DISCOVERY OF SHORT-PERIOD NON-TRANSITING PLANETS/BROWN-DWARF/LOW-MASS-STELLAR COMPANIONS THROUGH THE BEAMING (DOPPLER BOOSTING) EFFECT IN KEPLER LIGHTCURVES

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We developed a new algorithm, BEER, to search for a combination of the BEaming, Ellipsoidal and the Reflection/heating periodic effects induced by short-period non- transiting low-mass companions. The phases and amplitudes of the three effects form a periodic modulation with a specific signature, which is used by BEER to identify stellar candidates that have small non-transiting companions. The algorithm is constructed to work on the Kepler data and utilize the superb accuracy of its lightcurves. A paper describing the algorithm was submitted on Jan. 2nd , 2011 to MNRAS. BEER has already discovered in the Kepler data two very low-mass stellar companions, with masses, up to sine of the orbital inclination, of 88 and 73 Jupiter masses, on the border line between the stellar and the brown-dwarf mass ranges, with orbital periods of 5.6 and 3.5 days, respectively. The two detections were confirmed by radial-velocity observations. Although we used only data from Q1, spanned over only 33 days, BEER could find periodic effects with amplitudes as small as one part in 10,000 of the stellar flux. With access to the full Kepler accumulating dataset we will be able to detect amplitudes induced by most planets with masses larger than 7-10 Jupiter masses, with orbital periods shorter than 10 days. The goal is to discover most of the massive-planet/brown- dwarf/low-mass-stellar companions with short orbital periods, and not only the transiting ones. The radial-velocity follow-up will be relatively easy, as the expected amplitudes of the proposed detections are on the order of 1-10 km/s. The proposed search will map in details the famous brown-dwarf desert (BDD), which lies between 10-20 Jupiter masses on one side and 60-80 Jupiter masses on the other side. The large sample of detections will enable us to find the low-mass end of the distribution of stellar companions and the high-mass end of planets. It will eventually help to settle the long-lasting heated discussion about the definition of a planet and its mass upper bound. The new detections will enable us to find the dependence of the BDD on the stellar mass and metallicity, shading more light on the planetary formation and dynamical evolution processes. The success of such a search depends on access to the data as soon as they are ready. This is so, because comparing the phase of the follow-up RV observations with those of the photometric (ellipsoidal, beaming and reflection) modulations can solve the main problem of detecting orbital modulation through the beaming effect - how to exclude other interpretations of periodic modulation, stellar pulsation in particular. If the three or four observed modulations --- ellipsoidal, beaming, and possibly reflection effects, together with the RV variation, are all phased together as expected by the companion assumption, the attribution of those observations to a small companion is secure. Comparing the phase of the radial-velocity observations and the photometric modulation can be performed only if the RV observations are done not too late after the lightcurve was obtained; otherwise the knowledge of the photometric phase is lost. I therefore apply for being a Participating Scientist in the next two years. The application is without a budget. The whole analysis will be done in Israel supported by other sources. The proposed project, when performed, will be equivalent to a radial-velocity Doppler continuous monitoring of tens of thousands of stars with a precision on the order of 1 km/s. It will change substantially our view of the mass distribution of massive planets and low-mass secondaries in short orbital periods and the brown-dwarf desert between the two populations.