COUNTS OF FAINT GALAXIES

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The number-magnitude relation for galaxies is an insensitive test for discriminating between cosmological models. Nevertheless, counts of faint galaxies enable us to investigate possible evolutionary effects, which may be caused by time dependence of the luminosity and/or number density of galaxies.

The detection of evolutionary effects is masked by the following factors: photometric scale errors in measuring extended objects, inaccuracy of the K-correction for large redshifts, and uncertainties in the luminosity function of galaxies, and in the mean relative abundance of different morphological types of galaxies.

Numerical results on the counts of galaxies to $m_B = 24^m$ have been presented by Karachentsev and Kopylov (1977). We used data published by different authors and also counts of galaxies on plates obtained at the prime focus of the 6-metre telescope. The photometric accuracy of our counts is about a quarter of a magnitude.

To compare the observational data with the theoretical relations, the following assumptions have been adopted:

(a) A Friedmann cosmological model with decleration parameter $q_o = 0$

(b) K-corrections for elliptical E and spiral S galaxies according to Pence (1976); it was also assumed that among field galaxies the morphological types, E and S, have a relative abundance of 1:3, the same as in the neighbourhood of the Galaxy.

(c) The luminosity function of galaxies according to Abell (1974).

(d) Intergalactic absorption has been assumed to be zero.

Figure 1 shows the counts of galaxies to different limiting magnitudes in the form $\log(N/N_o)$ vs. blue apparent magnitude, where

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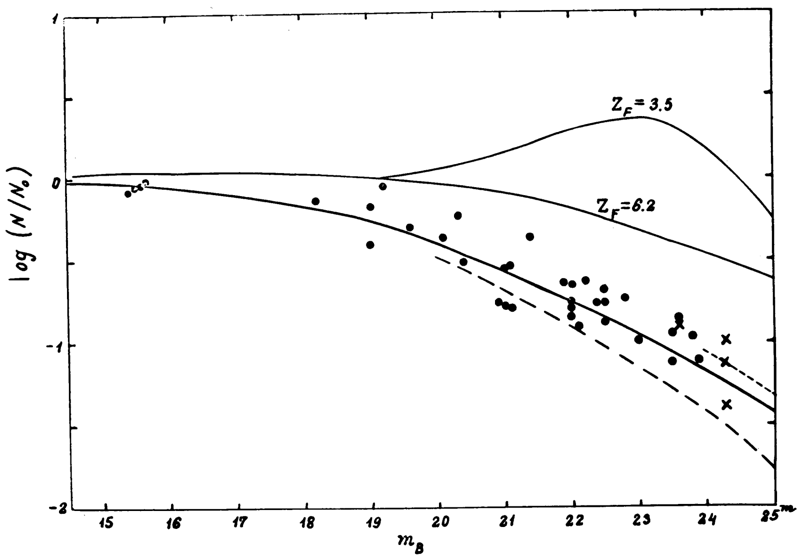

Figure 1

$N_0 = 10^{0.6m}$ is the number in a static, Euclidean model. The observational data are marked by full circles and by crosses (indirect estimates). Some theoretical results are shown in Figure 1. The lower solid line corresponds to no evolutionary effects. The lower dashed curve represents number density evolution according to the steady-state cosmology, $n(z) = n_0(1+z)^3$. The luminosity evolution, $L = L_0(1+z)$, which was proposed by Brown and Tinsley (1974), is indicated by the upper dashed line. The upper two curves are for strong evolution with different epochs of galaxy formation, $z_F = 3.5$ and 6.2, according to Tinsley (1977).

The present data indicate no strong evolutionary effects for the number density and luminosity of galaxies.

According to Dodd et al. (1975) the effect of clustering is more pronounced for remote than for nearby galaxies, which can be explained by the dynamical evolution of systems of galaxies. Since, the scatter of log N(m) is approximately the same for faint and medium bright galaxies, we conclude that there is not any increase in clustering for faint galaxies up to z = 0.3 - 0.4.

