TFAW K2 SURVEY: AN INSIGHT INTO A FEW HUNDREDS OF NEW EARTH-SIZED PLANETARY CANDIDATES

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OVERVIEW

- We performed a uniform reanalysis of ~300K EVEREST 2.0-corrected light curves from K2 campaigns C1-C8 and C12-C18.
- We combine TFAW's **improved photometric precision** and TLS **signal detection efficiency (SDE)** to search for new transit candidates.
- We present a first set of **220** planet candidates validated with VESPA.

TFAW ALGORITHM

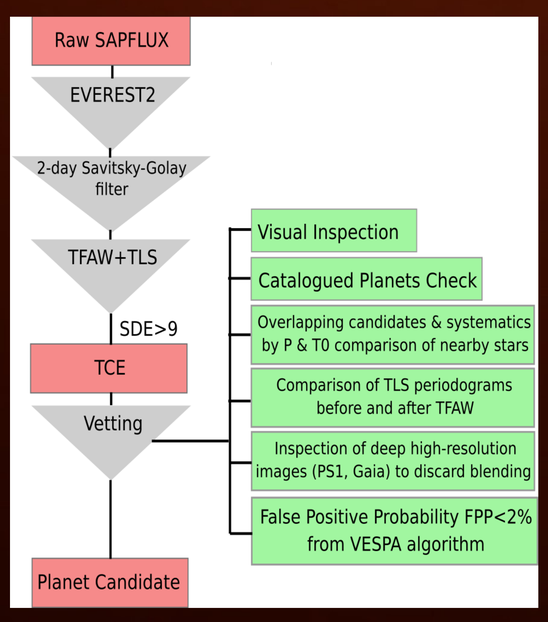
- Wavelet-based modification of the Trend Filtering Algorithm (TFA) [5].
- Divided in two steps:
  - *Frequency analysis*: Remove systematics, noise and outliers. Perform period search.
  - *Iterative signal reconstruction*: Once a significant period is found, the final light curve is reconstructed and de-noised.
- TFAW yields improved photometric precision, increased transit detection efficiency and better transit characterization [2].
- **K2-327 b & K2-328 b**: TFAW discovers two K2-C1 Earth-sized validated candidates [1].

TRANSIT SEARCH

- Transit Least Squares (TLS) [4] optimized to detect small planets.
- We combine TLS with TFAW's frequency analysis step to enhance the detection of transiting planet candidates.
- Stellar parameters obtained from "K2 star parameters from Gaia & LAMOST" [3] and EPIC catalogs.
- We consider **significant periods** those with SDE≥9.0 (false-positive rate $<10^{-4}$).

VETTING AND VALIDATION

- All light curves that have a significant detection undergo TFAW's iterative signal reconstruction and denoising. We visually inspect them and keep the ones which show transit-like features.
- The full vetting procedure consists on:

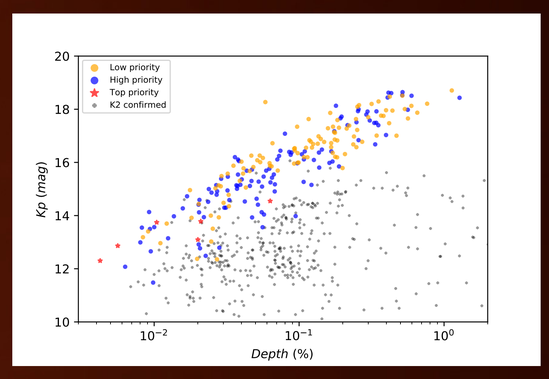


- Transit 0.5 days away from the beginning/end of any light curve gaps.
- Rule out eclipsing binary nature by checking odd/even transit depths.
- Catalog comparison to discard already found candidates.
- Check EVEREST 2.0 [6] aperture image for contaminating sources.
- Rule out that no other light curve(s) in the same CCD module present transit-like features with similar periods and T_0.
- Comparison of TLS periodograms before/after TFAW.
- Inspection of high resolution images from Pan-STARRS1 and Gaia DR2 to discard close stellar companions.

- VESPA [7] computes the probabilities of the transiting signal to be caused by six different astrophysical false positive scenarios with transiting planets.
- Only targets with **FPP lower than 2%** are considered as valid planetary candidates.

