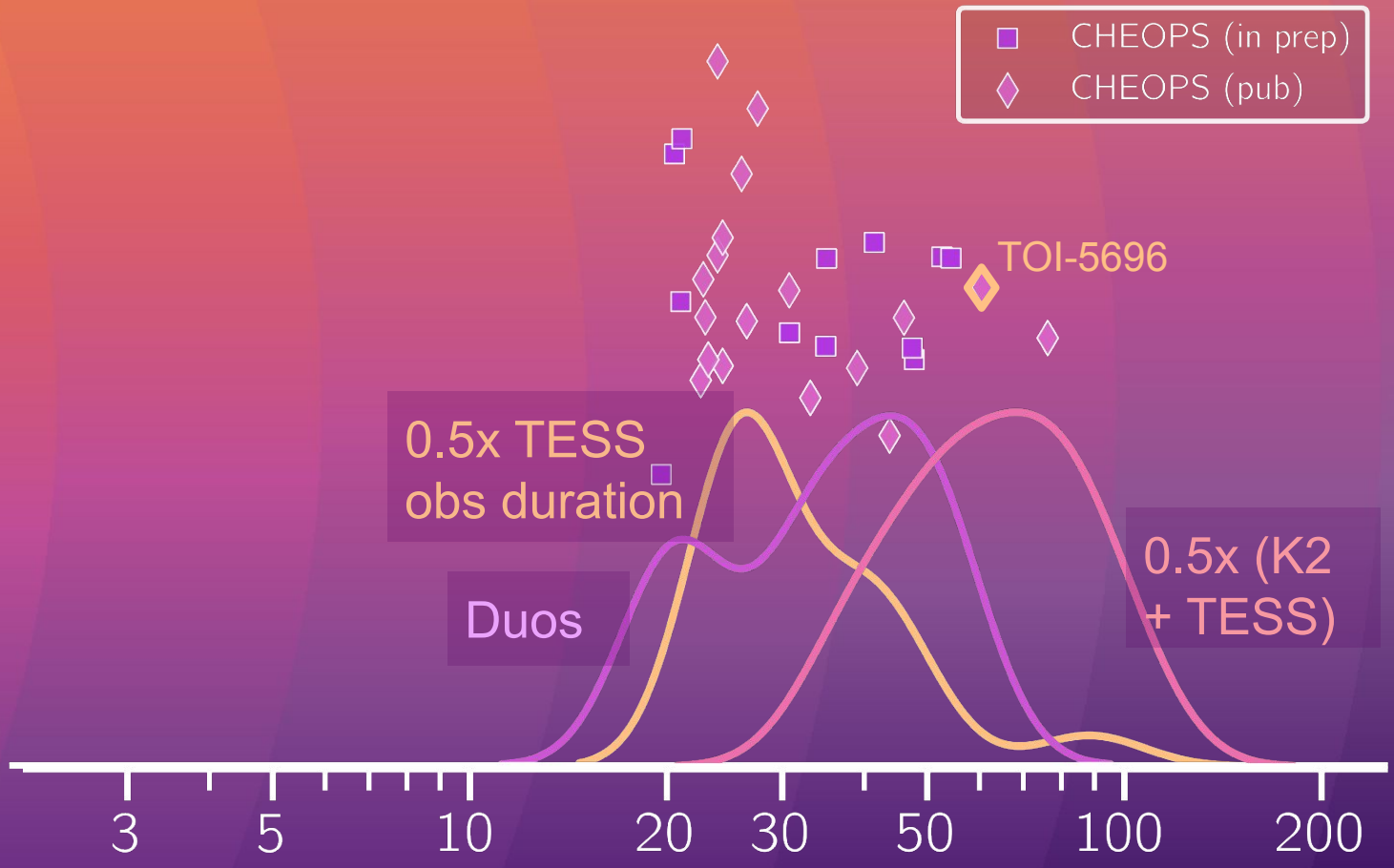
CHEOPS "Duos" are in multis



CHEOPS "Duos" are characterisable

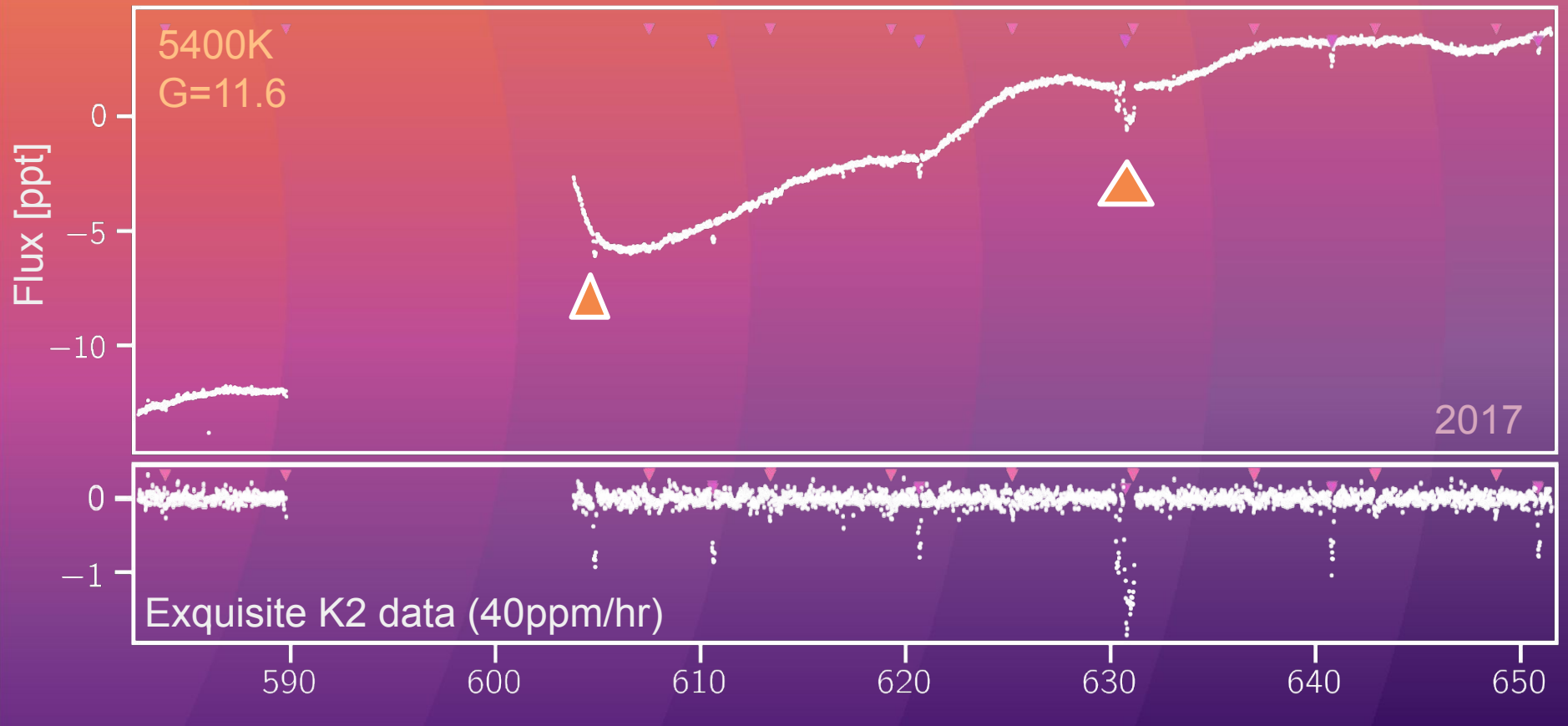


