# PROPERTIES OF GALAXIES IN LOW DENSITY REGIONS

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Isolated galaxies seem to have more nuclear activity and less disk activity than nonisolated objects. This is interpreted as an expression of the mass-profile in their halos.

The discovery of voids in the three-dimensional distribution of galaxies has rapidly been followed by claims that in at least one such void some objects, like Markarian and emission-line galaxies, are present. Why are only active galaxies found in these voids? Should we also expect the opposite to be true, namely that active galaxies ought to be found more often in voids, or in regions of the Universe with lower-than-average density? There are indications that this seems to be the case, as Gisler (1978) found that emission-line galaxies, Markarians and possibly Seyferts avoid environments of dense clusters. Differences between "field" and "cluster" populations are probably due more to the enhanced local density of galaxies than to the nature of the overall environment.

We have studied a sample of objects identified by Huchra and Thuan (1977, hereafter HT) as isolated, to check how different are the observed properties of galaxies at the low end of the neighborhood-density distribution. We (Brosch and Shaviv, 1982) found that the 12 HT galaxies show nuclear ultraviolet excesses when compared to the average properties of objects from de Vaucouleurs (1961). These excesses could not be modeled by reasonable mixtures of stellar populations. Brosch and Isaacman (1982) found that at least for half the HT sample, the spectral distribution of the nuclei between 3500 Å and 3.5 μm resembles that of late K stars. Brosch and Krumm (1982) detected compact nuclear 5 GHz sources in two HT objects, but their control sample (referred to as BK) showed no radio sources among nuclei of 17 galaxy members of sparse groups, "open clusters" in the nomenclature of Gisler (1978).

Balkowski and Chamaraux (1981) found that HT galaxies have more neutral hydrogen than group galaxies. The full-synthesis maps produced at Westerbork (Krumm and Shane 1982) confirm their values for the total hydrogen masses. The data available in the literature permit comparisons to be made between the HT and BK samples. We find that the BK objects show a tight correlation (r = 0.94) between the logarithm of the total hydrogen mass, M(H), and the logarithm of the optical physical diameter,



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D. A similar correlation has been reported by Giovanelli (1981) from the Arecibo survey of "isolated" galaxies drawn from the list of Karachentseva (1973, hereafter KI). Giovanelli finds $M(H) \propto D^{1.85}$, while we find $M(H) \propto D^{2.6}$. The HT objects show consistently higher values of M(H) for all values of D. The excess of hydrogen is more pronounced at the small-diameter end of the regression.

The HT galaxies have lower average blue surface brightness than the BK sample (90% confidence level). This is consistent with what Arakelyan and Magtesyan (1981) found from a comparison between galaxies in pairs and KI objects. The percentage of reported line emission in the optical spectra is also different; only 6/12 HT galaxies show emission, while the fraction among BK objects is 11/17. Adopting Gisler's (1978) statistics, we should have observed 9/12 HT and 10/17 BK galaxies with emission in their spectra.

Finally, the HT galaxies show some properties characteristic of later morphological types than those assigned from their optical images. There are the colors U-B and B-V as measured through the largest aperture by Brosch and Shaviv (1982), the distribution of neutral hydrogen in one object and the rotation curve derived from HI in the second galaxy studied by Krumm and Shane (1982). It appears therefore that there are several real differences between isolated and nonisolated, but noncluster, galaxies. Most of these differences indicate a trend towards less disk activity in HT objects, while the nuclear UV excesses and the discovery of compact nuclear radio sources (despite the small statistical sample) imply enhanced central activity relative to nonisolated objects.

This can be understood in the light of results from N-body simulations of slow tidal encounters between galaxies (Dekel *et al*. 1980) where it was shown that interactions modify the inner regions of galaxies by flattening their mass-profiles relative to those of unperturbed galaxies. Thus, HT objects probably have nearly unperturbed halos, while BK and other nonisolated galaxies have had their halos partially stripped and their inner regions "puffed up." A sharper mass-profile eases inflow of matter to the central regions and also delays star formation in the infalling gas. This implies that any activity would preferentially be confined to the nuclei. Similar arguments might apply to galaxies in voids; this would explain their being active as well as predict their being gas-rich.

## References

Arakelyan, M.A., and Magtesyan, A.P. 1981, *Astrophysics*, 17, 28.
Balkowski, Ch., and Chamaraux, P. 1981, *Astron. Astrophys*., 97, 223.
Brosch, N., and Isaacman, R. 1982, *Astron. Astrophys*., in press.
Brosch, N., and Krumm, N. 1982, in preparation.
Brosch, N., and Shaviv, G. 1982, *Ap. J*., 253, 526.
Dekel, A., *et al*. 1980, *Ap. J*., 241, 946.
de Vaucouleurs, G. 1961, *Ap. J. Suppl*., 5, 233.
Giovanelli, R. 1981, in "Extragalactic Molecules," NRAO, 141.
Gisler, G.R. 1978, *M.N.R.A.S*., 183, 633.
Huchra, J., and Thuan, T.X. 1977, *Ap. J*., 216, 694.
Karachentseva, V.E. 1972, *Comm. Spec. Astr. Obs. USSR*, 8, 3.
Krumm, N., and Shane, W.W. 1982, preprint.

## Discussion

*Giovanelli:* One comment and one question: The comment: I would advise caution in the inference of integral properties from such a small sample. Intrinsic scatter is very large. The question: Did I read correctly in one of your graphs that the difference in the hydrogen content between isolated galaxies and those in groups is one order of magnitude? If so, it sounds far too high.

*Brosch:* I) I agree with the need for extreme caution when dealing with small samples, but the HT galaxies are the only sample of bright "isolated" galaxies. The KI sample, as well as that of isolated pairs (KP; Karachentsev 1979, Comm. Spec. Astr. Obs. USSR, 7, 1), are heavily contaminated by members of systems. I found that among those KI and KP systems detected at 6 cm by Stocke and his collaborators and having published redshifts, those nearby (within $\sim$ 2000 km $s^{-1}$) have a significant number of companions within 0.5 Mpc ($H_o$ = 100 km $s^{-1}$ $Mpc^{-1}$), and within 150 km $s^{-1}$ of the primary system. The HT galaxies have effectively no companions. Thus, studies based on the Soviet samples of isolated systems should be approached with extreme caution because the samples are not clean.

II) I must emphasize that the M(HI) values for the BK and HT samples come from different authors. If you believe the Balkowski and Chamaraux HI masses, then the discrepancy between the two samples is indeed one order of magnitude at the low end of the M(HI)-D relation. It would be extremely useful to have both samples observed by one single person or group, with the same system.

*van Woerden:* Your claim that isolated galaxies tend to have strong nuclear radio-continuum sources appears at variance with the results of a large survey of galaxies by Hummell at Westerbork. Hummel (Astron. Astrophys., 89, L1) finds that in interacting pairs nuclear sources are more frequent than in single galaxies.

*Brosch:* I) We have observed at 5 GHz while Hummel (1981, Astron. Astrophys., 93, 93) looked at 1.4 GHz. Thus, we are looking at different things.

II) Our nonisolated galaxies have been selected not to be interacting or peculiar objects, because we wanted to check only the effects of slightly increased density of galaxies. This sample has been compared to the "cleanest" sample of isolated galaxies. Hummel (1981) had, on the other hand, used as the "isolated" class a quite badly defined sample.