Title: A search for habitable planets transiting the smallest stars.

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Abstract:

The discovery, and characterization, of an Earth-like planet in the Habitable Zone (HZ), defined as the region where liquid water can exists, is currently one of the major goals of Astrophysics and Science in general. To try to reach this goal, we plan to carry out a photometric search for transiting rocky planets located within the Habitable Zone of very low-mass stars ($M<0.5M_{sun}$), and with orbital periods shorter than 50 days, which roughly corresponds to M stars. Planets around low-mass stars have the advantage of a higher transit detection probability, shorter orbital periods, and produce larger radial velocity amplitudes than those orbiting solar type stars.

Science Justification:

The rapidly evolving field of exoplanet research has recently reached a significant milestone by pushing the detection limits into the regime of Earth-sized planets. Several rocky planets have been discovered, such as the Kepler-42 planetary system (Muirhead et al. 2012) and αCen-B-b (Dumusque et al. 2012). However, these exoplanets are usually too close to their parent star to be habitable.Yet, it is predicted that small planets should be very common in the universe (Howard et al. 2012). Radial velocities studies using HARPS have led to the preliminary conclusion that super-Earths around early M dwarfs are significantly more frequent than giant planets, and tend to appear in multiplanetary systems (Bonfils et al. 2007). In particular, low-mass planets may occur with a frequency higher than 30% (Pepe et al 2011). More recently, Bonfils et al (2013) have calculated the frequency of habitable planets orbiting M dwarfs ($1 \leq msin(i) \leq 10$ M⊕), and obtained an η⊕ value of $0.41^{+0.54}_{-0.13}$, which is roughly in line with the numbers obtained from the study of Kepler's data (Coutney et al. 2013).

Given the small radii ($R<0.5M_{sun}$) of low-mass stars, the depth of the transit, which depend on the ratio of the planet and star radius ($\Delta F \sim R_p/R_{star}$) is higher than in Solar type stars, and hence, easier to detect. For example a transiting Earth-like planet will produce a decrement of 0.08 mmag in the flux of a star like the Sun, while this is larger than 1mmag for intermediate and late M stars. The probability of finding a transit in the HZ is also much higher in very low-mass stars than around solar-type stars. For example a transiting Earth-like planet has a probability of only 0.5% to be detected at the HZ, while this is larger than 1.5% for M stars. Another advantage is that the amplitude of the radial velocity variations induced by the planet around very low-mass stars is larger and hence, it is easier to confirm them by this method. For example an Earth-like planet in the HZ produce a radial velocity variation of 10 cm/s, while this is larger than 1m/s in intermediate and late M stars. These transiting super-Earths around low-mass stars will be located at separations lower than 0.15 AU and have orbital periods shorter than 50 days. Their transit duration is estimated to be below 7 hours, assuming a circular orbit.

Here we propose to carry out a photometric search for transiting rocky planets located within the Habitable Zone of very low-mass stars ($M<0.5M_{sun}$) with the Kepler satellite. Our sample consists of a list of nearby M stars selected from a compilation of different catalogues (Casal et al., 2013).