FERMILAB-POSTER-22-160-PPD-STUDENT.

Angular Power Spectra Analysis of Large-Scale Structure

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Introduction

In cosmology, we model the universe using the Friedmann equations. Included in this model are the energy densities of matter, radiation, and dark energy, which tell us about the evolution of the universe. Values for these parameters have been measured, but we are seeking to study how fluctuations in these values will affect the large-scale structure and evolution of our universe.

The DELVE catalog was assembled from data taken with the Dark Energy Camera (DECam) mounted on the Blanco telescope at the Cerro Tololo Inter-American Observatory. First, we must verify the accuracy of our observations. Using rigorous selections we select bright (G,R,I,Z > 20 mag) objects that are morphologically classified as galaxies and divided into three bins in photometric redshift ($0 < z < 0.15$, $0.15 < z < 0.3$, $0.3 < z < 0.45$). From there, we were able to obtain data sets that can be used to calculate angular power spectra for the density distribution. In turn, this will provide information on the dark energy distribution in the local cluster.

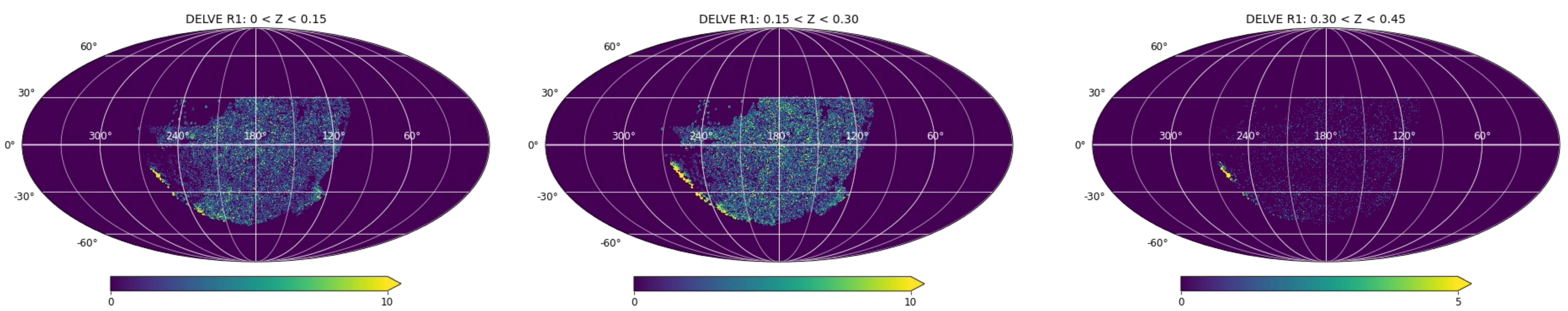

Fig 1: These maps show the three redshift cuts that were used to see how the galaxy density changed over time. Note that the scale is adjusted for redshifts 0.30 < Z < 0.45 due to the low density.

Data and Observations

In order to calculate the angular power spectrum, we needed to generate HEALPix maps of the DELVE observations. In addition, a mask was needed to select an appropriate section of the R1 region where we would get the least amount of noise. Inhomogeneities were observed when using the entire R1 region, indicating that there may be contamination from foreground stars or regions of high interstellar extinction.

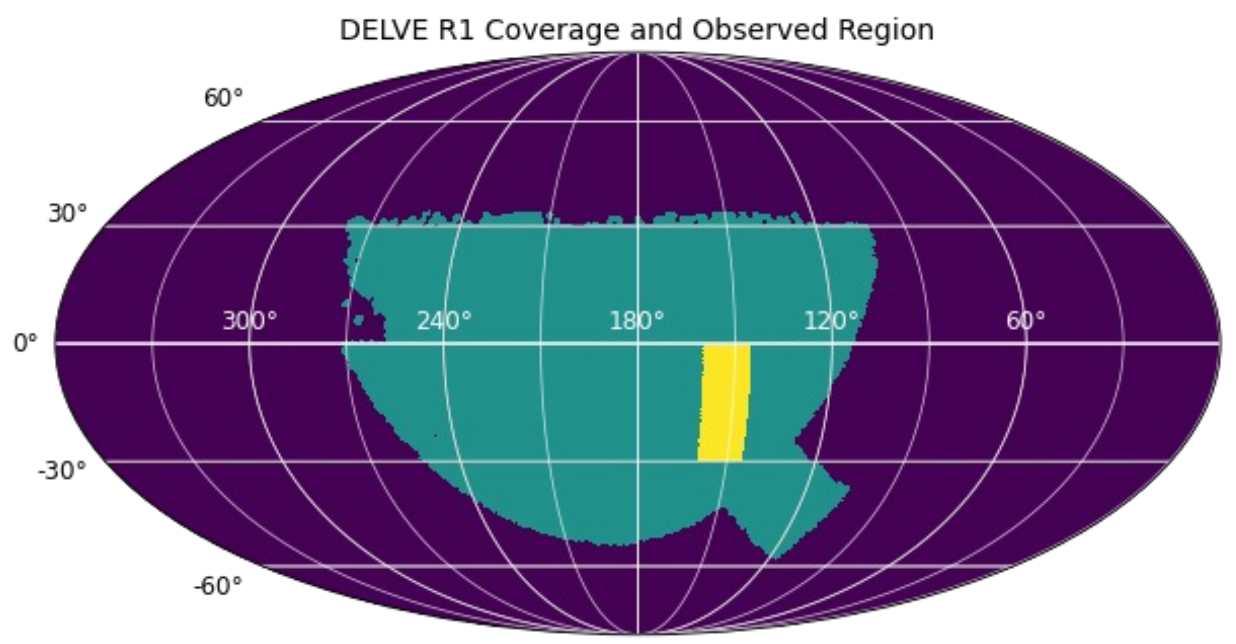

Fig 2: This map shows the area we selected with our mask in the DELVE R1 region in yellow and the total coverage of the DELVE R1 region in teal.

