Discovery of the Smallest Ever Ultra-Short-Period Planet Using Novel Phase Folding Detection System Parallelized on a Cheap GPU

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The longstanding question of how ultra-short-period (USP) planets form and survive so close to their host stars signifies a gap in our understanding of planetary formation. With only 127 USPs confirmed from the NASA Archive, the scarcity of samples hinders investigation. Searching for USPs which have avoided detection requires significantly higher sensitivity and faster computation than existing transit detection methods. I designed ExoScout, an exoplanet detection system comprising a new phase folding algorithm and a Convolutional Neural Network (CNN) detector. My phase folding algorithm enables parallelization for the first time to efficiently handle the computational workload, which when run on a cheap Graphics Processing Unit (GPU), increases speed by 120 times over the traditional Box-fitting Least Squares method. I trained the CNN to identify weak signals in light curves using a simulated dataset to address lack of samples, achieving 97% validation accuracy and recovering all known USPs from a blind search. With ExoScout, I report the discovery of the smallest USP ever detected and a rare USP found in adversely hot conditions around a high temperature F-dwarf, only the eleventh of its kind from the NASA Archive. ExoScout's increased efficiency and sensitivity allows new discoveries from large-scale datasets from TESS, James Webb, and Earth 2.0 missions, increasing sample size to advance our study of planetary formation. The innovation of this GPU-parallelized folding algorithm run on cheap hardware replaces expensive supercomputers to make research more accessible and can be applied for high-precision periodic signal detection in many fields.

Awards Won:

First Award of $5,000

George D. Yancopoulos Innovator Award