THE CHALLENGE OF LARGE-SCALE STRUCTURE

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Abstract. The tasks that I have assumed for myself in this presentation include three separate parts. The first, appropriate to the particular setting of this meeting, is to review the basic work of the founding of this field; the appropriateness comes from the fact that W. G. Tifft made immense contributions that are not often realized by the astronomical community. The second task is to outline the general tone of the observational evidence for large scale structures. (Here, in particular, I cannot claim to be complete. I beg forgiveness from any workers who are left out by my oversight for lack of space and time.) The third task is to point out some of the major aspects of the field that may represent the clues by which some brilliant sleuth will ultimately figure out how galaxies formed.

1. Discovery

G. deVaucouleurs 1975 (and references therein) followed up suggestions made in 1937 by E. Holmberg and identified the Local Supercluster in the 1950s. The general significance of this work was quite controversial; many thought that this structure might just be a statistical local overdensity. Real progress could not be made until the 1970s when large, statistically complete redshift surveys could be conducted as a result of the introduction of image intensifying tubes. Among the first of these surveys was my dissertation (results published in Gregory 1975) in which all galaxies with $m_p < 15.7$ within a radial distance of $r < 3$ degrees from the Coma cluster center were surveyed spectroscopically. It was in an early discussion of this data in 1973 that Tifft pointed out the lack of a foreground. I suggest that this is the birth of the concept of cosmic voids. Tifft and I, along with Laird Thompson, further developed the observational status of large structures.

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(Tifft and Gregory 1976 [first wedge diagram] & 1978) culminating with
the paper covering the Coma/A1367 region that is often cited as the first
full presentation of voids and superclusters as the fundamental features of
large-scale structure (Gregory and Thompson 1978).

A great deal of discovery-phase work was also done by Chincarini and
Rood 1976, Joeveer and Einasto 1978, Tarenghi et al. 1979, and by Tifft,
Hilsman, and Corrado 1975 who discovered the supercluster in Perseus
(more on this later – the Rosetta Stone of galaxy formation?). I note that
not much mention was made of the fact, but those of each of these groups
that I talked to at the time all noted that the then-known superclusters
had the interesting properties of having mean redshifts of approximately
3,000 km s⁻¹ (Hydra - Centaurus), 5,000 km s⁻¹ (Perseus), 7,000 km s⁻¹
(Coma) and 9,000 km s⁻¹ (Hercules). Chincarini and Rood went so far
as to describe these structures as having a “fabric” nature. The regularity
and our seeming location as the center of perhaps concentric shells were
disturbing to the standard view.

Additional observations of note include Tully and Fisher 1987 (and
references therein) who greatly elaborated on the structure of the Local
Supercluster showing it to have sheetlike and linear features similar to
those found in external superclusters and Kirshner, Oemler, and Schechter
1979 who found the Bootes void which was much larger than any previ-
ously known. Potentially important alignments were reported by Gregory,
Thompson, and Tifft 1981 for galaxies in the Perseus supercluster and by
Binggeli 1982 for the alignments of clusters with nearby clusters.

2. Bulk Motions

Rubin et al. 1976 studied ScI-II galaxies and found systematic motions,
but Chincarini and Rood 1979 argued that these observations were also
well interpreted as a mapping of large-scale structures. Aaronson et al.
1986 developed the IR Tully Fisher relation for spirals and Dressier et al.
1987 developed the $D_n - e$ relation for ellipticals. This body of work gave
us two means of estimating distances that were independent of redshift.
Hence, the difference between predicted Hubble flow distances and those
found by the new methods enabled these two groups to investigate bulk
motions. Various levels of refinements to these methods have yielded the
concept of a Great Attractor located at a redshift distance of about 4500
km s⁻¹ near to but not coincident with the Hydra and Centaurus clusters.

3. Intermediate Results and Implications

Batuski & Burns 1985 found unprecedentedly large structures in the distri-
bution of Abell clusters. These include a supercluster (including the Perseus