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CORRELATIONS BETWEEN ENVIRONMENTAL PARAMETERS AND NUCLEAR ACTIVITY

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The occurrence and quantitative properties of Seyfert 1 and Seyfert 2 galaxies as a function of the galaxy environment have been studied in a systematic way. For this investigation we have selected from the Catalogue of Quasars and Active Nuclei (Veron & Veron,1989) all Seyfert galaxies with the following properties:

(i) $m_V \leq 15$,
(ii) listed classification as Sey 1, Sey 2, or Sey 3,
(iii) $v_{rad} \leq 20000$ km s^{-1}.

This results in a sample size of 242 Seyfert galaxies. For all these objects their galaxy environment has been inspected on POSS and ESO/SRC plates.

The vicinity of each sample Seyfert galaxy was searched for companion galaxies out to at least 0.5 Mpc. Lacking redshift information we adopted as a companion galaxy any galaxy in this area having a size between 20 and 200 percent of the Seyfert galaxy size.

As an important environmental parameter for Seyfert activity we consider here the galaxy density within an environment of 500 kpc radius. We distinguish four density classes:

D1: no companion (isolated Seyfert)
D2: 1 companion
D3: 2-5 companions (group)
D4: ≥ 6 companions (dense group)

Table 1: The distribution of the various Seyfert classes among the density classes

	density class D			
	1	2	3	4
Sey 1	13 (11)	27 (22)	61 (50)	21 (17)
Sey 2	3 (3)	21 (20)	62 (60)	18 (17)
Sey 3	0 (0)	3 (19)	9 (56)	4 (25)

D = 1 for isolated Seyfert, D = 4 for Seyfert in dense group.
In brackets are given the relative percentages.

The distribution of the various Seyfert classes among these density classes is listed in Table 1, both in absolute numbers and in percentages (given in brackets). From this statistics the environments of Sey 1, Sey 2, and Sey 3 galaxies do not differ in general with the exception that among the isolated galaxies the Seyfert 1 galaxies dominate conspicuously. No significant dependence of morphological type (de Vaucouleurs T-type) on density class is observed both for Sey 1 and Sey 2 galaxies (cf. Fig. 1g).

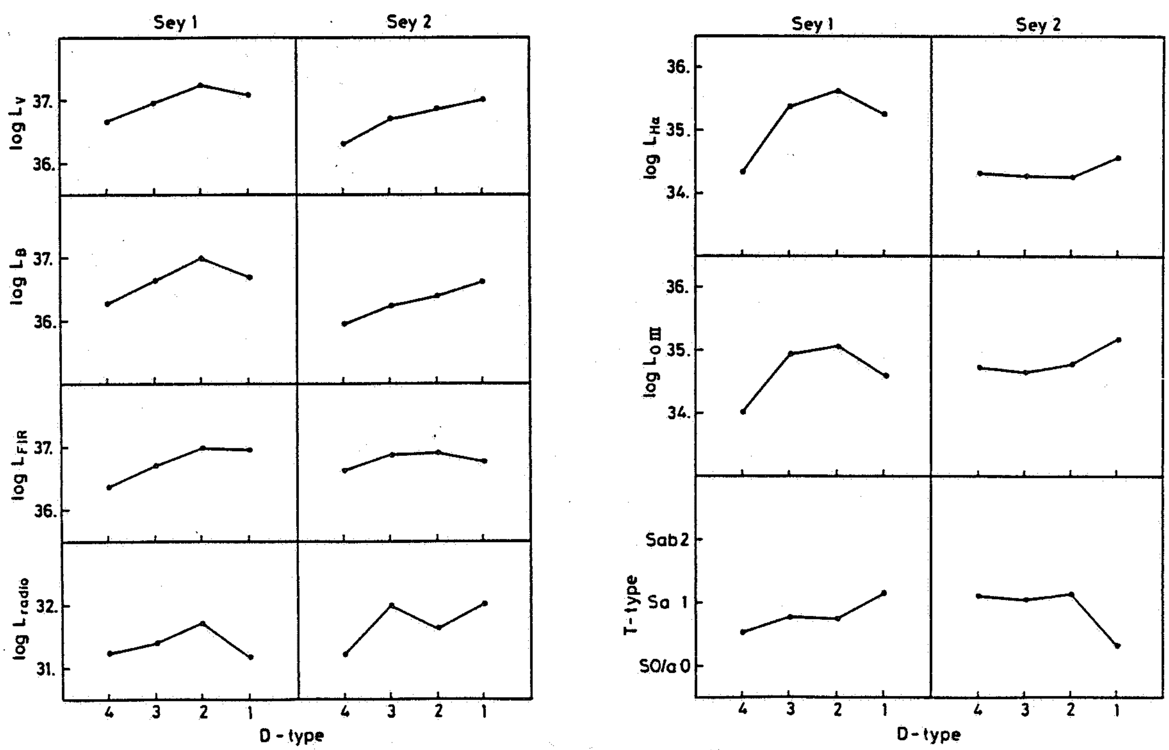
On the basis of an extensive search of the Seyfert literature we also investigated the dependence of the intrinsic parameters of the sample Seyfert galaxies on density class. In Figs. 1a - f we plot the absolute visual and blue luminosity L_V and L_B; the FIR luminosity L_{FIR}; radio luminosity L_{6cm}; the dereddened Hα luminosity $L_{H\alpha}$, and the dereddened [OIII] 5007 luminosity $L_{[OIII]}$ as functions of density class. Numerically, these functions (including the error bars) are presented in Table 2.

