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Counts-in-Cylinders in the Sloan Digital Sky Survey with Comparisons to N-body Simulations

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Environmental statistics provide a necessary means of comparing the properties of galaxies in different environments and a vital test of models of galaxy formation within the prevailing, hierarchical cosmological model. We explore counts-in-cylinders, a common statistic defined as the number of companions of a particular galaxy found within a given projected radius and redshift interval. Galaxy distributions with the same two-point correlation functions do not necessarily have the same companion count distributions. We use this statistic to examine the environments of galaxies in the Sloan Digital Sky Survey, Data Release 4. We also make preliminary comparisons to four models for the spatial distributions of galaxies, based on N-body simulations, and data from SDSS DR4 to study the utility of the counts-in-cylinders statistic. There is a very large scatter between the number of companions a galaxy has and the mass of its parent dark matter halo and the halo occupation, limiting the utility of this statistic for certain kinds of environmental studies. We also show that prevalent, empirical models of galaxy clustering that match observed two- and three-point clustering statistics well fail to reproduce some aspects of the observed distribution of counts-in-cylinders on 1, 3 and 6-Mpc/h scales. All models that we explore underpredict the fraction of galaxies with few or no companions in 3 and 6-Mpc/h cylinders. Roughly 7% of galaxies in the real universe are significantly more isolated within a 6 Mpc/h cylinder than the galaxies in any of the models we use. Simple, phenomenological models that map galaxies to dark matter halos fail to reproduce high-order clustering statistics in low-density environments.

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