

# Seyfert galaxies in UZC-Compact Groups

B. Kelm<sup>1</sup>, P. Focardi<sup>1</sup>, and V. Zitelli<sup>2</sup>

<sup>1</sup> Alma Mater Studiorum – Dipartimento di Astronomia, via Ranzani 1, 40127 Bologna, Italy

<sup>2</sup> INAF-Osservatorio Astronomico Bologna, via Ranzani 1, 40127 Bologna, Italy

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**Abstract.** We present results concerning the occurrence of Seyfert galaxies in a new automatically selected sample of nearby Compact Groups of galaxies (UZC-CGs). Seventeen Seyferts are found, constituting ~3% of the UZC-CG galaxy population. CGs hosting and non-hosting a Seyfert member exhibit no significant differences, except that a relevant number of Sy2 is found in unusual CGs, all presenting large velocity dispersion ( $\sigma > 400 \text{ km s}^{-1}$ ), many neighbours and a high number of ellipticals. We also find that the fraction of Seyferts in CGs is 3 times as large as that among UZC-single-galaxies, and results from an excess of Sy2s. CG-Seyferts are not more likely than other CG galaxies to present major interaction patterns, nor to display a bar. Our results indirectly support the minor-merging fueling mechanism.

**Key words.** galaxies: clusters: general – galaxies: Seyfert – galaxies: interactions

## 1. Introduction

Because of their high number density of galaxies (comparable to the central density in clusters) and relatively low velocity dispersion ( $\approx 200\text{--}300 \text{ km s}^{-1}$ ), Compact Groups (CGs) are predicted to constitute the most probable sites for strong galaxy-galaxy interactions and mergers to occur. As a consequence, they are also expected to display a high fraction of AGNs, provided they are bound systems (Hickson et al. 1992; Diaferio 2000) and the interaction-activity paradigm (Barnes & Hernquist 1992; Shlosman et al. 1990) holds true. The detected fraction of AGNs in CGs might then help to constrain the dynamical status of CGs. A high fraction of AGNs would indicate that CGs are not only physical, but also highly unstable, and would thus support the interaction-activity paradigm, as well as hierarchical scenarios in which large isolated elliptical galaxies (Zabludoff & Mulchaey 1998; Borne et al. 2000) are eventually the end-product of every CG. Conversely, a low fractions of AGNs would be more in accordance with recent results indicating that the occurrence of emission-line galaxies decreases in dense environment (Balogh et al. 2003; Gomez et al. 2003) and with optical and IR observations claiming that spiral galaxies in CGs (Sulentic & de Mello 1993; Verdes-Montenegro et al. 1998; Kelm et al. 2003), in groups (Maia et al. 2003) and in pairs (Bergvall et al. 2003) do not show starburst and/or Seyfert enhancement typically expected in interacting galaxies. In general, a strong correlation appears to hold between AGN and the presence of tidal interaction only for very luminous QSOs (Bahcall et al. 1997), while the excess of companions for Seyferts is still controversial

(Dahari 1985; Keel et al. 1985, 1996; Rafanelli et al. 1995; Fuentes-Williams & Stocke 1988; Mackenty 1989; De Robertis et al. 1998; Schmitt 2001).

Concerning CGs, only the Hickson Compact Groups (HCG, Hickson 1982, 1997) have been extensively studied as for many years it was the only large and uniform sample available. The results from this sample are somewhat conflicting. Several HCGs show evidence of ongoing interaction, but components usually remain distinct, with recognizable morphological types (Sulentic 1997). The fraction of blue ellipticals (which are plausible merger remnants) has turned out to be rather low (4 in 55), predominantly associated with faint members (Zepf et al. 1991) and similar to the estimated fraction ( $\approx 7\%$ ) of currently merging galaxies (Zepf 1993). Hickson et al. (1989) found the FIR emission in HCGs to be enhanced compared to a sample of field galaxies, but Sulentic & de Mello (1993) and Verdes-Montenegro et al. (1998) suggest there is no firm evidence for enhancement.

