VALIDATION OF KEPLER CANDIDATE TRANSITING PLANETS WITH BLENDER

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In its quest to determine the frequency of Earth-size planets in the habitable zone of Sun- like stars, the Kepler Mission has identified hundreds of stars displaying small and periodic drops in brightness that appear to be due to a transiting planet, some possibly as small as the Earth. However, experience has shown that a significant fraction of these are due to phenomena other than a planet, such as a faint background eclipsing binary along the same line of sight (a "blend") that is contaminating the photometry. The Kepler Team is now faced with the difficult task of sorting through the candidates to rule out these false positives, in order to confirm a transiting planet. This is an essential step for establishing the frequency of such objects. Some of the most troublesome cases are those with shallow signals that might correspond to Earth-size planets in the habitable zone of their parent stars. These are precisely among the most valuable and exciting candidates the Kepler Mission has found, yet confirmation by the usual spectroscopic methods is often beyond reach. This is because the reflex radial-velocity motion they impose on the star is typically too small to detect with current instrumentation, or because the star is too faint, chromospherically active, or rotating too rapidly. Other follow-up observations such as near-infrared spectroscopy, Spitzer observations, or high-resolution imaging, along with an analysis of the motion of the image centroids, can help to rule out many of the false positive scenarios, but not all. The most effective way of exploring the remaining scenarios that are the most difficult to exclude is to model the Kepler light curves directly in terms of a blend. Once these cases are identified, validation of a candidate must come through a careful statistical assessment of the likelihood of such blends compared to the likelihood of a true planet. This is a proposal to perform this computationally intensive modeling for the most interesting candidates that the Kepler Mission is not able to validate in any other way. We propose to make use of BLENDER, a sophisticated light-curve analysis technique developed by the PI specifically for this purpose. BLENDER is able to systematically explore the vast space of parameters for blends and pose tight constraints on the configurations that can mimic the photometric signal. These constraints are complementary to those placed by other observations, and drastically reduce the overall number of blends that remain possible. The statistical estimate of the a priori likelihood of those blends, which is also part of this proposal, will incorporate information on the mean number density of stars around the target, as well as the expected frequencies of background (or foreground) eclipsing binaries, hierarchical triples, and other configurations. The end result of the analysis is a confidence level for the statement that the candidate is a planet rather than a false positive. BLENDER is a powerful new tool in the field of exoplanet discovery that has already had a significant impact on a number ground-based surveys, and has been applied successfully by the PI in a pilot study to several of the most interesting Kepler candidates. The ability to perform these critical studies will enable the Kepler Team to validate small planets that cannot be confirmed by the usual means, and thus clearly supports one of the main science objectives of the Mission.