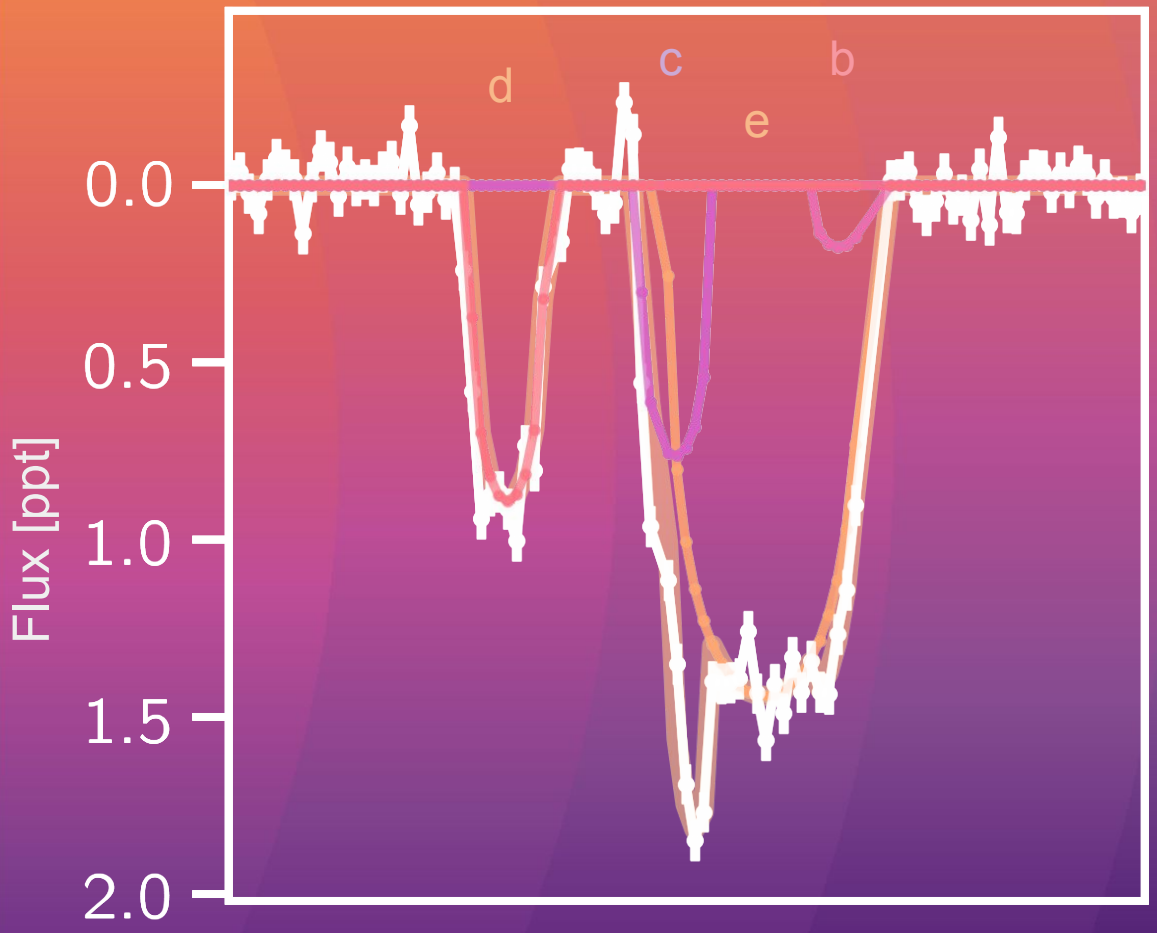
CHEOPS "Duos" periods



K2-158

K2-158


5400K
G=11.6
2017
Flux [ppt]
0
−5
−10
0
−1
Exquisite K2 data (40ppm/hr)
590
600
610
620
630
640
650