The specific issue of AGNs in HCGs has been addressed by the Kelm et al. (1998) finding that only  $\approx 2\%$  of the member galaxies display a Seyfert spectrum, and that this fraction is similar to that found in galaxy pairs. They also find that HCG Seyferts are hosted by luminous spirals, as is usually the case (Heckman 1978). However, a relevant population of low-luminosity AGNs (LLAGNs) in HCGs as well as in the SCG sample (Iovino 2002) has been revealed by means of deep resolution spectroscopy (Coziol et al. 1998a,b, 2000), with a significant preference for early-type hosts. Coziol et al. (2000) state that AGNs (including low luminosity/dwarf sources) are the most frequent (41%) activity type encountered in CGs. Shimada et al. (2000) confirm a high fraction of LLAGNs

Send offprint requests to: B. Kelm, e-mail: birgit.kelm@uniibo.it

in HCGs, but claim that there is no statistically significant difference in the frequency of occurrence of emission line galaxies between the HCGs and the field. Whether a CG environment really triggers an AGN at all, or whether CGs are favourable hosts for low-excitation, low luminosity AGNs only, remains controversial, however.

In this paper we address the issue of Seyfert occurrence in CGs making use of the new large sample of UZC-CGs (Focardi & Kelm 2002), selected from a 3D magnitude limited catalogue (UZC, Falco et al. 1999). In Sect. 2 the UZC-CG and the Seyfert samples are presented, in Sect. 3 UZC-CGs with and without a Seyfert are compared; a similar comparison for HCGs is performed in Sect. 4. In Sect. 5 the frequency of Seyferts in UZC-CGs and in a single-galaxy sample (selected in UZC) are discussed. In Sects. 6 and 7 we address the relative occurrence of Sy1, Sy2 and LINERs, and in Sect. 8 the presence of interaction patterns.

A Hubble constant of  $H_0 = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$  is used throughout.

## 2. The samples

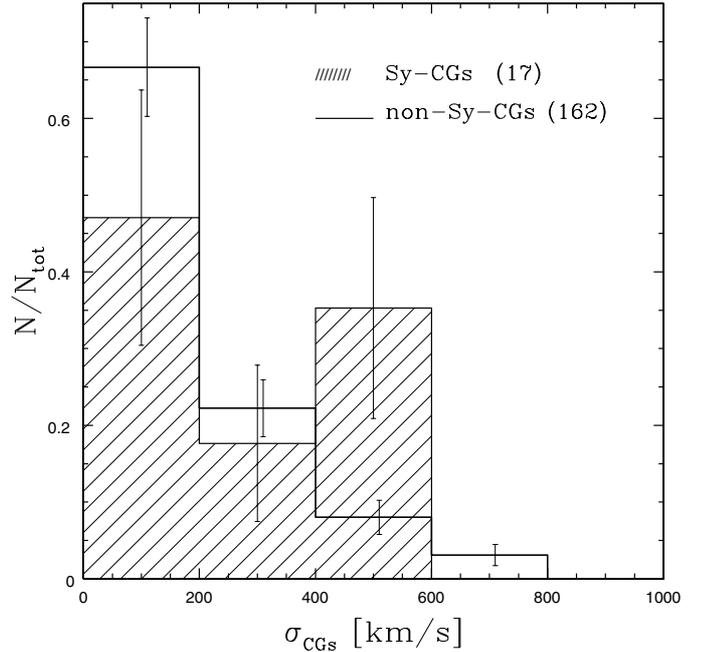
UZC-CGs (Focardi & Kelm 2002) have been extracted from the UZC catalog (Falco et al. 1999) using an objective algorithm. UZC lists redshift for nearly 20 000 galaxies in the northern sky and is 96% complete for  $m_B \leq 15.5$  galaxies. UZC-CGs are systems of 3 or more galaxies lying inside a  $200 h^{-1} \text{ kpc}$  radius area and radial velocity within  $1000 \text{ km s}^{-1}$  from the center. Possible ACO clusters substructures have been excluded from the UZC-CG sample.

The present analysis is restricted to 192 UZC-CGs (639 galaxies) in the  $2500\text{--}7500 \text{ km s}^{-1}$  radial velocity range. The lower limit in radial velocity has been set to avoid possible Local Supercluster structures and major contamination of distances by the effect of peculiar motions. The upper limit avoids including a large population of galaxies with uncertain morphological classification.

Seyfert galaxies are identified by cross correlating UZC-CG galaxies with the Veron-Cetty & Veron (2001, V&V) AGN catalogue. V&V is still the largest all-sky available catalogue of bright nearby Seyfert galaxies. It is neither complete nor homogeneous, nevertheless it is not severely affected by survey biases (i.e. there are no large sky regions in which the absence of Seyferts can be attributed to the lack of data) and can be used at least for a preliminary analysis.

