FILAMENTS

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I would like to make a brief comment on some work that John Moody, Edwin Turner and I have done on filamentary structure in the Shane-Wirtanen galaxy counts. The picture of the Shane-Wirtanen galaxy counts to the 19th magnitude appears quite filamentary to the eye. The existence of such filaments is quite important theoretically, since filaments could easily be Zeldovich pancakes seen edge-on, and filamentary structure is expected in general when the perturbation spectrum is cut off at small scales. So if the filaments are real, they are telling us something quite important about the universe. The experience of the Martian "canals" reminds us, however, that the eye is very good at picking linear features in random data, and here we are dealing with a clumpy distribution where such effects may be enhanced.

To investigate this problem, we devised a computer algorithm which identified filament pixels as those which lay on ridge lines. This algorithm is quite successful at identifying just those filaments which one's eye detects. We then applied the algorithm to the Soniera-Peebles simulation which contains a hierarchical pattern of clustering, reproduces the two- and three-point correlation functions, but which contains no intrinsic filamentary structure. Of course, random alignments of clumps in this model can produce filaments and the simulation does appear somewhat filamentary to the eye, but not as dramatically so as the real sky. When our filament algorithm is applied to the simulation, it produces a pattern of filaments which is astonishingly similar to that in the real sky: the fraction of pixels that are filament pixels and the lengths of the filaments are statistically indistinguishable in the real sky and the simulation.

There are some differences, however. The filaments in the real sky are somewhat brighter than those in the simulation, making them more prominent. Whether this difference could be eliminated by a hierarchical simulation with somewhat different parameters is not clear. So while there are differences between the real sky and the simulations, their similarities are striking. Thus, a good deal of the filamentary appearance of the Shane-Wirtanen counts may simply be due to hierarchical clustering.

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Discussion

Scott: Some years ago, Scott, Shane and Swanson (1954, Ap. J., 119, 91) constructed a synthetic plate in order to compare to the Shane and Wirtanen Lick survey. The synthetic plate was constructed by Monte Carlo clustering. That is, the cluster centers were assigned in space by a three-dimensional Poisson distribution, using a table of random numbers. The number of galaxies assigned to each cluster followed a geometric distribution as in Neyman, Scott and Shane (1953, Ap. J., 117, 92); galaxy coordinates with respect to centers were trivariate normal; luminosity function, etc., also, as in Neyman, Scott and Shane (1953), using random numbers. The resulting galaxies were projected onto two dimensions; galaxies falling on a hypothetical $6° \times 6°$ plate were retained. They were next retained if brighter than varying limiting apparent magnitude. They were next corrected for random errors in counting. The final synthetic plate, entirely based on random numbers under the hypothesis of complete clustering, was compared to actual plates in the Lick survey. Among other comparisons, we looked for "chains," "crescents," etc., that would now be called filaments. We found good agreement between the synthetic and actual plates, but filaments on the synthetic plates were clearly optical, since the distribution was composed of galaxies from different clusters at different distances. Due to construction by hand, we kept track of which cluster each galaxy comes from. It was convenient to do by distance shells. Therefore, apparent filaments will be found when none really exist -- when we have just simple clustering.

Shandarin: Filamentary structure exists in any distribution of particles; for example, in a pure Poisson one. Thus, it is not a qualitative question but a quantative one.

Gott: We have run our filament algorithm on Poisson data, and the results are highly statistically significantly different from the sky or the hierarchical simulation. But the sky and the hierarchical simulation were statistically indistinguishable, except for the brightness effect discussed.

B. Jones: The Shane-Wirtanen survey is not very uniform and the filamentary structures seen in their survey are not always as evident on modern surveys.

Osmer: Will your approach allow you to distinguish among different types of clustering, e.g., hierarchical or power law?

Gott: So far we have just tested it on the sky and on the hierarchical clustering simulation, but it would be interesting to try it on a variety of types of simulations.

Peacock: Are you then saying that the real sky shows a deficiency of faint filaments?

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Gott: Yes. The number and lengths of the filaments in the simulations and the real sky are the same and the filaments in the sky are on average slightly brighter. So the sky contains, therefore, fewer faint filaments.

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