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Peculiar Velocity Estimators

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ABSTRACT

1 INTRODUCTION

2 METHODOLOGY

The Millennium Simulation was used as a main source for the data. Galaxies were extracted from the !!! database of the original Millennium run, and reorganized into mock surveys. To make a mock survey, a selection function was fitted using a chi-squared fit to the radial galaxy distribution of the real CosmicFlows-2 and COMPOSITE surveys.

The velocity correlations are computed as described in Górski et. al. (1989). We reproduce his equations here for reference. Sums are performed over pairs of galaxies at approximately the same distances, in bins. The quantities u_1 and u_2 are the peculiar velocities of the two galaxies in a given pair. Because this statistic only depends on radial velocities, it is measurable, unlike the original velocity correlation tensor, which requires three-component measurements of particle velocities. The known distances to the galaxies from the survey centerpoint allow the construction of a triangle with points at the survey origin and each galaxy. This fact is used to calculate $\cos\theta_1$, $\cos\theta_2$, and $\cos\theta_{12}$ efficiently. The quantity $\cos\theta_1 = \hat{r}\cdot\hat{r}_1$ is the angle at the vertex of galaxy 1, $\cos\theta_2$ is the angle at galaxy 2, and $\cos\theta_{12}$ is the angle between the two galaxies in the sky as seen from the survey origin.

$$\psi_1 \equiv \frac{\Sigma_{pairs(r)} u_1 u_2 \cos\theta_{12}}{\Sigma_{pairs(r)} \cos^2\theta_{12}} \tag{1}$$

$$\psi_2 \equiv \frac{\Sigma_{pairs(r)} u_1 u_2 \cos\theta_1 \cos\theta_2}{\Sigma_{pairs(r)} \cos\theta_{12} \cos\theta_1 \cos\theta_2} \tag{2}$$

In our computations, the individual values of the sum terms are computed out to a maximum pair distance and stored, then the sums are computed over these values several times for different bin widths. The results of the sums are then divided, resulting in the final ψ_1 and ψ_2 correlations.

3 DATA

4 DISCUSSION AND CONCLUSIONS

5 FUTURE WORK