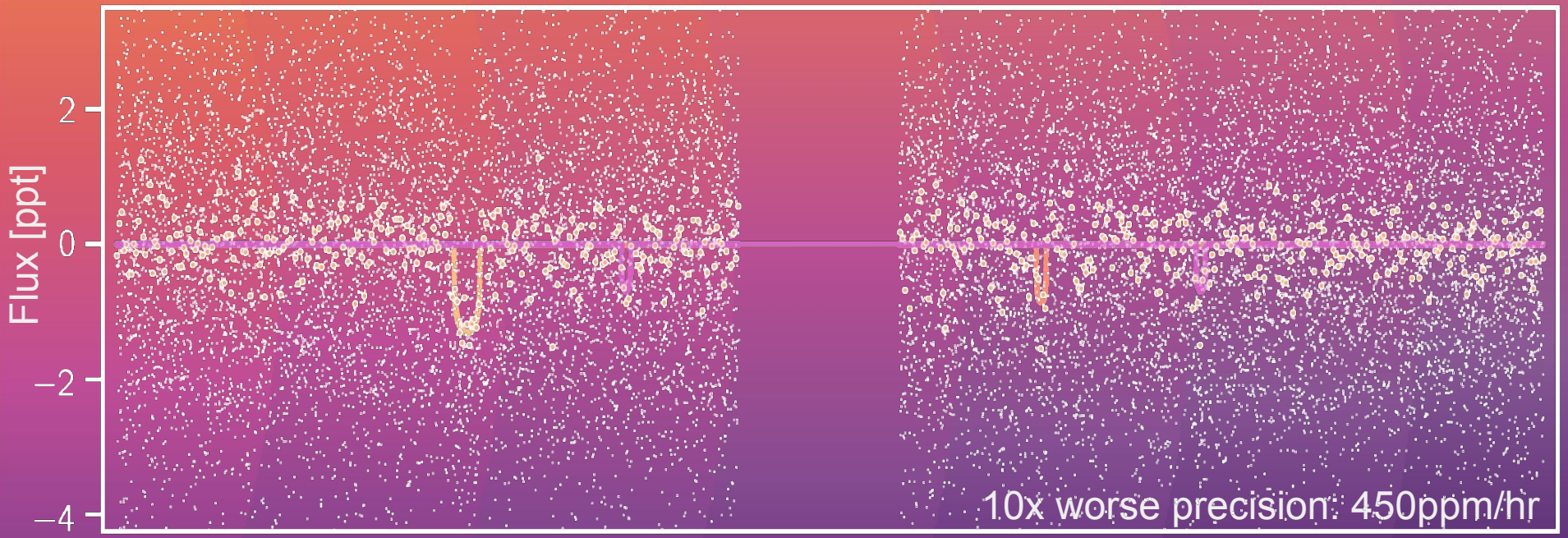
K2-158

900ppm transit which matches earlier event (P=25.5d)

1500ppm single transit event - 2.5x longer transit than d!

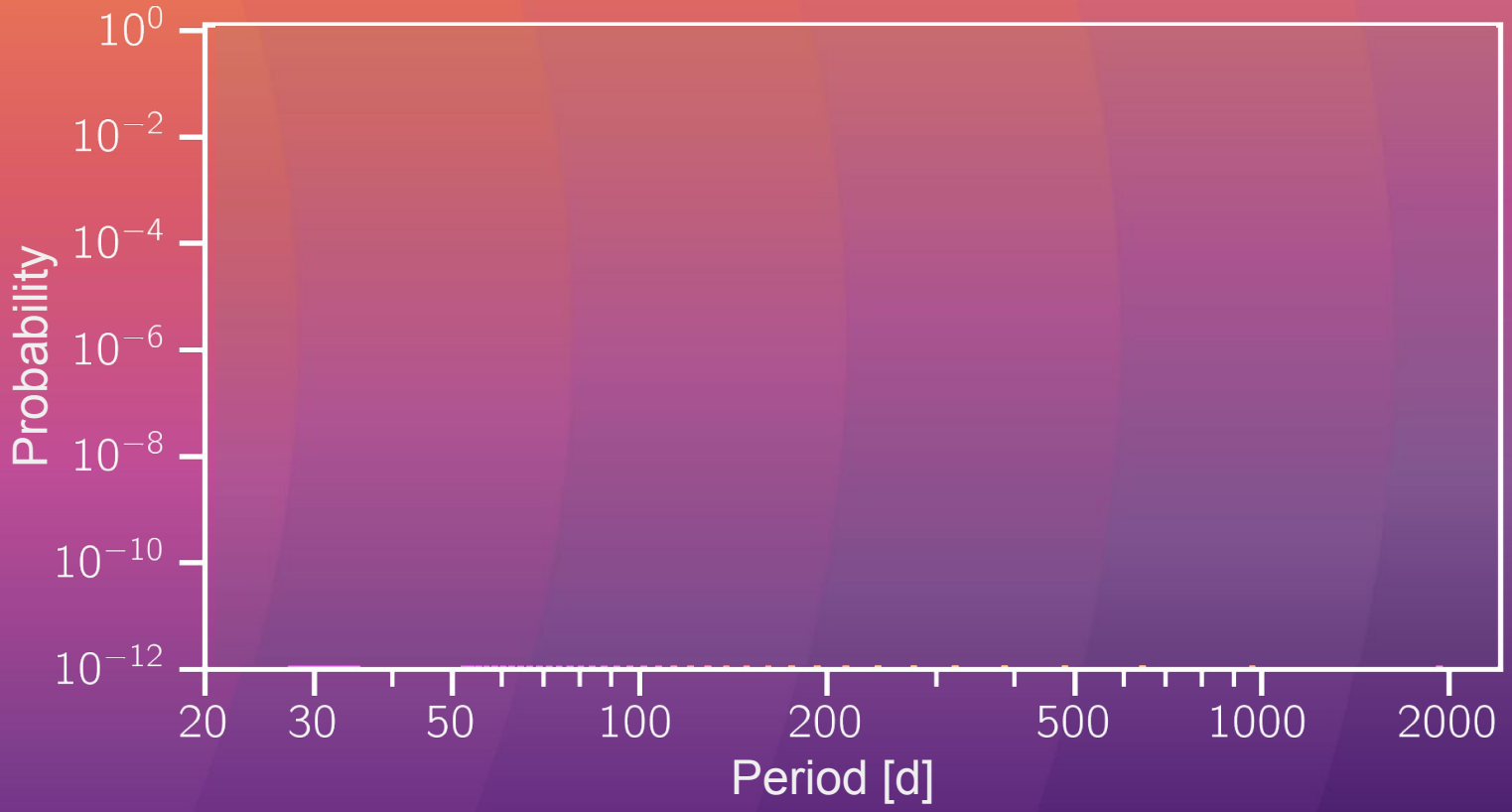
“Triple transit” with b & c matches data well