Results and Conclusions

After obtaining data maps and associated masks, we were able to generate an angular power spectrum for the region of interest and look at the galaxy densities. We used the NaMaster python package to make these calculations and obtained an angular power spectrum for the DELVE observations.

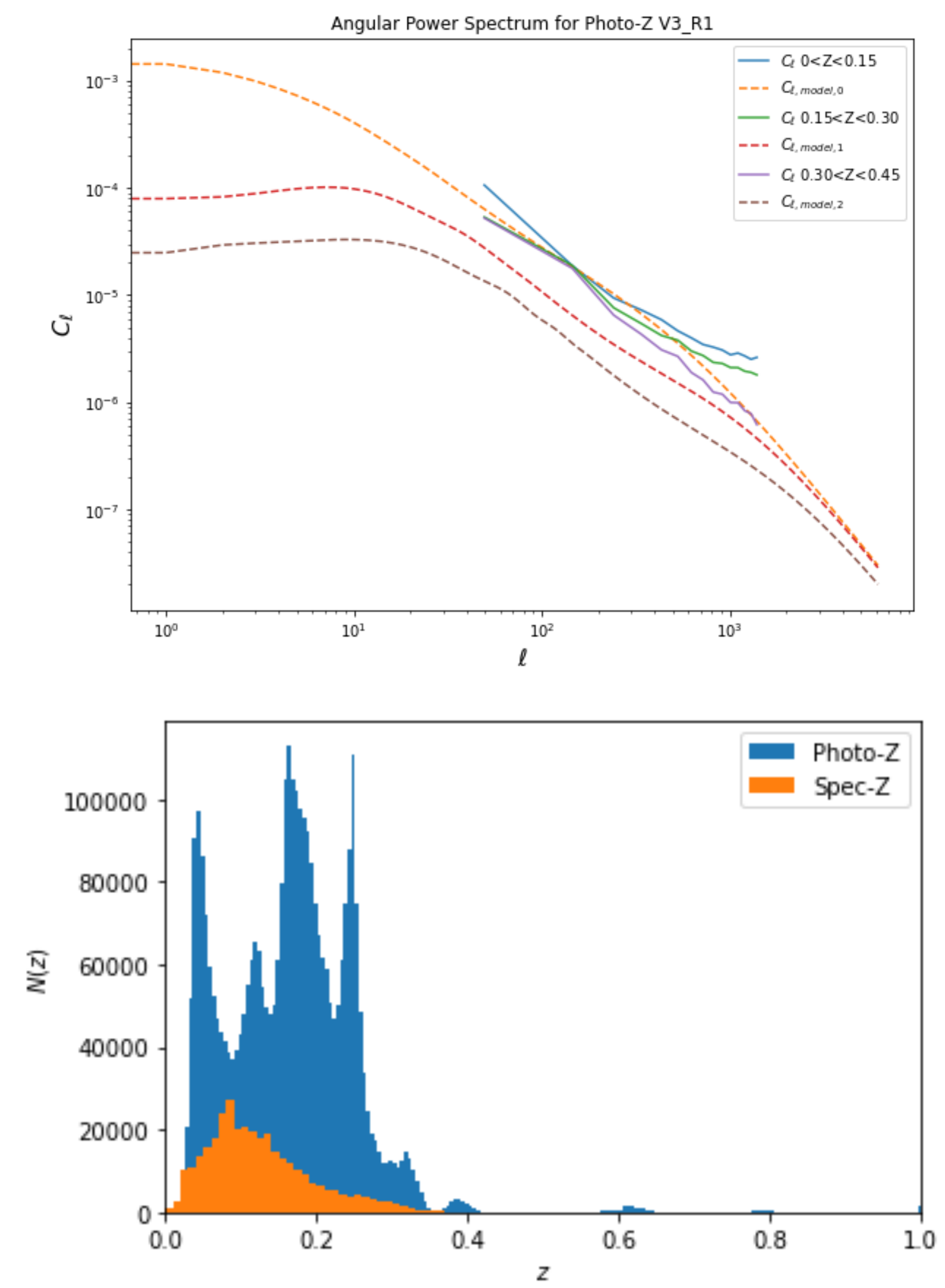

Fig 3: The angular power spectra shows that as redshift increases, there is a decrease in galaxy density, which is consistent with models showing the effects of dark matter on the formation of the filaments that house these large over-densities. Below it is a histogram of the photometric redshifts for all of our observations and the associated spectroscopic redshifts for the subset of galaxies that had them.

As of right now, there is some noise that is apparent in our results. We plan to make adjustments to our masking methods to further refine our results. Going forward, we plan to run simulations of different models of the universe with different values for the cosmological parameters in the Friedmann equations. Doing so will be able to help us understand how much of an effect these parameters have on our universe's evolution and how accurate our measurements are for the current values of these parameters.

References

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This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.