MONTE-CARLO SIMULATIONS OF THE DISTRIBUTION OF FAINT GALAXIES

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Simulations of static (non-evolving) fields of galaxies are carried out by means of a Monte-Carlo computer technique which models all physical effects acting on the light from distant galaxies, from emission at the source up to the final detection and measurement on the photographic plate by means of a high-speed measuring machine. Parameters for the model galaxies are computed in order to match the main types of measurement made on astronomical photographs (e.g. image centroids, isophotal magnitudes and colours, orientations and shapes).

In the simulations, galaxies are generated according to any desired clustering scenario in three dimensional (3-D) space, and then projected onto the plane of the sky. Wherever possible, observationally determined parameters are used as input to the simulations. For example, we use the cluster luminosity function of Schechter (1976), power-law radial distribution of galaxies within clusters from Peebles and Groth (1975), the shapes of clusters from Binggeli (1982), etc. The light from a galaxy is increased for evolution and cosmology and decreased for internal absorption, effects of distance and K-dimming, Galactic obscuration, telescope vignetting, scattering by the point-spread function and finally for detection above an isophotal threshold. The simulation proceeds until a specified number of galaxies in the model field is detected above the limiting magnitude.

The model fields may be compared directly with observational data from scans, using the COSMOS automatic plate-measuring machine at the Royal Observatory Edinburgh (MacGillivray, 1981), of deep photographs taken with the UK Schmidt (UKST) and Anglo-Australian (AAT) Telescopes. Images are detected on these plates down to thresholds in the range 2-10% of night sky intensity level (corresponding approximately to the B = 26-27 mag/sq arcsec isophotes). Star/galaxy separation is performed by computer down to $m_J \sim 21$-22 (MacGillivray and Dodd, 1980b) and the distribution of the galaxy images investigated by means of suitable clustering algorithms.

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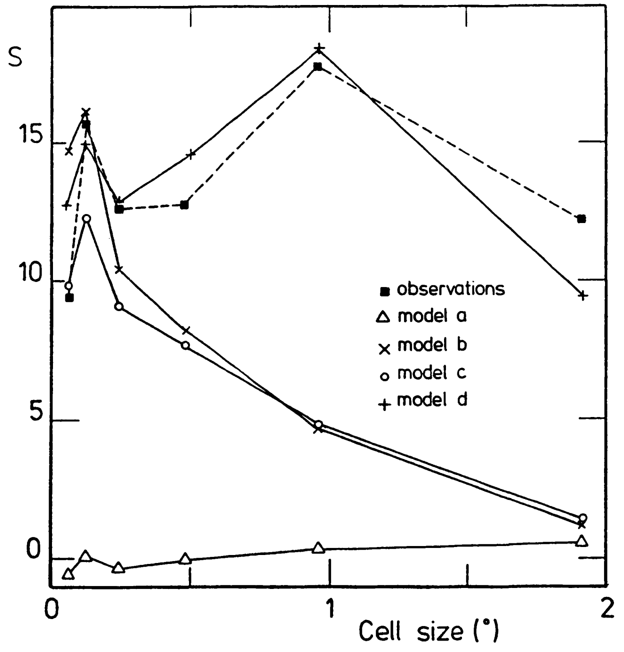

Figure 1. The result of applying Meads analysis to observational data described in the text and various simulated fields involving galaxies distributed at random (triangles), within clusters of fixed and continuous scales (crosses and open circles respectively) and galaxies in clusters which are in turn clustered into high-order clusterings (plus-signs).

Figure 1 shows the result of applying the method of Meads analysis (see Shanks, 1979) to the galaxy field of MacGillivray and Dodd (1980a), involving some 30000 galaxies in a field of 4 × 4 degrees down to a limiting magnitude of B ∿ 22 near the South Galactic Pole. If the estimated plate selection function for these data is correct, then at the typical sample redshift of z' ∿ 0.15, the clustering detected at angular scales of 0.12° and 1.0° corresponds to linear scales of ∿ 1.0 and 8.0 Mpc respectively (with H_0 = 75 km s^{-1} Mpc^{-1} and q_0 = +1). The larger clustering scale compares with the size of typical groups of clusters, e.g. the Hercules supercluster (Tarenghi et al., 1979) and the Horologium-Reticulum supercluster (Dawe et al., 1979).

The results for various simulated fields (with similar parameters for the plate/machine combination - i.e. seeing of 2 arcsec and isophotal threshold at the 9.6% night sky level, and no luminosity evolution included) are shown also in Figure 1. The models shown include a completely random model (model a), clustering on a fixed scale (model b) with cluster radii of 2.5 Mpc, clustering on continuous scales (model c) with all cluster radii in the range 1-5 Mpc being allowed, and a model involving second-order clustering of the galaxies, with supercluster diameters of 10 Mpc (model d). As can be seen, only models incorporating second order clustering can reproduce the peak at angular size of 1°, thus supporting the presence of second order clustering in the observational data. However, the exact nature of this second order clustering cannot be unambiguously ascertained from these data.

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Discussion

Giovanelli: I would like to make a comment on your remark on Martian canals. If superclusters have redshift depths of several hundred km/s, even volume density enhancements as high as 100 would not appear conspicuous in galaxian distributions as deep as the ones you showed. For example, for a sample as shallow as the Zwicky catalog, an overdensity of 100, about 600 km/s deep will appear with a surface density contrast of at best (depending where it is centered in redshift) of only 7 or 8. If the depth of the sample is many times higher, as yours, superclusters will wash away.

MacGillivray: I agree that any large-scale structures would be completely swamped by foreground and background contamination in these very deep galaxy surveys. This makes it even more interesting when examining isoplethal plots of the distribution of the galaxies, in which "ridges" are clearly seen connecting the rich clusters. The consequences for the interpretation of ridges seen in other galaxy samples cannot be ignored.

J. Jones: In working on the calibration of Schmidt plates, I have found a great deal of patchiness and nonuniformity over the plates at these low light levels. Have you done any tests to ensure that this is not affecting your conclusions about large-scale structure?

MacGillivray: The problem of nonuniformities over plates is one which we are examining with great care at Edinburgh. Ultimately, one can be absolutely certain only when two plates of the same field are examined and in such instances our results remain valid.

On a similar note, we have also attempted to model the effect of patchy galactic obscuration on simulated galaxy fields using the most recent observations of H I clouds. We find that although patchy obscuration can indeed influence the galaxy counts, it cannot produce features of the magnitude observed in our data at large ($\sim 1°$) angular scales.