TESS observations



December 2021

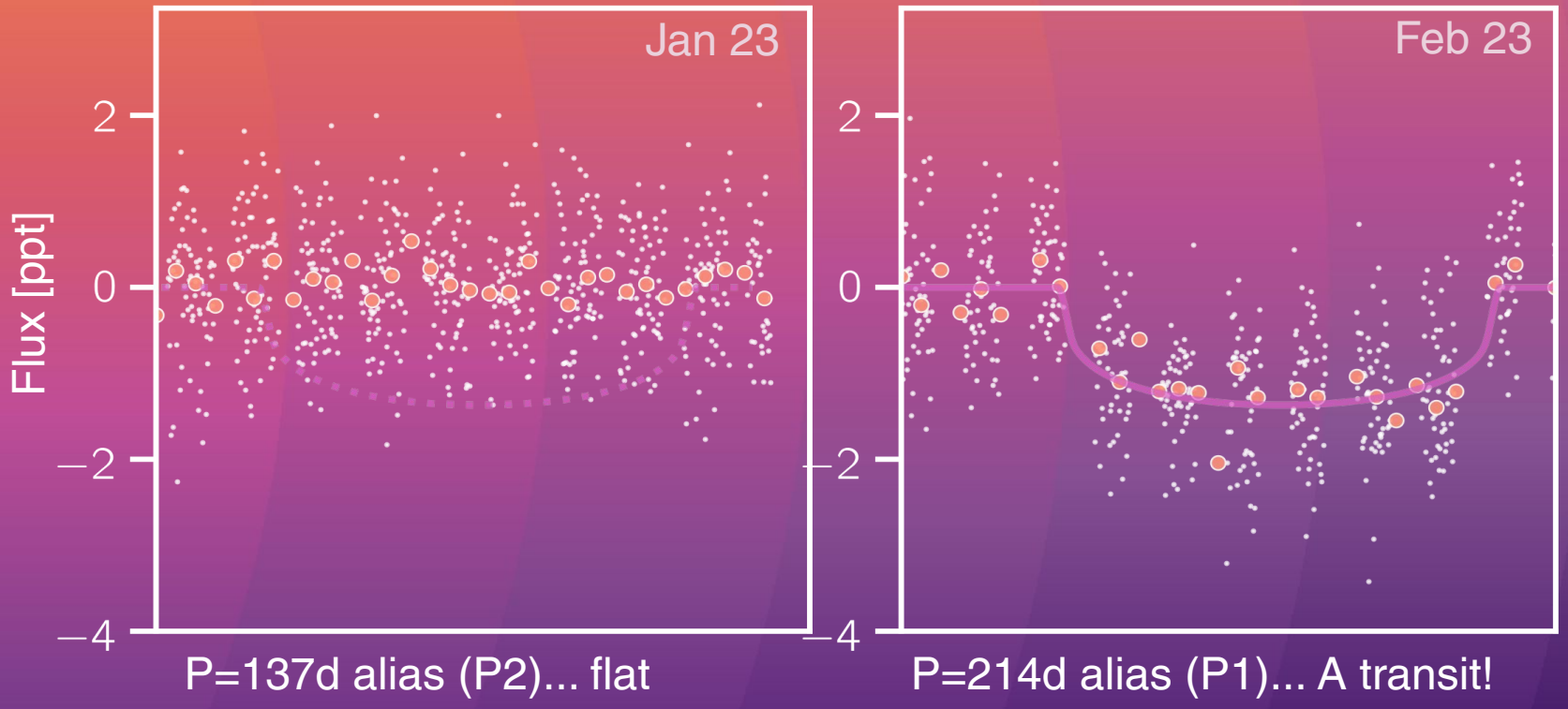
Period Aliases



Probability
=
model
likelihood
x
period prior
x
eccentricity
prior
x
stability prior

