LOCAL CELLS OF THE UNIVERSE: TWO VOIDS OF DIAMETER 200 MPC

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Recent studies of the spatial distribution of galaxies and of clusters indicate that practically all clusters and a vast majority of galaxies are concentrated into supercusters. The space between superclusters has no rich clusters and very few galaxies. The whole structure is cellular, with cell walls formed from sheetlike superclusters and the empty cell interiors being huge voids.

In this presentation we show how the observed distribution of clusters, and the Local Supercluster in particular, are part of a cellular structure and suggest that the entire pattern of superclustering is cellular. Our study is based on the recently completed CFA redshift survey. All other available redshifts are also used, including cluster redshifts where available.

All nearby rich clusters of galaxies in the northern hemisphere form a huge aggregate that lies along a belt that spans the whole northern hemisphere and that lies close to the equator of the Local Supercluster. It is interesting to ask whether this belt continues also into the southern hemisphere. One of us (H.G.C.) is engaged in a search for southern clusters. This is part of a major project aiming to complement the Abell catalogue of clusters for the southern sky. Several new redshifts have been determined by one of us (M.T.) for southern clusters.

In Fig. 1 we give Aitoff plot of clusters in supergalactic coordinates. The redshift interval used in Fig. 1 3750-7500 km s^{-1} corresponds to 75-150 Mpc for Hubble constant 50 km s^{-1} Mpc^{-1} used throughout this paper. We see that nearby southern clusters exactly continue the belt observed in the northern hemisphere so the belt spans the whole sky. The belt is slightly inclined (about 20°) to the supergalactic equator. Altogether the belt consists of six superclusters: our own Local Supercluster (not plotted in Fig. 1), Lynx-Ursa Major (A569, A779, U118) Coma (A1656, A1367, U249, U313), Hydra-Centaurus (A1060, C34, C37, C44, C47), Pavo-Corona Australes (C52, C54, C57), Perseus-Pisces (A194, U487, N507, A262, A347, U47, A426).

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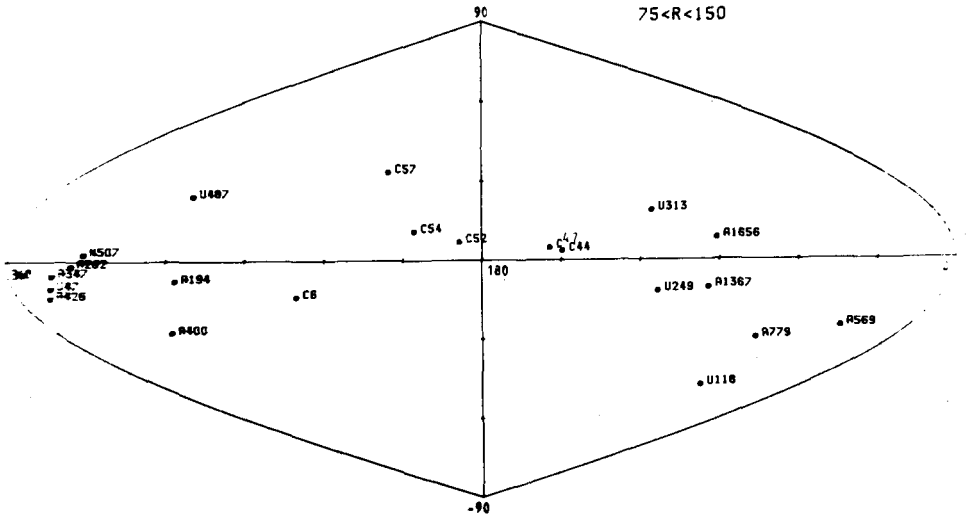

Fig. 1. Nearby [75 < R < 150 Mpc] rich clusters of galaxies plotted in equal area projection in supergalactic coordinates. Cluster names are given either from the Abell catalogue (a) or from our compilation (C). Cluster belong to five superclusters and form a continuous belt in the sky.

