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First Results from Planet Hunters: Exploring the Inventory of Short Period Planets from *Kepler*

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Abstract

We present the first results and planet candidates from Planet Hunters, part of the Zooniverse collection of citizen science projects. [3,4]. Planet Hunters enlists more than 40,000 members of the general public to visually identify transits in the publicly released Kepler data via the World Wide Web in order to provide a completely independent assessment of planet frequencies derived from the Kepler light curves. We examine the abundance of large planets (> 2 earth radii) on short period (< 15 days) orbits based on Planet Hunters detections for the first 33.5 days of the Kepler mission, and highlight a selection of planet candidates.

1. Introduction

The Kepler light curves are complex, with many exhibiting significant structure which includes multiple oscillations as well as quasi-periodic oscillations and short-lived variations. It is difficult to characterize such variability and therefore an automated search algorithm looking for a periodic signal may miss a transit signal dominated by the natural variability of the star. Despite the impressive success of the Kepler Team's automated Transit Planet Search (TPS) algorithm [2], truly unusual patterns may be challenging for the automated software to recognize.

The human brain is a superb pattern recognition device and with minimal training can often outperform the most sophisticated machine learning devices. Unlike a machine learning approach, human classification is inherently flexible, able to flag unusual items while performing routine classification tasks. Human classifiers have a remarkable ability to recognize patterns and archetypes and assemble groups of similar objects. The human eye is well suited to picking out outliers and can find most transits that cannot be detected in periodograms and identify transit signals that may be missed by the sophisticated TPS. It is unrealistic to expect a single individual or a small group of experts to review the entire Kepler dataset, but with over 40,000 volunteers examining the light curves on the Planet Hunters interface, we have the ability to visually inspect the entire public dataset for signatures of exoplanet transits.

2. Planet Hunters

For each of the ~150,000 Kepler-monitored stars, approximately 10 users examine the light curve identifying potential transits. Since launch in December 2010, over 40,000 volunteers have made over 3 million classifications with the average Planet Hunters user classifying more than 50 light curves. Within four weeks, we had successfully searched the light curves from Kepler's first publicly released quarter of data (first ~33 days of science operations) finding planet candidates that are free of centroid pixel photoshifts (which typically indicate contamination from a background eclipsing binary) and which were not on the Kepler team's published lists of planet candidates, [1], eclipsing binaries [5] or false positives [1].

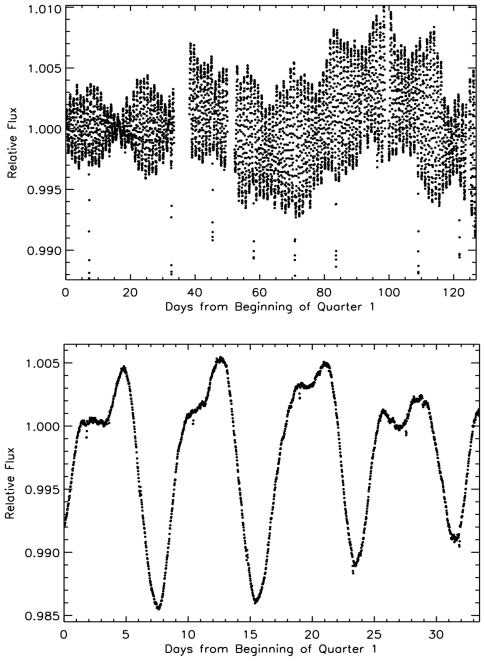
3. Summary

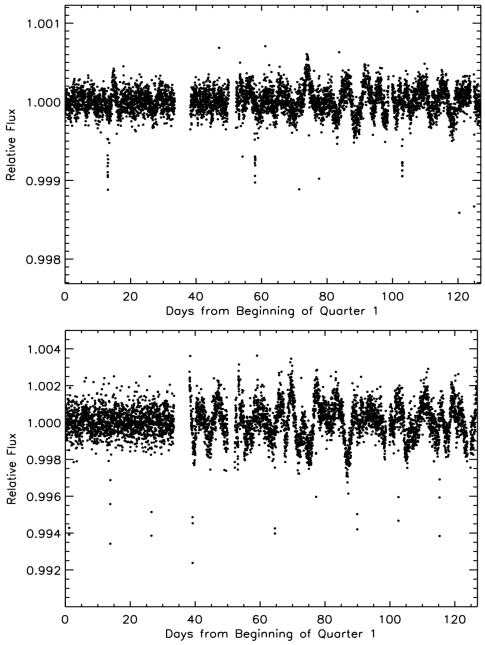
We present these first results along with an analysis of the detection efficiency of human classifiers to identify planetary transits. Planet Hunters is a novel and complementary technique to the Kepler Team's TPS algorithm with different systematics and intrinsic biases providing an independent assessment of the completeness of the Kepler inventory of exoplanets. Planet hunter classifications were processed through a pipeline which uses synthetic

low-period planets to assess the capabilities of individual volunteers. Weightings were assigned to individuals and an iterative process was used to converge on final classifications. A comparison was made with both synthetic and known Kepler candidates in order to measure the sensitivity of the Planet Hunters system and thus derive a final estimate of planet frequency. We will examine the planet candidates identified by Planet Hunters comparing to the Kepler team's published lists of planet candidates (Borucki et al., 2011). In particular, we discuss the abundance of large planets (> 2 earth radii) on short period (< 15 days) orbits based on Planet Hunters detections for the first 33.5 days of the Kepler mission.

4. Figures

Candidates identified by Planet Hunters which are excluded from the list in Borucki et al. 2011.





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Acknowledgements

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References

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