https://github.com/hposborn/MonoTools

CHEOPS* observations

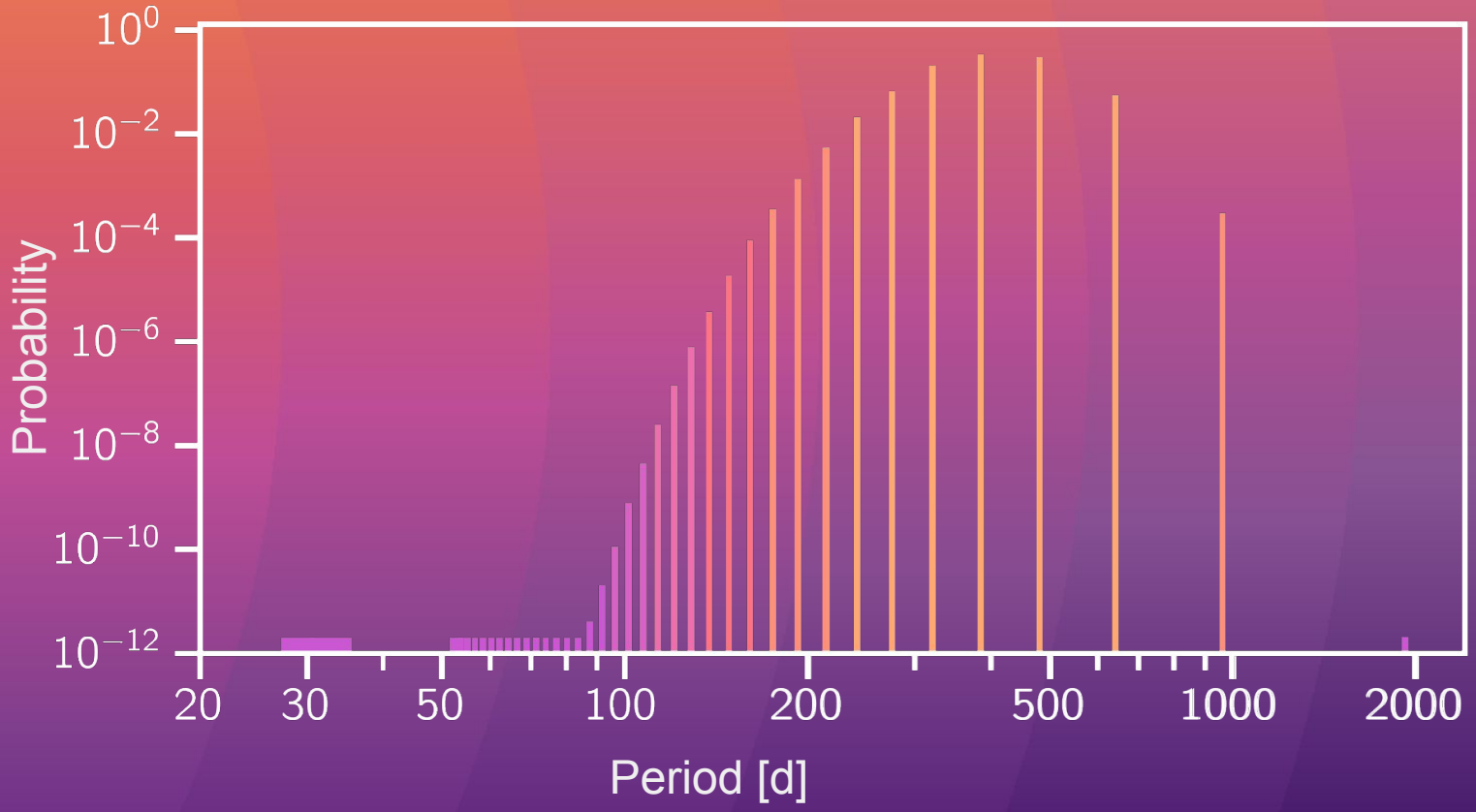


P=137d alias (P2)... flat

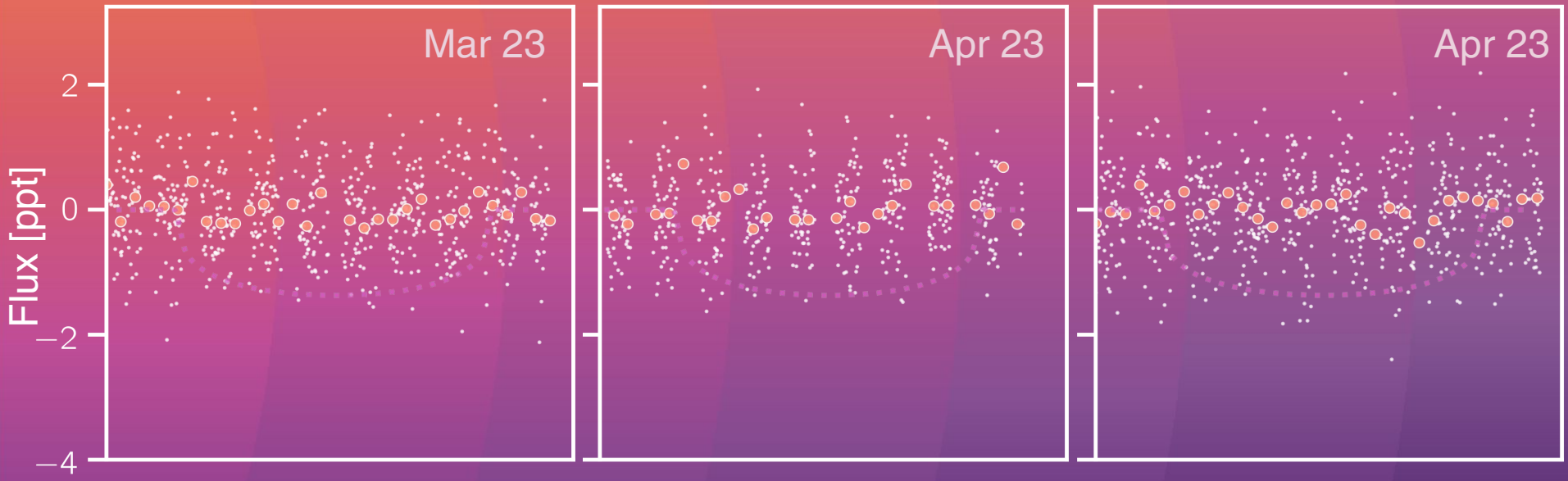
P=214d alias (P1)... A transit!

