Discovering Hidden Worlds with DYNAMITE

An Integrated Analysis of Multi-planet Systems

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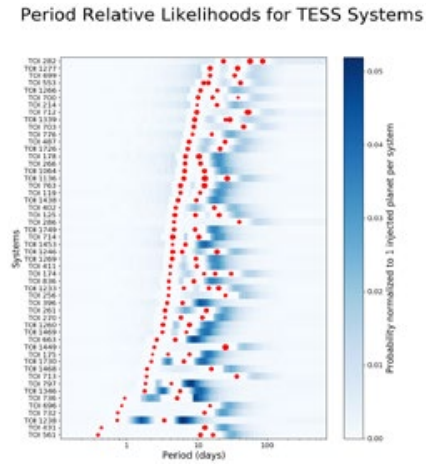
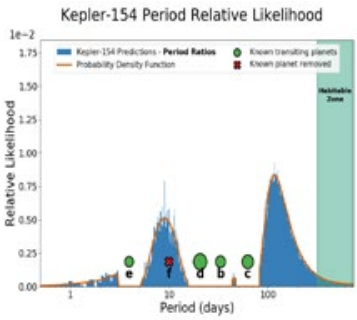
True Nature of System Architectures?

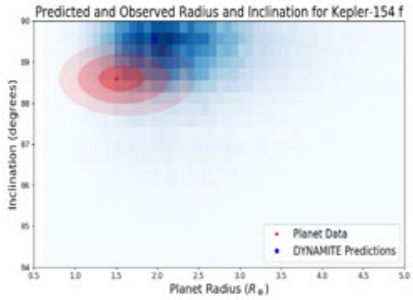
From our vantage point on the Earth, we have an extremely limited view of planetary systems beyond our own, as we are limited by observation biases, both geometric and instrumentational. However, thanks to the Kepler Space Telescope, we do have a good knowledge of the overall population statistics for exoplanet systems and can provide a statistical analysis of likely orbital architectures.

We created the DYNAmical Multi-planet Injection TEster (DYNAMITE) algorithm to combine the specific but incomplete data from each individual planetary system with the population statistical distributions (along with a few other rules to ensure dynamical stability) and sample the posteriors to provide predictions and confidence intervals for the presence and parameters of an additional planet in the system.



Hunting for Previously Undiscovered Planets



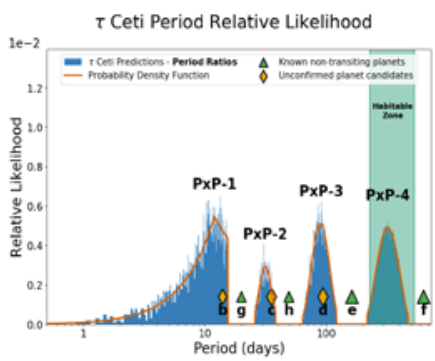


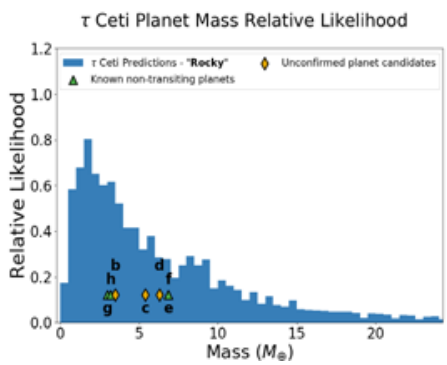
Utilizing this full integrative analysis, we applied DYNAMITE to known systems with one or two planets removed, in order to test the stability and robustness of the algorithm. With the removal of Kepler-154f, we find that the removed planet is predicted almost perfectly in period space, and very close in radius and inclination space.

From this analysis, we provide predictions for 45 multi-planet systems discovered by TESS, with multiple of these planet candidates already having tentative positive evidence for their existence.

Predicted Habitable Zone Planet: τ Ceti

We also applied DYNAMITE to the τ Ceti planetary system, currently with four known planets and at least three additional candidates. We find that the three candidates have support from the DYNAMITE predictions, and we also predict a fourth additional planet between known planets e and f. Excitingly, this planet would be in the habitable zone around τ Ceti. Based on the other planets' assumed masses in the system, this planet would have an equal chance of being a super-Earth vs. being a sub-Neptune.





eos-nexus.org/dynamite

github.com/JeremyDietrich/dynamite

References:
Dietrich & Apai (2020a), AJ, 160, 107D
Dietrich & Apai (2020b), accepted to AJ