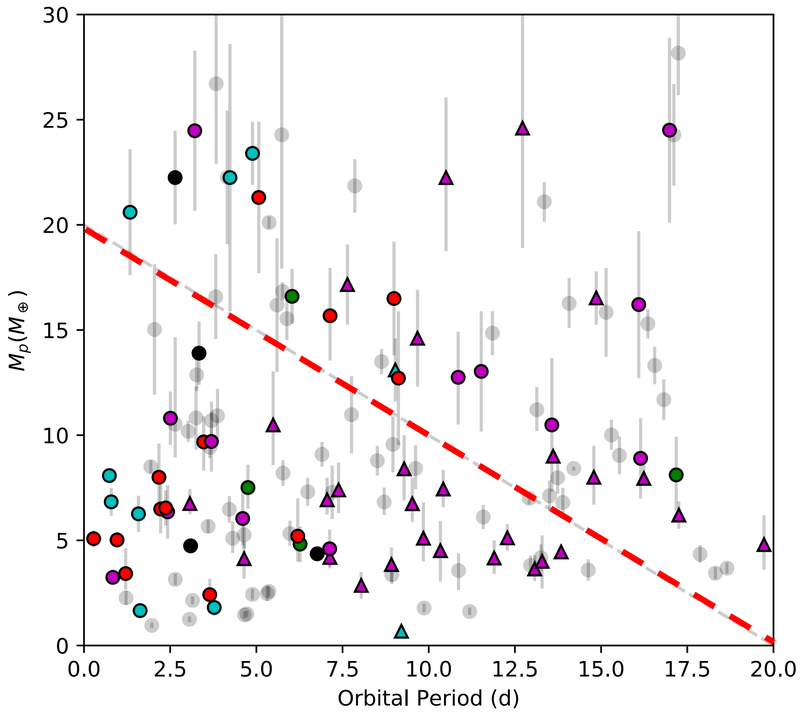
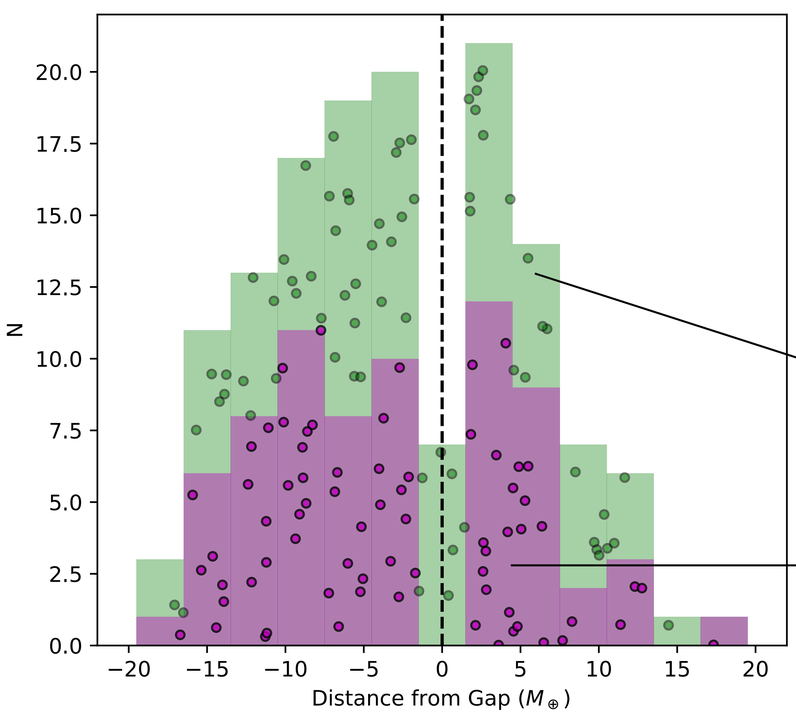
A Gap in the Mass Distribution for Warm Neptune and Terrestrial Planets

David Armstrong, Farzana Meru, Daniel Bayliss, Grant Kennedy, Dimitri Veras

Centre for Exoplanets and Habitability, University of Warwick, UK





Left: *Planets around the gap*
Discovered by*: Kepler (41) – Purple, K2 (13) – Red, TESS (4) – Green, RV surveys (4) – Black, Photometric surveys (10) – Cyan*
Planets without measured inclination are faded

Right: *Histogram on gradient of dashed line*

Planet Sample

All planets with >3σ mass measurements, P < 20d and M_P or $M_P \sin(i) < 25M_\oplus$, as of February 2019.

P2 sample: whole set, 143 planets (green)

P1 sample: 72 transiting planets with measured inclination (purple)

A Gap appears between 20d and $20M_\oplus$

Observational Biases?

The gap is independent of discovery mission, mass determination method, or host star brightness (as a proxy for follow-up priority).