The following trends can be derived from Table 2:

The Seyfert galaxies which are located in the densest environments show the lowest absolute luminosities in the continuum and in the emission lines. The luminosities decrease by more than a factor of 2 with increasing environment density, both for Seyfert 1 and Seyfert 2 galaxies.

This trend is weaker in the far-infrared; probably due to starbursts triggered in denser environments.

The results for the isolated Seyfert 2 galaxies (D1 class) have no high significance; only 3 galaxies of this type exist. The decreasing of the luminosity of isolated Seyfert 1 galaxies might be explained with the late state of the Seyfert activity triggered a long time ago by a distant neighbour.



Figs. 1a-g: Dependence of various properties of Seyfert galaxies (type 1 left-hand frames, type 2 right-hand frames) as functions of density class D: a) log L_V, b) log L_B, c) log L_{FIR}, d) log L_{6cm}, e) log $L_{H\alpha}$, f) log L_{OIII}, g) de Vaucouleurs morphological type 1. Luminosities are given in Watts.

Table 2: Intrinsic mean properties and morphological type of Sey 1 and Sey 2 galaxies as functions of density class (log of luminosities given in Watts)

Sey 1

D-type	4	3	2	1
L_V	36.67±.14	36.98±.06	37.25±.07	37.07±.14
L_B	36.28±.15	36.64±.08	37.01±.10	36.70±.22
L_{FIR}	36.37±.24	36.72±.81	36.98±.16	36.96±.16
L_{radio}	31.23±.23	31.38±.13	31.71±.16	31.19±.52
$L_{H\alpha}$	34.32±.31	35.38±.10	35.64±.20	35.26±.32
L_{OIII}	34.02±.25	34.94±.10	35.07±.14	34.60±.37
T-type	.52±.60	.77±.24	.74±.41	1.14±.69

Sey 2

D-type	4	3	2	1
L_V	36.32±.56	36.73±.07	36.88±.09	37.03±.39
L_B	35.96±.16	36.26±.09	36.40±.12	36.64±.39
L_{FIR}	36.64±.15	36.88±.10	36.91±.15	36.78±.55
L_{radio}	31.21±.40	31.99±.19	31.64±.16	32.01±.16
$L_{H\alpha}$	34.32±.29	34.27±.16	34.25±.24	34.56±1.03
L_{OIII}	34.72±.29	34.63±.18	34.78±.24	35.18±.98
T-type	1.11±.57	1.03±.25	1.14±.50	.33±.88

As demonstrated in a previous paper (Kollatschny and Fricke 1989) it is crucial to analyse in detail the properties of all the companions concerning their redshift and activity state in order to assess the impact of the environment on Seyfert activity. In the quoted paper a smaller sample had been analysed in such detail. As a result it was possible to identify the group member which was involved in the interaction and triggering process via a hyperbolical encounter, as well as to determine the activity patterns of the surounding groups. In Fig. 2 the Hα fluxes of the companions as a function of their separation from the Seyfert galaxies are reproduced from the paper quoted above. The nearby companions develop on average pronounced higher fluxes than the more distant ones.

The existence of similar groups as those investigated here, which are not hosting a Seyfert galaxy, indicates that a suitable group environment provides only a necessary condition for the development of Seyfert activity which in addition requires favourable conditions within the host galaxy itself.

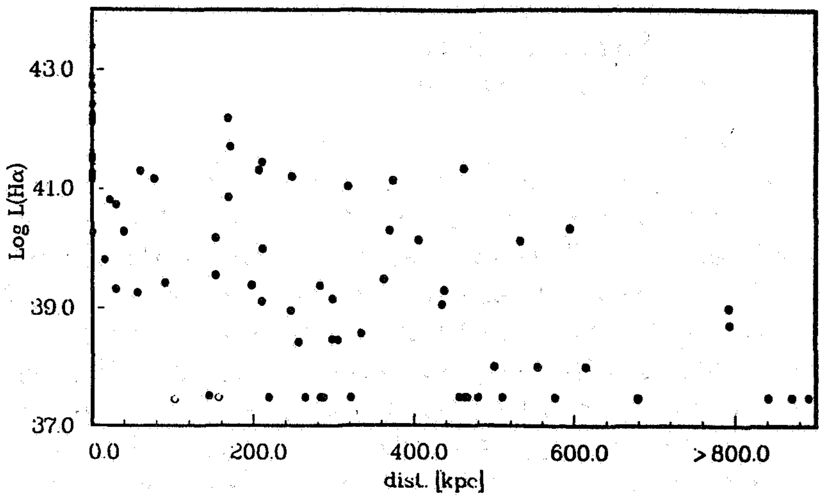


Fig. 2: The Hα luminosity as a function of projected distance from the Seyfert galaxy for all Seyfert group members

References

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Veron-Cetty, M.-P., Veron, P., 1989: A Catalogue of Quasars and Active Galactic Nuclei (4th Edition), *ESO Scientific Report* No. 7