ANALYSIS OF THE CFA "GREAT WALL" USING THE MINIMAL SPANNING TREE

S.P. BHAVSAR AND D.A. LAUER
University of Kentucky
Lexington, KY 40506-0055, USA

Abstract. MST analysis shows the "Great Wall" as a statistically significant linear feature in the galaxy distribution. It is not as long as visual impressions may suggest. Another "Wall" extends radially, perpendicular to the GW. These two walls intersect at the Coma cluster.

The Minimal Spanning Tree or MST (Barrow, Bhavsar and Sonoda 1985) has proved to be a valuable tool for the identification and analysis of filamentary structures (Bhavsar and Ling 1988). The operations of pruning and separating the MST, called the reduced MST, allow one to extract the prominent linear features from any point distribution. We have used these constructs to extract the "backbone" of the linear features from the CfA redshift survey extension (Geller and Huchra 1989). This makes for an objective selection of these features, which can then be studied in a quantitative way. Figure 1 shows the data and its reduced MST.

It is interesting to compare the visual impressions in the point data

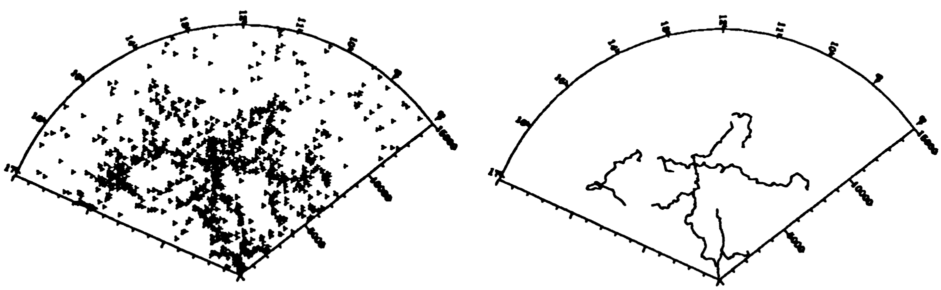

Figure 1. The CfA galaxy survey and the reduced MST

M. Kafatos and Y. Kondo (eds.), Examining the Big Bang and Diffuse Background Radiations, 517–519.

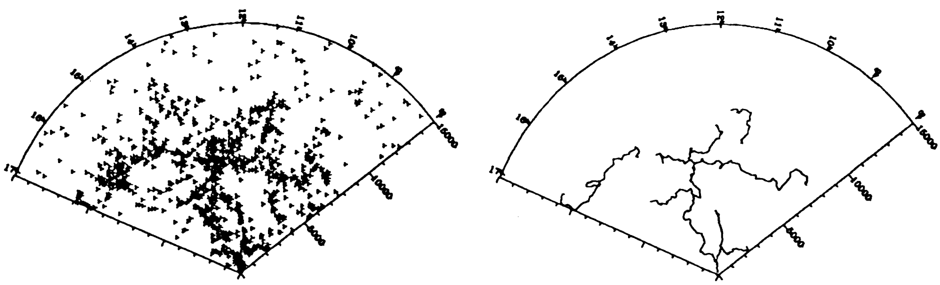

Figure 2. Same as figure 1 with "fingers of God" removed

set with features picked out by the MST. The MST does quite well as a filament finding algorithm. Its objectivity is an important bonus, since the same quantitative criteria are used on different data sets, a distinct advantage when dealing with visual bias (Barrow and Bhavsar 1987).

The Great Wall [GW] (Ramella, Geller and Huchra 1992) is one of the most prominent features, both visually and in the reduced MST. Notice that the traditional GW has a break in it as picked out by the reduced MST. The break may not initially be noticed in the point data set because of visual inertia (see Barrow and Bhavsar 1987). Another prominent feature, picked out by the MST analysis which one notices in the data in retrospect, is the long radial linear feature, starting from the vertex, going somewhat left of the vertical and then toward the right. This feature has more galaxies in it than any continuous portion of the GW. At the intersection of this feature and the GW is the Coma cluster. Figure 2 shows the same data with the "fingers of God" removed. The same prominent features that were picked out before are again picked out.

Bhavsar and Ling (1988) have described the statistical "shuffling" technique which keeps small scale correlations intact but breaks large scale coherence. This is used to determine the physical significance of the linear features. If the features are just visual artifacts as a result of small scale clumping, they will persist in shuffled distributions in a statistical way. If they are real then at that level of pruning and separating the filamentary structure is unique to the data and can be interpreted as (in fact to define) real filaments. Here the shuffling was done only among thin radial wedges. As a consequence, correlations in the radial direction are not disturbed. Thus in this analysis only the reality of the non-radial features, like the GW have been tested.

Figure 3 shows one such shuffled data set and its reduced MST. The GW feature is no longer seen. This is the case in repeated shufflings, indicating that the GW is a real feature in the data, not a visual artifact of chance

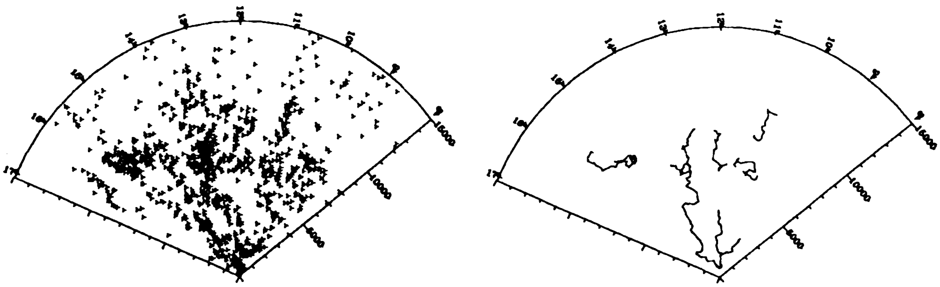

Figure 3. A shuffled data set and its reduced MST

superpositions and visual bias. The vertical feature still persists, but this analysis cannot make any statement about its reality.

References

Barrow, J.D. and Bhavsar, S.P. (1987), *QJRAS*, **28**, pp. 109–128.
Barrow, J.D. , Bhavsar, S.P and Sonoda, D.H. (1985), *MNRAS*, **216**, pp. 17–35.
Bhavsar, S.P and Ling, E.N. (1988), *Ap. J. Lett*, **331**, pp. L63–L68.
Geller, M.J. and Huchra, J.P. (1989), *Science*, **246**, pp. 897–903.
Ramella, M. , Geller, M.J. and Huchra, J.P. (1992), *Ap. J.*, **384**, pp. 396–402.

https://doi.org/10.1017/S007418090011054X Published online by Cambridge University Press