* Representative lightcurves only

Period Aliases



CHEOPS* observations (2023)



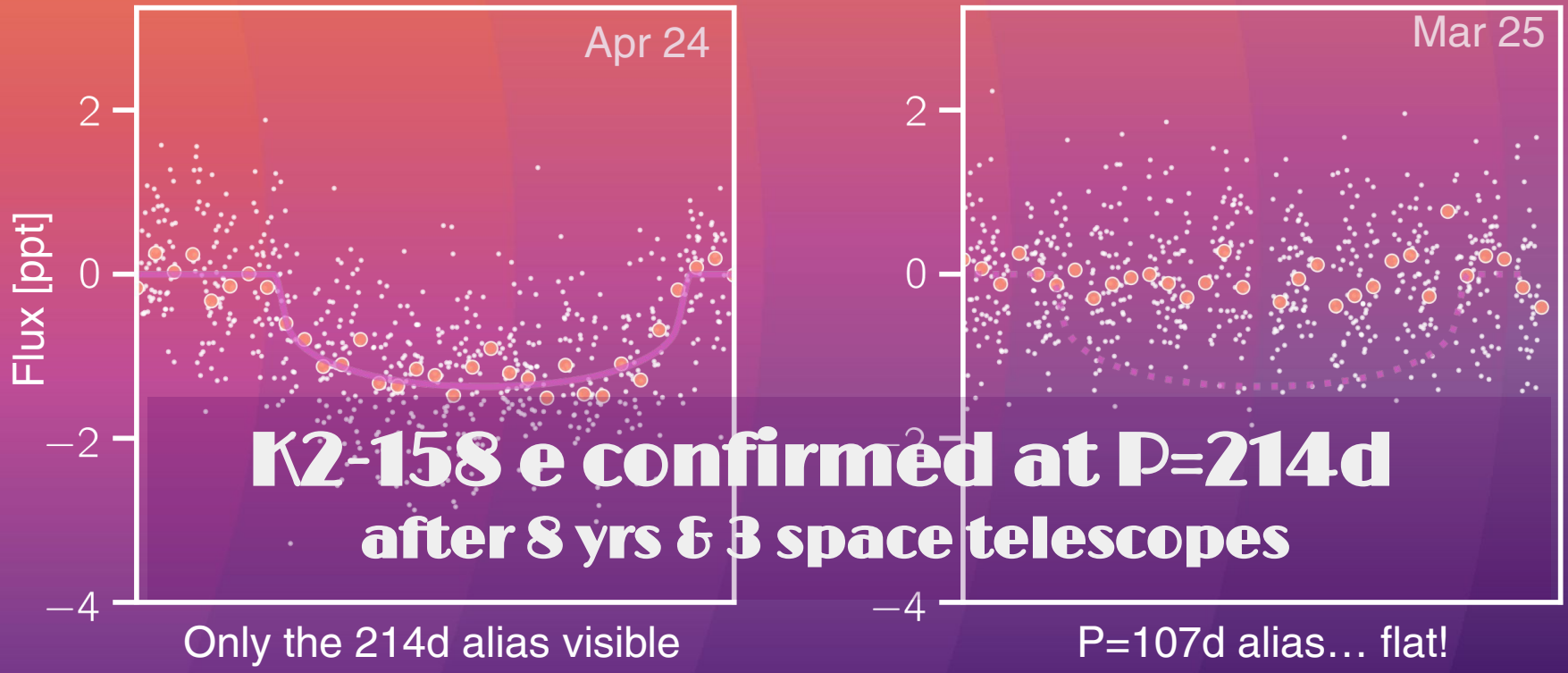
P=35.7d alias

P=53.58 alias

P=71.44d alias

* Representative lightcurves only

