Architecture and Dynamics of Kepler's Multi-Transiting Planet Systems.III. Comprehensive Investigation Using All Four Years of Kepler Mission Data

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Abstract

We study the orbital architectures of planetary systems orbiting within ~1 AU of their stars by analyzing the ensemble of Kepler systems having two or more planet candidates. We use data from the entire Kepler mission, and in many cases we apply improved analysis techniques (e.g., replacing histograms by top-hat Kernel Density Estimators that avoid the loss of information resulting from choosing a particular phase for the bin boundaries) to extend and enhance the studies of Lissauer et al. (2011, ApJS 197, 8) and Fabrycky et al. (2014, ApJ 790, 146).These data show ~ 1700 transiting planet candidates in > 600 multiple-planet systems, far more than were available for our previous two studies. The increased numbers and better information about planetary radii and the properties of stellar hosts made possible by Gaia DR2 allow more statistically-robust analyses of the entire ensemble of Kepler multis as well as independent analyses of subsets of the population. We are thus able to contrast the dynamical configurations of small and large planets, short-period and longer-period planets, and planets orbiting various types of host stars. We reinforce our previous

findings that most pairs of planets within the same system are neither in nor near low-order mean motion resonances and that there is a substantial excess of planets having period ratios slightly larger than those of first-order mean-motion resonances. However, neglecting three systems whose planets are locked in 3-body resonances and summing over all first-order mean motion resonances, the deficit of planet pairs with period ratios just narrow of resonance is as large as the excess of planets wide of resonance (within statistical uncertainties), suggesting that overall there is no overall excess of planet pairs in the vicinity of resonance. Other aspects of our study, including estimates of the typical relative inclinations of planetary orbits and their variations as functions of orbital period, planet sizes and stellar properties, are in progress, with results expected to be available for presentation by the time of the conference.