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Abstract:

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The Kepler mission has yielded hundreds of multiple extrasolar planetary systems. Many of these systems contain four or more planets. However, the architecture of the high multiplicity planetary systems found by Kepler appears different than in the solar system.

A well known numerology feature of the solar system is the Titus-Bode (TB) law. It claims that the spacing of planets has a logarithmic dependence on their sequences in the system. The physical origin of this relation is not well understood, but it has been thought of as the result of the dynamical stability criterion or the power-law surface density profile of the protoplanetary disk.

Bovaird and Lineweaver 2013 proposed a general two-parameter logarithmic spacing law to describe the known high multiplicity systems. They showed that among the dynamically most-complete samples, 94\% of which adhere to this general TB relation as tight as the solar system. They predicted "extrapolated" planets for all the systems according to this relation. For the systems that do not fit well with a general TB relation, they predicted "inserted" planets to improve the tightness of the fitting.

We report the study of the 99 predicted planets in the 56 high multiplicity systems using the Q1-Q15 long cadence Kepler data. We failed to find most of these predicted planet in the available data. Two "inserted" and one "extrapolated" planet candidates have been found around the predicted locations. One planet candidate and two single transits have been found in these systems which do not match the predictions. We also discuss the possibility that these predicted planets were not seen in the Kepler data due to their small sizes or non-coplanarity. Finally, we examine the distribution of period ratios between neighboring pairs of planets with the "inserted" planets taken into account. It suggests that the general TB relation might over-predict the presence of planet pairs near the 3:2 resonance.