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The SDSS Galaxy Angular Two-Point Correlation Function

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ABSTRACT

We present the galaxy two-point angular correlation function for galaxies selected from the seventh data release of the Sloan Digital Sky Survey. The galaxy sample was selected with r-band apparent magnitudes between 17 and 21; and we measure the correlation function for the full sample as well as for the four magnitude ranges: 17–18, 18–19, 19–20, and 20–21. We update the flag criteria to select a clean galaxy catalog and detail specific tests that we perform to characterize systematic effects, including the effects of seeing, Galactic extinction, and the overall survey uniformity. Notably, we find that optimally we can use observed regions with seeing $< 1.''5$, and r-band extinction < 0.13 magnitudes, smaller than previously published results. Furthermore, we confirm that the uniformity of the SDSS photometry is minimally affected by the stripe geometry. We find that, overall, the two-point angular correlation function can be described by a power law, $\omega(\theta) = A_\omega \theta^{(1-\gamma)}$ with $\gamma \simeq 1.72$, over the range $0.^\circ005$–10°. We also find similar relationships for the four magnitude subsamples, but the amplitude within the same angular interval for the four subsamples is found to decrease with fainter magnitudes, in agreement with previous results. We find that the systematic signals are well below the galaxy angular correlation function for angles less than approximately 5°, which limits the modeling of galaxy angular correlations on larger scales. Finally, we present our custom, highly parallelized two-point correlation code that we used in this analysis.

Key words: cosmology: observations – large-scale structure of universe

1 INTRODUCTION

One of the most powerful and simplest probes of the galaxy distribution is the two-point angular correlation function, which quantifies the excess probability above a random distribution of finding one galaxy within a specified angle of another galaxy. For the case of a Gaussian random field, the two-point angular correlation function and its Legendre transform pair provide a complete statistical characterization of the galaxy clustering (see, e.g., Peebles 1980). Even for the case of non-Gaussianity, the two-point angular correlation function provides a simple and important statistical test of galaxy formation models (Tegmark et al. 2004).

The two-point angular correlation function has been studied at bright magnitudes from the data releases from the Sloan Digital Sky Survey (SDSS) such as the Early Data Release (EDR; Connolly et al. 2002). This data release covered a few hundred square degrees of the in sky, and the two-point galaxy angular correlation function was calculated on scales from a few arc seconds to a few degrees. The measured correlation functions from the EDR were consistently found to obey a power law, $\omega(\theta) = A_\omega \theta^{(1-\gamma)}$, where $\gamma \simeq 1.7$ on small scales, with a break at 2°, beyond which the correlation dropped more steeply (Connolly et al. 2002). For deeper surveys, the power law relation of the small-scale correlation function held, with the amplitude decreasing at fainter magnitudes (Connolly et al. 2002).

While these early SDSS results have provided a nice description of the angular clustering of galaxies, they only covered a relatively small area of the sky. In this paper, we present the measurement of the SDSS DR7 galaxy two-point angular correlation function. The SDSS DR7 galaxy sample covers nearly 10^4 square degrees of the sky and includes approximately 10^8 galaxies to a median redshift of 0.22. Furthermore, in comparison to the SDSS EDR, the data processing techniques of the SDSS DR7 have been greatly improved (Abazajian et al. 2004, 2009). The DR7 thus provides better image quality and photometric calibrations, with less severe systematic effects; and will, therefore, provide a more robust measurement of the galaxy angular clustering than previous large scale surveys.

To accurately calculate the galaxy two-point angular correlation function, we must first minimize potential systematic effects in the galaxy catalog used to measure the correlation function. The systematics of the SDSS EDR were thoroughly studied by Scranton et al. (2002). To min-