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Proposal Attachment - Latex Template *proposal* **Panel:**
Date received: *Thesis* **Category:**

Using Ground-Based Observations to Help Identify False Positive and False Alarm Exoplanetary Transits from the Kepler Mission

Scientific Justification *Be sure to include overall significance to astronomy. For standard proposals limit text to one page with figures, captions and references on no more than two additional pages.*

Background Info Notes

- The Kepler Mission is a spaced-based project that launched in 2009 in search for Earth-like and large exoplanets orbiting in their Sun-like host's habitable zone
- Kepler uses **transit method:** a star's apparent flux will decrease as an exoplanet transits its host star along our line-of-sight because it will block out some of the star's light
- **KOI:** Kepler Object of Interest
- **CFP:** Certified False Positive
- **FPWG:** False Positive Working Group
- KOI becomes CFP when FPWG determines there is no planetary interpretation of its data
  - Vetting process includes data analysis and using results ground-based observations to support false positive or false alarm claim
- A false positive is when a transit is detected, but it is not due to an exoplanet transiting the target star
- Eclipsing Binaries (EBs) and Background Eclipsing Binaries (BGEBs) are false positive causes
- EB false positives happen when a star transits the target star, producing a planetary-transit-like light curve
- BGEB false positives happen when an EB in the background of the target star blends with it, making it look like a planetary transit
- False alarms are invalid observations caused by stellar variability or instrumental errors that make the light curve look transit-like even though there was no transit.
- Sometimes FPWG fails to present enough evidence to certify a KOI as a false positive or false alarm. These KOIs have dispositions 'DATA INCONCLUSIVE' or 'POSSIBLE PLANET' in the CFP table.
- Some CFP candidates have not been examined by FPWG yet and are thus labeled 'NOT EXAMINED' in the CFP table

Introduction to Project

- **Goal:** Identify false positive detections of exoplanets and false alarms
- Observe targets from the CFP table that have not been certified as a false positive or false alarm
- Important to astronomy because the confirmation of false positive candidates will help astronomers avoid observing a false positive.

References

KFPWG 2017, KSCI, 19093, 3

Borucki 2016, Rep. Prog. Phys., 79, 036901

Coughlin 2014a, KSCI, 9105, 001

Coughlin et al. 2014b, AJ, 147, 119

Coughlin 2017, KSCI, 19105, 001

Kaye et al. 2022, MNRAS, 510, 5464-5485

Experimental Design *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification?*

- Kepler bandpass ranges from 400 to 1100 nm, so ground-based observations can use the Johnson-Bessel B, V, R, and I filters and SDSS's g', r', i', and z' filters.
- Will observe using Las Cumbres Observatory's (LCO) Sinistro imager on the 1-meter telescopes at McDonald Observatory in Texas, USA, Teide Observatory in Tenerife, Sliding Spring Observatory in Australia, and Cerro Tololo in Chile
  - These four observatories are located in both hemispheres and have different timezones which will lower the chances of not being able to observe a KOI due to location and/or time limitations, thus allowing me to maximize the number of targets to observe
  - Using observatories in different timezones will also allow me to observe KOIs that take more than one night to observe
  - Additionally, Sinistro has all of Johnson-Bessel and SDSS filters, so I will be able to observe at most of Kepler's bandpasses
- Observe targets from the CFP table with dispositions 'NOT EXAMINED', 'DATA INCONCLUSIVE', or 'POSSIBLE PLANET'.
  - Targets should have transiting periods less than seven days
  - Choose KOI whose transit depth is at least 0.1%
- For false alarm candidates that may be caused by stellar variability, I will observe at non-transiting times and perform photometry to check for variability
- Exposure time of 90 seconds like in Kaye et al. 2022
- Data analysis will be performed as described in Coughlin 2017, Coughlin 2014a, and Coughlin 2014b
- For KOIs that have comments on what the cause of a false positive or false alarm may be, I will perform data analysis to check for that specific cause. Otherwise I will perform data analysis for all possible scenarios
- NASA's Exoplanet Archive will be used to extract all target information needed