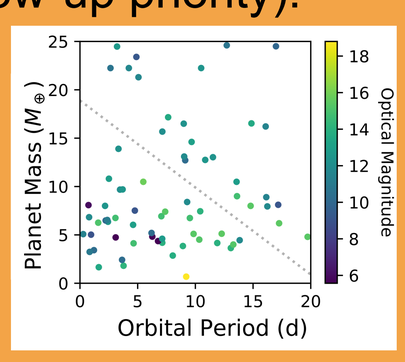


Figure: Host star brightness dependency (P1 sample)

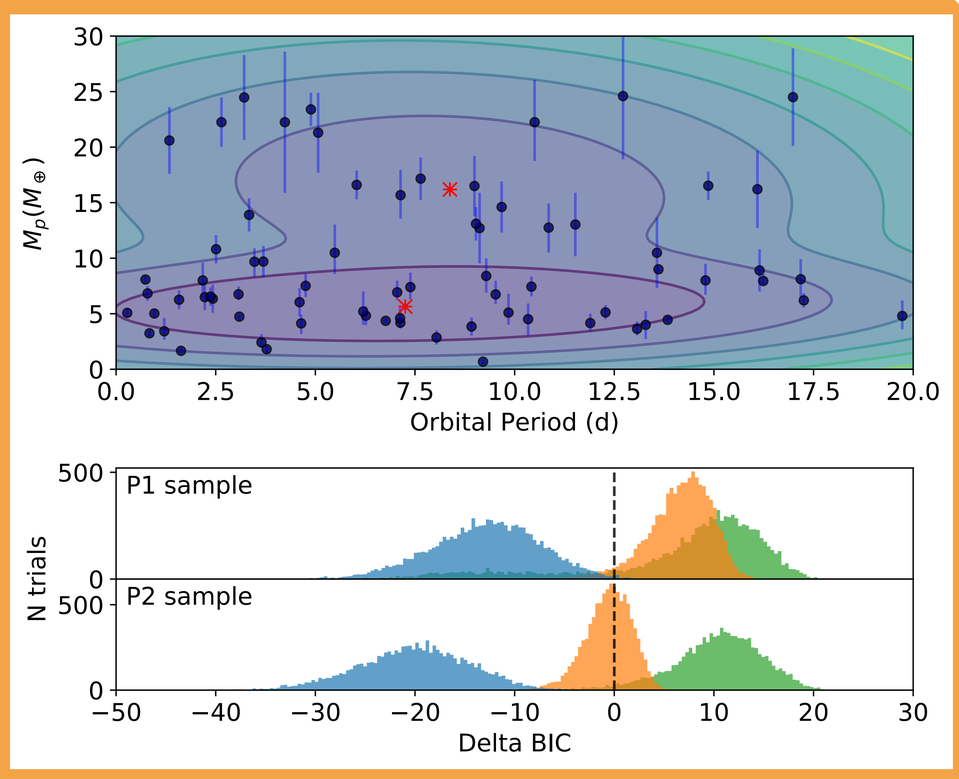
Strength of Doppler signal goes as $M_p \sin(i) M_*^{-2/3} P^{-1/3}$ i.e. if the gap was due to SNR limits, we would expect its gradient to have the opposite sign.

Gap Significance

Gaussian Mixture Models strongly favor two component model over one component, or > 2.

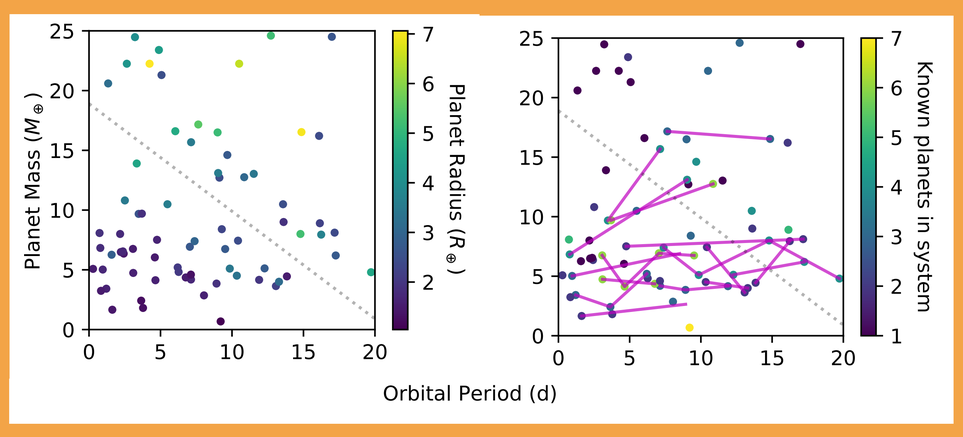
Hartigan's dip test gives $p = 2.4 \times 10^{-4}$ that distribution is unimodal.

Gap significant when considering only RV masses, only TTV masses or only space-based discoveries.



Top: *Two-component Gaussian Mixture Model fit to P1 sample*
Bottom: *Distribution of ΔBIC over 10000 trials going from 1-2 components (blue), 2-3 components (orange), 3-4 components (green)*

Physical Mechanisms



P1 sample colored by planet radius (left) and known multiplicity (right). Planets in the same system are connected, often crossing the gap.

No clear dependence on planet radius, density, multiplicity, eccentricity, or stellar mass or metallicity.

Plausible mechanisms to form the gap include tidal interactions with the host star, or a combination of planets piling up above the gap and local instability.

Further work - TESS

TESS will provide a more homogenous sample to investigate the planet mass distribution, and determine the gap's structure and depth in more detail.

See *Armstrong et al 2019, ApJL, 880, 1* for full analysis.

d.j.armstrong@warwick.ac.uk