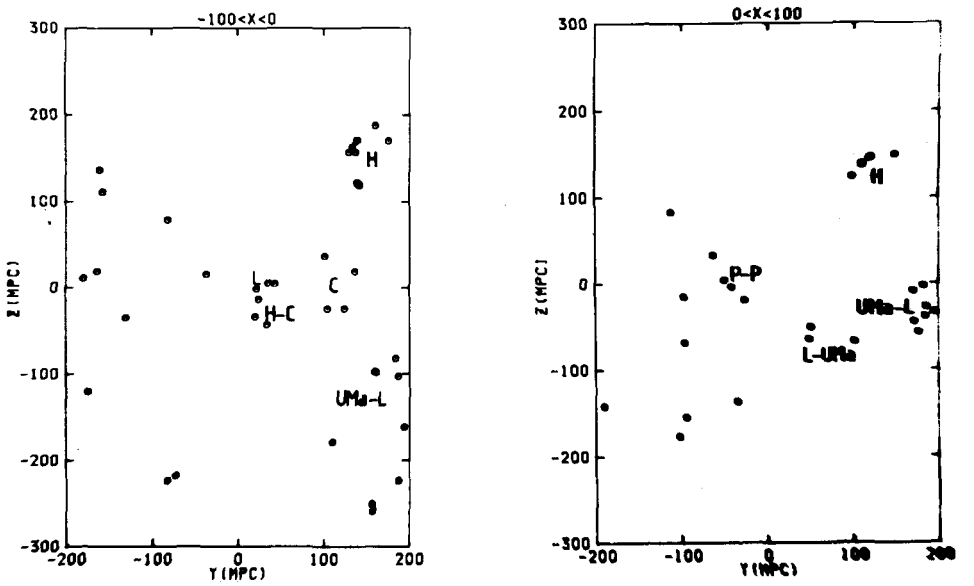

Fig. 2. Vertical cross sections through Local cells. Clusters are plotted in supergalactic Y and Z coordinates, X interval is indicated at the top. Principal superclusters are designed as follows: Hercules, UMa-L: Ursa Major-Leo, Pe: Pegasus, Pi: Pisces. L-UMa: Lynx-Ursa Major, C: Coma, P-P: Perseus-Pisces, H-C: Hydra-Centaurus.

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In space these six superclusters are located within a disk about 250 Mpc in diameter and 50 Mpc thick. This disk can be considered as a cell wall. The fact that nearby northern clusters lie in a relatively thin disk was noted already by Randon (1982 A.A. in press). However he did not notice that the plane defined by nearby superclusters lies close to the supergalactic plane. This coincidence can be accidental because main cluster chains of other nearby superclusters are highly inclined to this plane.

A plot of clusters in rectangular supergalactic coordinates is given in Fig. 2. Our Galaxy is in the center, Z-axis is directed to the north supergalactic pole, Y=0 plane almost coincides with the galactic plane.

The sheet of nearby clusters discussed in the preceding paragraphs is well visible in rectangular plots at Z ~ 0. Above and below we see large regions void of rich clusters. The diameter of these voids is ~ 200 Mpc (10,000 km s^{-1} in redshift space). Both voids are surrounded from all sides by superclusters. Among these superclusters we note the Hercules supercluster which contains ten Abell clusters.

This supercluster has coordinates Y ~ 140 Mpc and Z ~ 160 Mpc. At similar Y but lower Z the Ursa Major-Leo supercluster is located, it contains clusters A999, A1016, A1139, A1142, A1185, A1228, A1257 and A1314. At negative Y the voids are surrounded by Pegasus supercluster (A2593, A2589, A2572, A2634, A2666) and a number of southern superclusters.

We shall call these voids and surrounding superclusters the Northern Local Cell (NLC) and the Southern Local Cell (SLC). In the sky NLC covers the whole northern supergalactic hemisphere and SLC the whole southern hemisphere.

Two important properties of cluster distribution are clearly visible in our plots: (i) the majority of clusters in the superclusters mentioned above are aligned in long cluster chains, (ii) cell walls are not continuous surfaces but consist of a network of clusters and galaxy strings. Galaxies also concentrate to this plane which can be considered as a cell wall. In the direction of both supergalactic polar gaps there are huge regions of diameter 10,000 km s^{-1} in redshift space, containing no rich clusters. The density of galaxies is much less than average. Principal results of this study can be summarised as follows:

(1) The distribution of rich clusters of galaxies suggests the presence of two local cells, the Norther Local Cell and the Southern Local Cell, each about 200 Mpc in diameter.

(2) The Local Supercluster and other nearby superclusters (Coma-A1367, Perseus-Pisces, Lynx-Ursa Major, Hydra-Centaurus and Pavo-Corona Australes superclusters) are located in a disk about 250 Mpc in diameter and 50 Mpc thick. This disk can be considered as a wall between Northern and Southern Local Cells.

(3) Superclusters located at ~ 200 Mpc from us (Hercules supercluster, Ursa Majoris.Leo supercluster and several southern superclusters) form side walls of Local Cells. Hercules and Ursa Majoris-Leo supercluster are located in a wall between the Northern Local Cell and the Bootes cell. Perseus-Pisces supercluster is located in a wall between both Local Cells and a new cell that lies beyond that supercluster.

(4) Galaxy density is peaked at the disk the Local Supercluster belongs to. In cell interior the mean galaxy density is by a factor of ten lower than in cell walls. This demonstrated that voids defined by rich clusters are not completely empty but regions of low galaxy density.

(5) The principal structural element in cell walls is a galaxy chain Within superclusters the chains are rich in galaxies and consist mainly of clusters. In the central regions of cell interiors there are a few chains, but these chains are less populated and consist of groups and poor clusters.

(6) Galaxy chains connect near-neighbour superclusters into a single lattice. Mean spacement of neighbouring chains within superclusters is about 10 Mpc, in cell interiors up to 50 Mpc. There are smaller voids between chains in the cell interiors.

(7) No large-scale sheet of galaxies, more-or-less uniformly filled with galaxies, has been observed so far. Small scale sheets surround some clusters (Virgo).

It is clear that these findings set severe restrictions to galaxy formation scenarios.