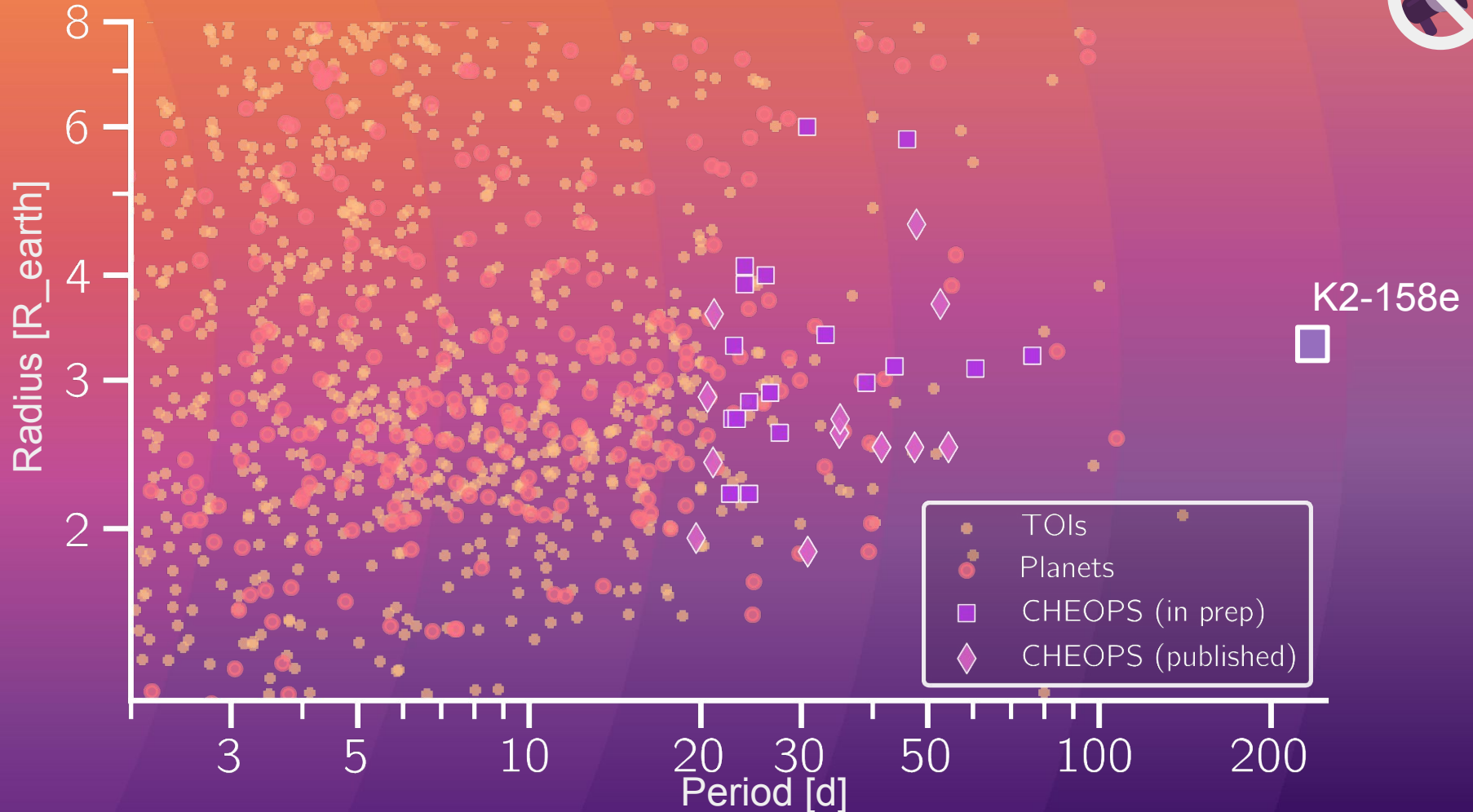
CHEOPS* observations (2024)



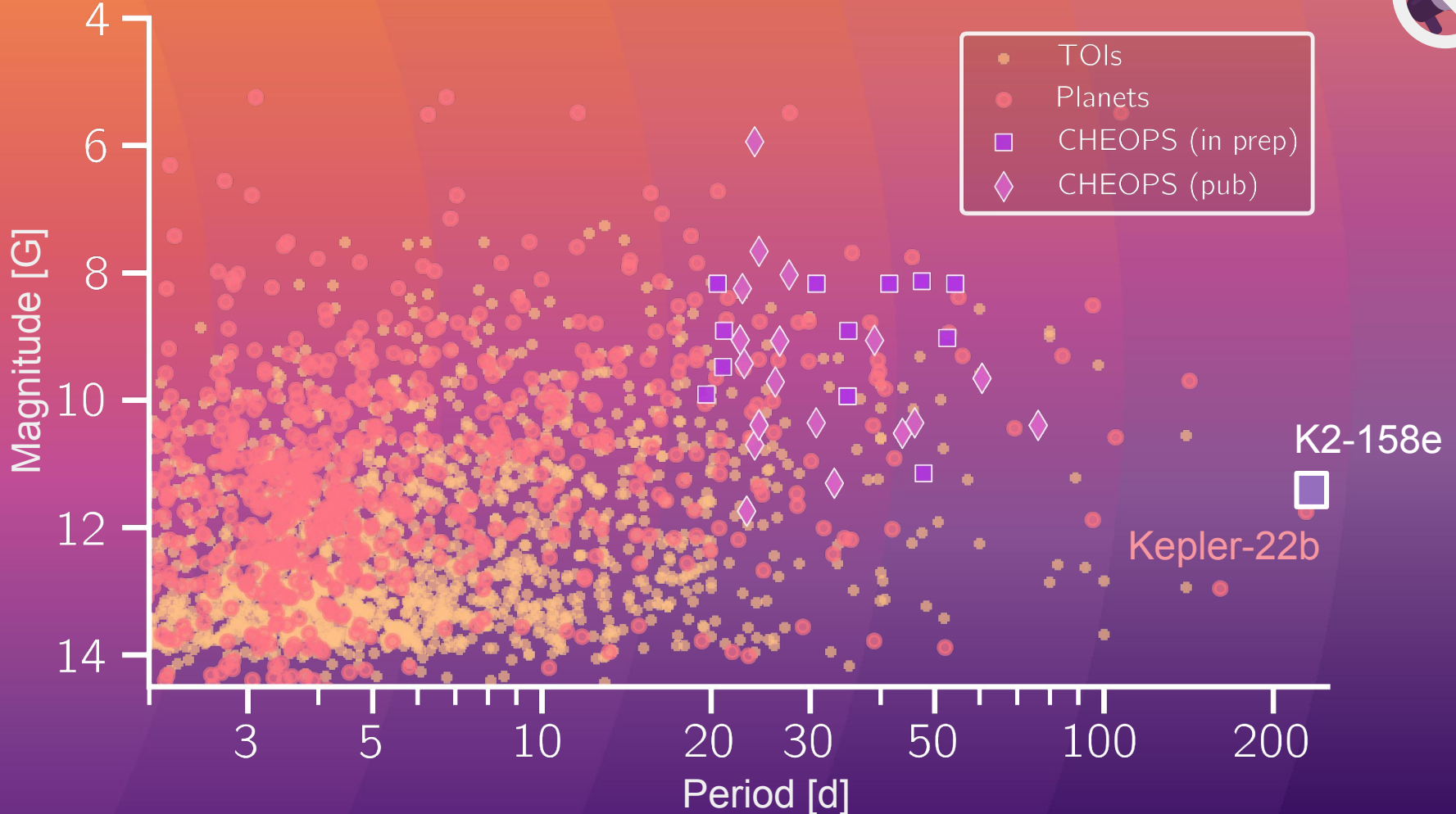
K2-158 e confirmed at P=214d
after 8 yrs & 3 space telescopes

