The Environments of Markarian Galaxies

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The extensively studied Markarian sample of 1500 ultraviolet excess galaxies contains many Seyfert, starburst, and peculiar galaxies. Using the 20 minute V plates obtained for the construction of the Hubble Space Telescope Guide Star Catalog, we have investigated the morphologies of the Markarian galaxies and the environments in which they are located. This paper reports on the relationship between the types of nuclear activity and the morphologies and environments of the Markarian galaxies.

Previous studies of the environments of Seyfert galaxies establish a connection between the nature of the activity in the nuclear regions of the galaxy and its external environment. Petrosian (1982) finds that type II Seyfert galaxies are located in regions of higher density than type I Seyfert galaxies. Dahari (1985) finds an excess of close companions to Seyfert galaxies compared to field galaxies. MacKenty (1989) confirms these results. However, MacKenty (1989) finds that non-Seyfert Markarian galaxies have the same frequency of companion galaxies as Seyfert Markarian galaxies. He uses their IRAS colors to argue that the companion galaxies tend to enhance star formation rather than directly influence the nuclear activity. The influence of companion galaxies has also been demonstrated on emission line galaxies (Kennicutt and Keel 1984; Keel et al. 1985; Cutri and McAlary 1985) and on IRAS infrared luminous galaxies (Lonsdale, Persson, and Matthews 1984).

Sample Selection and Data

The sample is drawn from Markarian Lists I - XV (Markarian 1967, Markarian, Lipovetskii, and Stepanian 1979) and is based on the data in Mazzarella and Balzano (1986). Joe Mazzarella kindly provided a digital copy of their tables. The sample contains 970 Markarian galaxies (including 116 Seyferts) after the exclustion of:

: 280 galaxies without redshifts
: galaxies with redshifts < 2000 or > 15000 km/s
: 12 special galaxies (i.e. BL Lac, NELG)
: about 20 galaxies with confused positions or identifications

Regions 7 by 7 arcminutes in size (with a pixel size of 1.7 arcsec) were extracted from the 20 min V band Schmidt plates obtained for the Hubble Space Telescope Guide Star Catalog (see Lasker et al. 1990 for a description of the GSC). A COSMOS type algorithm was used to locate and classify all objects on the extracted images. Objects were classified as stellar, non-stellar, or galactic. All but the stellar objects will be taken to be galaxies in this analysis. All galaxies detected within 50 kpc projected radius of each Markarian galaxy were counted. These counts were analyzed first using all of the galaxies and then were re-analyzed excluding those galaxies with whose total intensity (on the Schmidt plates)

differed from the Markarian galaxy's by more than a factor of 5 and by more than a factor of 2.

Morphological Classification

The central 80 by 80 pixel regions of the extracted images were mosaiced into 100 object composites and examined visually on an image display device. Each Markarian galaxy was assigned a simple morphological classification based on the following scheme:

: Stellar or Nearly Stellar
: Extended but No Evident Structure
: Spiral Structure Evident (but no Bar)
: Spiral with Bar or Ring
: Peculiar or Significant Asymmetry
: Multiply Nuclei or Probable Interacting Pair
: Highly Peculiar (Jets or Strong Interaction)
(In the present analysis the last three classes are combined.)

Results

From the table below, it is evident that Seyfert galaxies do NOT have a higher frequency of close (within 50 kpc) neighbors than Star Burst galaxies or the Unclassified Markarian galaxies. There may be a slight trend for Seyfert galaxies to have fewer neighbors than other Markarian galaxies but this is not conclusive. This result is independent of our efforts to reduce contamination by foreground and background galaxies (although excluding potential neighbors based on the ratio of their total intensity to the Markarian galaxy's removes the bias to find an excess of neighbors in the vicinity of lower redshift galaxies).

Local Density versus Type of Nuclear Activity

	Seyfert	Star Burst	Unclassified
(No Limit on Neighbors)			
Neighbors	64.7% (75)	81.3% (78)	75.2% (568)
Average Number	2.26	4.62	3.16
(Neighbors within a Factor of 5 in Total Intensity)			
Neighbors	15.5% (18)	18.7% (18)	28.7% (217)
Average Number	0.19	0.28	0.43
(Neighbors within a Factor of 2 in Total Intensity)			
Neighbors	6.0% (7)	6.2% (6)	13.8% (104)
Average Number	0.06	0.09	0.17
Number of Galaxies	116	96	755

Furthermore, as seen in the following table, there is no strong correlation between the type of nuclear activity and the morphology of the host galaxy. That Bars and Rings seem to be more common in both the Seyfert and Star Burst populations compared to the Unclassified population may be the result of greater study of these relatively closer galaxies.

Morphology versus Type of Nuclear Activity

Morphology	Seyfert	Star Burst	Unclassified
Stellar	4.3% (5)	6.2% (6)	10.8% (82)
Extended	38.8% (45)	27.8% (27)	46.5% (352)
Spiral	21.6% (25)	17.5% (17)	15.3% (116)
Bar or Ring	14.7% (17)	13.4% (13)	4.0% (30)
Peculiar or Interacting	20.7% (24)	35.1% (34)	23.4% (177)

Conclusions

From this study, we conclude that the *type of nuclear activity* present in the galaxies of the Markarian sample is *not dependent on either the morphology or the local environment* of the galaxy. This is not to imply that nuclear activity per se is not influenced by the environment in which the nucleus is located. Rather the *type* of nuclear activity (at least in the Markarian population) does not appear to be determined by the environment.

References

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