A Redshift Survey in the Direction of a Void near the Pisces-Cetus Supercluster

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Overview

The work described here has two main goals:

(1) To test the usefulness of Abell clusters for locating voids.

It is well known that Abell clusters are not uniformly distributed in three-dimensional space (e.g. Bahcall and Soneira, 1983). Recently, Batuski and Burns (1985a, b) have suggested that Abell clusters tend to form filamentary structures between which there appear to be large regions (50-200 Mpc across) devoid of bright galaxies. The technique of using Abell clusters as tracers of voids is controversial because the correlation length of Abell clusters is so much larger than the galaxy-galaxy correlation length. However, compared to an all-sky magnitude-limited survey, the technique, if valid, potentially reduces the amount of telescope time required to identify significant voids and map them in redshift space. To investigate this possibility we have undertaken a redshift survey of galaxies in the direction of a nearby and relatively compact candidate void surrounded by a ring of Abell clusters.

(2) To identify a void suitable for more extensive study.

Ultimately we would like to know not only the degree to which voids are empty, but also to what extent those galaxies that may be found within a void differ from those in the surrounding shell. Some theorists (e.g. Dekel and Silk, 1986 and references therein) suggest that as a result of biased galaxy formation, galaxies within a void might be expected to be preferentially younger, fainter, more irregular, more metal-poor and more gas-rich than shell galaxies. The region we selected for study is one which forms part of the Haynes and Giovanelli (1986 and references therein) 21 cm redshift survey. It was chosen, in part, because it is of interest to compare optical results with radio data to determine whether or not the two techniques reveal the same structure.

Results

We have obtained redshifts for 138 galaxies in a magnitude-limited survey of a region ~ 9° in dec by ~ 20° in R.A. centered on an apparently underdense area surrounded by a ring of Abell clusters. These redshifts were combined with redshifts for 50 additional galaxies which had been obtained in the same region of the sky in earlier surveys by the Harvard CFA group. In the ring of Abell clusters surrounding the candidate void we have observed a further 150 galaxies, concentrating in particular on those areas which are overdense in Abell clusters. The data on these shell galaxies are still being reduced. Galaxies were selected from the Zwicky catalogue.

The northern 2/3 of the candidate void region is 95% complete to Zwicky magnitude 15.7, while the southern 1/3 is 65% complete to this limiting magnitude. Incompleteness arises because some of the data are still being reduced and because a few galaxies had such low surface brightnesses that we have not yet obtained spectra with sufficient signal-to-noise to generate reliable redshifts for these sources. Velocities were determined to an accuracy of 50 km s^{-1} by cross-correlation with high S/N templates.

The figure below is a wedge plot for the 95% complete northern portion of the void. Notice a dense ridge of galaxies, centered near 8000 km s^{-1} and a less well defined but still significant ridge at about 13,000 km s^{-1}. In between these ridges is a significantly underdense region centered at about 10,000 km s^{-1}. There are indica-

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tions from CFA survey data, kindly provided by John Huchra, that adjacent to this underdense region is another void whose center appears to be located at about 12,500 km s^{-1}, just to the west of the boundary of this plot. The string of galaxies which divides these two underdense regions shows up clearly in our data although so far we have observed only the edge of the adjacent void. The dense ridge at 8000 km s^{-1} is not apparent in the Haynes and Giovanelli 21 cm redshift data.

We have compared our velocity distribution with the expected distribution derived from the Schechter form of the luminosity function (Schechter, 1976) fitted to the CFA redshift survey data (Davis and Huchra, 1982) and found a density contrast, $n/\overline{n}$ of ~ .25, a value which is similar to that found in the CFA survey. However, most of these galaxies appear to lie on the boundary between the adjacent voids. The effective depth of our sample is 110 h^{-1} Mpc.

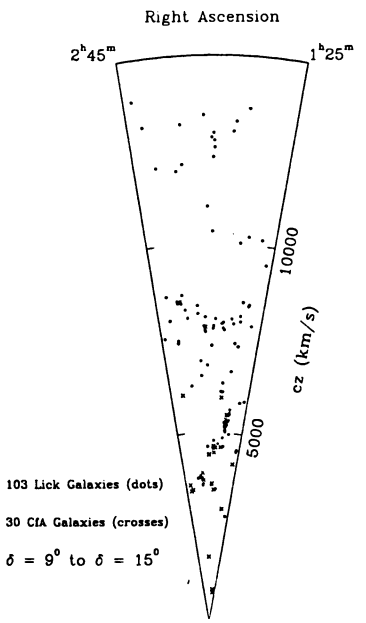
Within the ring of Abell clusters there appear to be cell-like structures on scales of ~ 25 h^{-1} Mpc. The cells have sharp boundaries ($\lesssim$ 1000 km s^{-1} wide) which are densely overpopulated with galaxies. Such cells appear to be a common feature of large scale structure. Structure on these length scales is not picked up by the technique which uses Abell clusters as tracers, although the technique may be useful in defining structure on scales encompassing several cells. This issue may be clarified when we have completed our survey of the entire region surrounded by Abell clusters and have considered the data on those galaxies which lie along the structure defined by Abell clusters.

Future Developments

We plan eventually to extend the survey down to 19th or 20th magnitude where there will be on the order of 100 galaxies per square degree. Clearly, at this level the amount of telescope time required to complete the sample within a void using single slit spectroscopy would be prohibitive and a different approach must be adopted. One of us (JPB) is in the process of building a prime focus instrument, for use on the 120" telescope at Lick Observatory, which will allow the simultaneous acquisition of spectra of 50-90 objects over a one degree field.

Finally, as a test of the idea of biased galaxy formation, we intend to re-observe, with higher resolution and signal-to-noise, those galaxies found within the void, as well as a sample of galaxies from the void boundary. Comparison of these two samples might reveal systematic differences in internal velocity dispersion, gas content, metallicity etc.

In the fall of 1987 we plan to extend the 15.7 magnitude-limited survey a further 6° in R.A. on either side of the void center. This will help determine the reality and precise location of the adjacent void, apparently centered near 12,500 km s^{-1}, and confirm the cellular nature of the substructure contained within the "ring" of Abell clusters.



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