* Representative lightcurves only

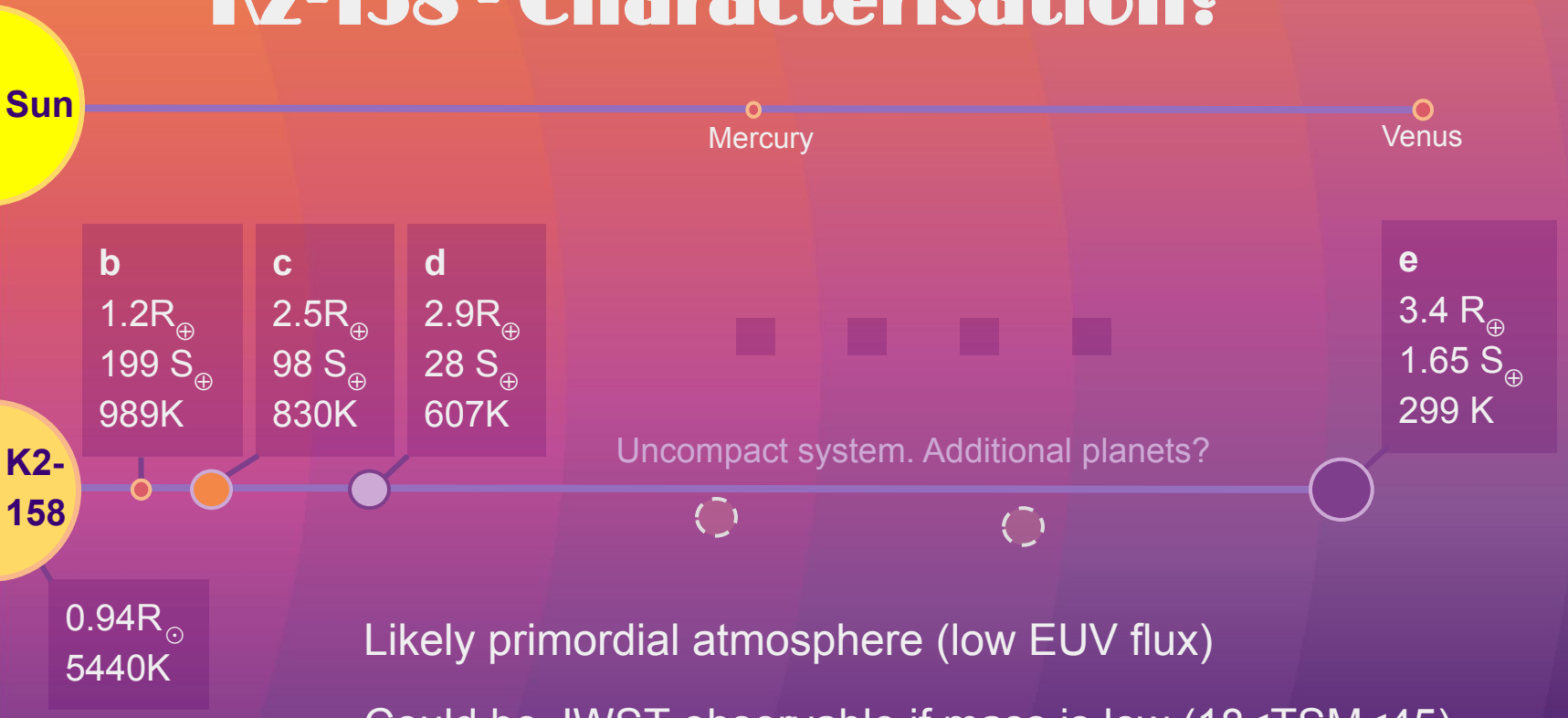
K2-158e in context



K2-158e in context



K2-158 - Characterisation?



Likely primordial atmosphere (low EUV flux)

Could be JWST-observable if mass is low (18<TSM<45)

ESPRESSO observations ongoing (K_e < 5m/s; M_e < 37$M_\oplus$)

Unlocking cool transiting planets across the sky:

A temperate sub-Neptune discovered using K2, TESS & CHEOPS

Thanks for listening!

Hugh Osborn, Solène Ulmer-Moll, Thomas Wilson, David Degen, Amy Tuson, Luisa Maria Serrano, Davide Gandolfi, Yann Alibert, Willy Benz, Didier Queloz,

ETH zürich

UNIVERSITÄT BERN

PlanetS
National Centre of Competence in Research