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DISCUSSION

Abell: How large a total field was counted?

Karachentsev: The diameter of the field observed at the prime focus of the 6-metre telescope is 12 arcmin.

Abell: How did you measure your faint magnitudes? Were they photoelectric, extrafocal, iris diaphragm, or what?

Karachentsev: The counts were made visually in the regions of well-known photometric standards: M3, M31, M101, Abell 4, NGC2419, and also in other regions at high galactic latitude. The plates were obtained on the same nights as those taken for the photometric standards. In counting faint galaxies we stopped counting at $\Delta m = 0.7$ magnitudes above the plate limit. We believe that the observation of 50% of light of a galaxy beyond a stellar image allows us to distinguish between stellar and galactic images. Of course, this criterion is not justified in the case of compact galaxies.

Tinsley: What types of plate were used in these observations and what is the magnitude system?

Karachentsev: Generally, we have used IIaO plates. For some plates we have used a B magnitude system; for others, we reduced the magnitudes to Zwicky photographic magnitudes. In comparing the counts with the predictions of your models, we took into account differences in the magnitude systems we used and those of the models.

Chincarini: My experience of 4-m plates taken at Cerro Tololo with good seeing is that it is rather difficult to distinguish between stars and galaxies at the plate limit. My questions are:

(1) The determination of the magnitude scale between $B = 20^m$ and $B = 24^m$.

(2) How were the counts corrected for the effects of contamination and what is the size of error?

(3) What kind of correction for foreground stars was used, how was it determined and what is the error?

(4) What is the sensitivity correction across the field of the 6-m telescope?

Karachentsev: Please see my answers to Dr Abell. Details about the galaxy counts have been described by us in a paper published this year.

van der Laan: Can you give more details of how the counts were made, in particular, what measuring machines were used?

Karachentsev: The counts were made by eye.

Tinsley: The theoretical curves that Dr Karachentsev derived from my 1977 *Astrophys. J.* paper assume that all galaxies above a given magnitude limit are counted, regardless of their angular size. It should be pointed out that a large fraction of the galaxies comprising the excess with "strong evolution" will be of very small angular diameter and could have been rejected as stars.

Another point is that much smaller evolutionary excesses are predicted in the galaxy models discussed in my paper at this conference. For example, an excess of a factor ~ 2.5 over the "local Euclidean" value $N(m) \propto 10^{0.6m}$ is predicted at $B = 24^m$.

R. G. Kron, at Berkeley, has counted galaxies to 24^m and reports approximately $N \propto 10^{0.6m}$ even at 24^m in blue light. It would be interesting to understand this discrepancy with Dr Karachentsev's results. It should be noted that Kron's result is inconsistent with the models I discuss at this conference.

Karachentsev: We find that for $m_B \gtrsim 22\overset{m}{.}5$ the number of galaxies is larger than the number of stars and for $m_B \simeq 24\overset{m}{.}5$ this ratio amounts to a factor of 3. That is why in the counts of very faint galaxies the problem of distinguishing between stellar and galactic images loses its significance as a source of systematic errors.

de Vaucouleurs: The critical point in all log N(m) plots is the determination of m. How to measure it correctly is discussed at length in the dissertation of G. S. Brown to be published shortly in the *University of Texas Astronomy Publications*. Counts of galaxies down to $B = 18^m$, 19^m, 20^m and 21^m in 13 fields at $b = +70^o$, $+80^o$ and 90^o are reported.

Karachentsev: I have had an opportunity to compare our galaxy counts with those by King and Kron in the blue region. The difference in lg N $(m = 24^m)$ is only about 20%. The problem is the difference for brighter $(m \lesssim 21^m)$ galaxies. I would like to emphasize that the data we presented today included galaxy counts by different authors, namely, by Harris and Smith, by Partridge, etc.