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The planetary existence around M type main sequence stars

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Abstract: One of the most commonly accepted scenario about planetary formation around main sequence stars is that every one of them hosts at least one planet. We present the results of statistical analysis over 1300 M type main sequence stars which are showing the complete opposite. As a sample we choose the LRa02 and LRc01 fields of the CoRoT space mission. For each star's light-curve we calculate the rms and after the trends removal with the CoRoT Detrend Algorithm (CDA) we search for planetary transits. Also we have derived the relationship between the mass and radius versus b-v for each star. With the hypothesis that around each star there is one planet we used the probability of each one of them to actually show a transit. With the above assumption, more than one transit is expected in the CoRoT sample. The observational results do not confirm this theory.

1 CoRoT Mission

In the last four and a half years the CoRoT space mission fas been one of the most promising surveys for detection of extra solar planets. The CoRoT space telescope was placed by a Soyuz launcher in polar inertial circular orbit at an altitude of 896 km and it is consists of a 27 cm afocal telescope and four back-illuminated CCDs with a 2048 pixel by 2048 pixel array. Each pixel is 13.5 $\times 13.5 \mu m^2$ in size which corresponds to an angular pixel size of 2.32 arcsecs. The CoRoT space mission is programmed to observe two target fields for 150 and 20 days of observations respectively. After one year of observations the data are released in public, under the CoRoT data policy (*http://idoc-corot.ias.u-psud.fr/index.jsp*). We have used the 150 and 20 days runs for LRc01 and LRc02 respectively, as they include most of the detected M type stars.

2 Light-curves correction and analysis

The radius ratio between an M type dwarf and any planet around it is very big. This fact allows the detection of an earth-sized planet transit signal, if the photometric precision is accurate enough. The lack of the atmospheric turbulence allows to reach this level of accuracy, thus the CoRoT light-curves are affected by trends, caused by the instrumental structures only. We removed these trends with the CDA [1], which uses the Green and Blue colours of the light-curves as comparisons. The probability for an exoplanetary transit to occur in a way that it could be detected from Earth, if we only consider the geometry of the system star-planet, is given by the relationship:

$$N_i = 0.0045 \cdot \frac{R_i}{a} \tag{1}$$

R_i is the radius of each star of the sample and a is the semi-major axis [2]. As mentioned above the duration of the observations were 150 and 20 days. This allows the selection of periods between 1.5 and 75 days for the LRa01 run and 1.5 and 10 for the second one. In order to determine the mass and the radius of each star we assume that it belongs to the Main Sequence star. The final number of the transits which we expect to detect is given by the sum of the probabilities for each star. Finally with

Monte Carlo simulations we derived the number of planets, with radius between 1 and 9 $R_\oplus$, which should have been detected with the achieved photometric accuracy for each star, using the assumption that the 100%, 90% etc until 0.1%, of stars host a planet between these radii.

3 Results

In those two runs of the CoRoT mission we found no transits around any M star. Figure 1 shows the expected number of transits, that should have been detected in our sample. With the assumption that there is one planet in 100% of the stars [3], the expected number of the detected transit events should be over 1300. This numbers remains over zero even if the 0.5% of the stars host a planet. In this point we should mention that no assumption was made for multiple planetary systems. The discrepancy

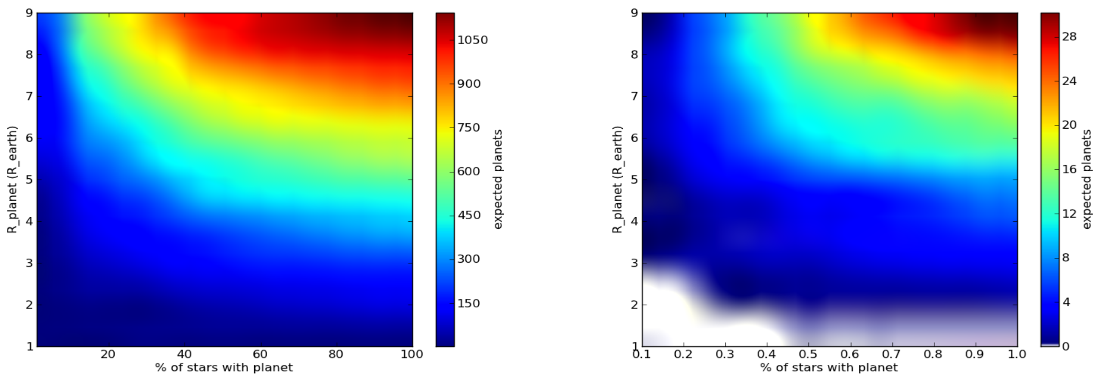

Figure 1: The expected number of planets versus the planet radius and the hypothesis of planetary existence around (a) 1 to 100 % and (b) 0.1 to 1 % of the sample. The white region in (b) shows for what kind of planets and for what assumption of hostility we expected not to find planets in these two rans.

between the actual and the expected results, suggests that the planetary formation theory around M dwarf stars is different than other stars (F, G or K). Until now, only 35 planets have been found around M stars, most of them with the RV method. This small sample can only give us no conclusive results, so in order to be able to find out which are the reasons for this behavior we have to wait to discover more planets around M dwarfs.

References

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