Astro 61 Paper Review: Week 1

By Elizabeth Mills

In his article <u>Clusters as Tracers of Large Scale Structure</u>, Marc Postman argues that galaxy cluster analysis is an optimal method for observing universe large-scale structure. Because of the vast distance separation between clusters, one can view a large volume of space with few samples. Also, clusters have retained much of their initial formation properties, offering insight about our universe's beginnings. Postman also asserts that techniques for determining relative redshift-independent distances to clusters are highly accurate, and that clusters contain smaller scale significance within them that aids in distance measuring.

Postman defines a cluster of galaxies from the physical, N-body, and observational perspectives. Physically, a galaxy cluster is matter gravitationally bound and virialized within constraint: M_{Total} 10^{14} (M_{sun}) within r = 1/h Mpc. The N-body and observational definitions are less precise, respectively involving the effect of dark matter on observable matter in the system and observations about certain locations and qualities within the cluster compared to others.

Postman describes various functions that are used to limit such clustering properties, specifically the two-point special correlation function, its Fourier Transform, and the cluster auto-correlation function. Labeled and P(k) respectively, the first two functions are usually the most straightforward methods for obtaining cluster matter distribution data. The Cluster Auto-Correlation Function: , works for r values over a certain range. Postman admits the flaw that amplitude differs from its galaxy auto-correlation function counterpart, but asserts that the two have similar correlation shapes. Thus, he pursues his focus on based structure formation model constraints. From prior research results, a relationship has been found between and (mean inter-object separation), but no relationship between and (mean inter-cluster separation). In addition, and strongly co-variate, correlation amplitude and inter-cluster separation are weakly connected.

Another factor in narrowing constraints comes from the power spectrum of clusters, which can be more precise because errors and uncertainty affect data less compared to other methods. This method has produced results showing the absence of dark matter, which pinpoints vast areas of empty space, known as the voids. Also, higher order statistics present another means for obtaining constraints.

Lastly, Postman recognizes the potential in very large scale structure analysis, but the low probability of such success in obtaining significant results. This is because while very large-scale research is in theory highly spacious and very clustered, it in reality yields low signal strength and an enormous possibility for error. Postman believes we still need greater understanding and cataloguing for these structures, and looks to the future for such new data. He also supports the mapping of large-scale velocity fields to research large-scale structures. These peculiar velocity surveys can be more reliable than red-shift surveys due to their completeness and reduced radial density gradients, yet they need specific photometric and spectroscopic requirements and homogenous data.

In summary, both clusters-cluster and galaxy-galaxy relationships are useful in analyzing large scale structure, except one must note they have very different constraints and provide information in very different ways. We still have much to learn about large scale structures, and even how to use the data we have from observation in our analysis.