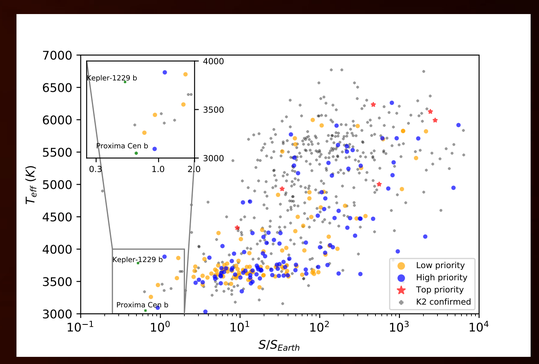
STATISTICAL RESULTS

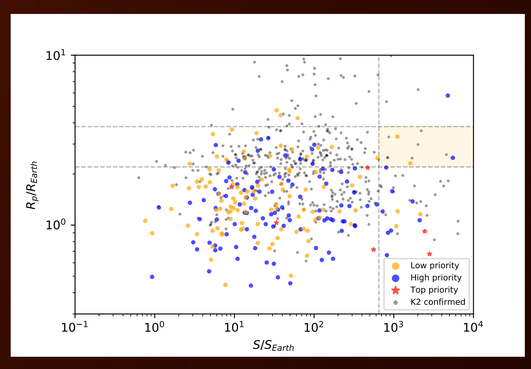
- We present a sample of **220 new planet candidates** detected with TFAW and TLS from K2 campaigns C1-C8 and C12-C18.
- All have passed our vetting procedure and validated by VESPA.
- Classified in three priority ranks: 6 **"top"** (red): detected in two or more K2 campaigns; 110 **"high"** (blue): vetted and validated; and 104 **"low"** (orange): vetted and validated but either have SDEs~9, FPP~2% or need further reanalysis.



- TFAW opens a **new niche** for exoplanetary candidate search.
- It allows to detect transiting objects **around fainter stars** than any other previous survey.

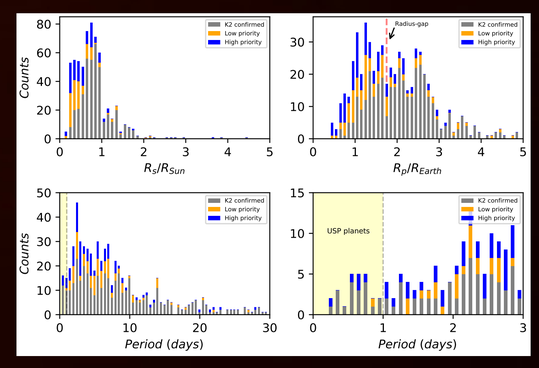
- Most of our candidates orbit low-mass stars.
- Four candidates lie in the **conservative HZ of their host stars.**
- Two other lie in the **optimistic HZ.**





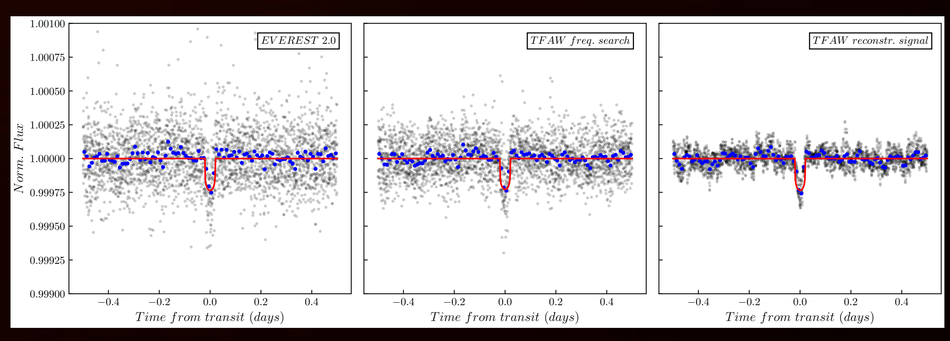
- No Jupiter-sized candidates found around M-dwarfs.
- Four candidates lie within the **Hot-Super-Earth desert**.

- We mainly populate the **small planet radius** range ($< 1.5R_\oplus$).
- We **duplicate** the sample of candidates within the **small planet radius gap** ($\sim 1.8R_\oplus$).
- We also add some candidates in the **Ultra-Short-Period (USP)** range.



EPIC 248828117.02: A NEW EARTH-SIZED CANDIDATE FROM C14 FOUND BY TFAW

- We present EPIC 248828117.02 to illustrate the noise filtering efficiency of TFAW.
- EPIC 248828117.02 is a $1.3R_\oplus$ planet candidate orbiting a G3 star with a 2.896 day orbit.



Normalized phase-folded EPIC 248828117.02 light curve with TLS model data marked in red for EVEREST 2.0 (left), TFAW's frequency analysis step (middle) and for the TFAW-reconstructed signal (right)). Blue represents the binned data.

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