Welcome to DAVE: Discovery and Vetting of K2 Exoplanets

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Welcome to DAVE:
Discovery and Vetting of K2 Exoplanets

- Semi-automated exoplanet vetting pipeline
- Adapts vetting tools developed for the Kepler mission to K2 planet candidates.
K2’s Road to Planets

Light Curve Generation → Signal Detection → Signal Vetting → High Reliability Catalog

Efficient Follow-up Observations

Confirmed Planets

Measured Catalog Biases

Better Occurrence Rates
DAVE Catalog: Benchmarking K2 Vetting Tools

http://keplertcert.seti.org/DAVE/

- Campaigns 1 through 10 examined — NASA Exoplanet Archive
- 4 detrending pipelines (K2SC, Everest, PDC, SFF)
- 772 K2 detections examined with DAVE
- Human experts + DAVE pipeline metrics
- **60 new False Positives**
Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Modshift** — Is there evidence that it is an eclipsing binary?
  - (odd/even, secondary)

planet candidate, EPIC 201345483

EB, EPIC 212443457 (odd-even difference)
Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Photocenters** — Is there evidence the signal comes from a background star?
Transit-shape Metrics — Is the signal found shaped like a transit?

Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Transit-shape Metrics** — Is the signal found shaped like a transit?

Quasi-sinusoidal modulations masquerading as a transit signal (EPIC 212454160.01)

- LPP Transit Metric — Compares signal to Kepler transits
- SWEET — Fits sine-wave to signal to see if it is a simpler model.
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- Comparison between detrending pipelines:

  Aigrain — K2SC
  Luger — Everest

AGP (left panels) vs EVEREST (right panels) light curves for EPIC 211808055.01 (upper panels) and EPIC 210605073.01 (lower panels).
Comparison between detrending pipelines:

Ratio of planet-star radius ratios, e.g. \((R_{\text{planet}} / R_{\text{star}})_{\text{K2SC}} / (R_{\text{planet}} / R_{\text{star}})_{\text{EVE}}\), for the candidates that show significant transits in the respective pair of datasets. There is no apparent trend with radius ratio and light curve detrending pipelines.
K2 Vetting and Catalog Generation

Lessons Learned

- K2’s systematics are unique. (6-hr roll, single campaign) Blindly using Kepler trained metrics is dangerous.

- We find that there is no one-size-fits-all recipe to choose one detrending over another. Consider them all.

Future Work

- K2 Campaigns 11-20 remain
- Multi-campaign search/vetting will create new challenges.
- Improve Automation and Usability of Code
- Generate a full consistent catalogs

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Comparison between targets with overlapping apertures (photocenter analysis):

EPIC 212572439.01 (brighter, FP) and 212572452.01 (fainter, PC).
Complementary visual inspection: 2609 DAVE dispositions humans agree, 277 disagree

DAVE missing a clear secondary eclipse (EPIC 206135267.01, EVEREST upper, PDC lower).