The NED database has further been inspected to include any additional AGN and to check V&V's activity classification. It has also been used to assign morphological classification, available for 75% of the galaxies. In Table 1 basic data for each Sy1 and Sy2 in UZC-CGs are listed: UZC-CG number (Col. 1), Seyfert name (Col. 2), V&V and NED activity classification (Cols. 3 and 4), morphological classification (Col. 5), radial velocity (Col. 6), apparent blue magnitude as in UZC (Col. 7), luminosity rank (1 = first ranked, 2 = second ranked ...) (Col. 8), presence of interaction pattern (Col. 9), other identification (Col. 10).

To identify LINERs (L) we have also inspected the list by Carrillo et al. (1999). LINERs are named Sy3 in V&V,



**Fig. 1.** Velocity dispersion distribution for Sy-CGs (hatched) and non-Sy-CGs. Though an excess of Sy-CGs emerges in the  $400\text{--}600 \text{ km s}^{-1}$  bin, differences between distributions are not highly significant (91% cl according to the KS test).

and occasionally AGN in NED. LINERs in UZC-CGs are listed in Table 2. LINERs are found in galaxies of earlier Hubble type than Seyferts and their nuclear continua are usually dominated by old stars (Heckman 1980; Ho et al. 2003). We have kept Sy1 and Sy2 separate from LINERs because the nature of the central power-source in LINERs remains uncertain; they might constitute a transition class between non thermal objects and starburst (Carrillo et al. 1999) or between normal galaxies and Seyferts rather than a true low luminosity extension of the AGN sequence.

## 3. CGs with and without a Seyfert: Is there any difference?

To derive useful constraints on the role of the environment on AGN activation we investigate whether a segregation can be found between CGs hosting (Sy-CGs) or not (non-Sy-CGs) a Seyfert member. We find 17 Sy-CGs and 162 non-Sy-CGs. The 13 CGs hosting a LINER/Sy3/AGN have been excluded from our UZC-CG sub-sample.

Figure 1 shows the velocity dispersion distributions of CGs with (hatched) and without (solid line) a Seyfert member. Distributions peak below  $200 \text{ km s}^{-1}$  in both samples however, Sy-CGs are marginally more likely (at 91% confidence level according to the KS test) to display larger velocity dispersion. This could indicate that CGs hosting a Seyfert are systems more massive than those without.

Figure 2 shows the distribution of the number of large scale neighbours (number of galaxies within  $1 h^{-1} \text{ Mpc}$  radius and  $|\Delta cz| \leq 1000 \text{ km s}^{-1}$  from the CG center) for both samples. The KS-test indicates that Sy-CGs are more likely (at 98% cl)

**Table 1.** Seyferts in the UZC-CG sample.

UZC-CG	Name	V&V	NED	Morphology	<i>cz</i>	$m_B$	Lum. rank <sup>1</sup>	Inter. <sup>2</sup>	Other id.
19	NGC 449	Sy2	Sy2	S	4750	15.2	3		MKN 1
23	NGC 513	Sy2	Sy2	Sb/c	5840	13.4	1		ARK 41
30	UGC 1479	Sy2	Sy2	Sc	4927	14.8	2		
57	UGC 3752	Sy2		S?	4705	14.5	2		
109	ZW 63.06	Sy2			3988	15.5	3		
143	NGC 3798	Sy1		SB0	3563	13.9	1		
144	NGC 3822	Sy2	Sy2	Sb	6138	13.7	1	Y	HCG 58a
156	NGC 4074	Sy2	Sy2	S0 pec.	6802	15.4	6		AKN 347
162	NGC 4169		Sy2	S0/a	3755	12.9	1		HCG 61a
186	IC 4218	Sy1	Sy1	Sa	5808	14.4	1		
200	ZW 45.099	Sy2	Sy2		6870	15.4	2		
207	NGC 5395		Sy2	Sb	3522	12.6	4	Y	Arp 84, IZw 77
240	NGC 5985	Sy	Sy1	Sb	2547	12.0	1		
242	NGC 5990	Sy2		Sa pec.	3726	13.1	1		
272	NGC 6967	Sy2	Sy2	SB0	3768	14.3	3		
276	UGC 11950	Sy2		E	6224	14.3	1		
279	NGC 7319	Sy2	Sy2	SBpec.	6652	14.8	2	Y	HCG 92c

<sup>1</sup> Column 8 indicates the luminosity rank of the Sy galaxy within its group.

<sup>2</sup> Column 9 indicates the presence of major morphological-peculiarities/interaction-patterns visible on POSS plates.

**Table 2.** LINERs in the UGC-CG sample.

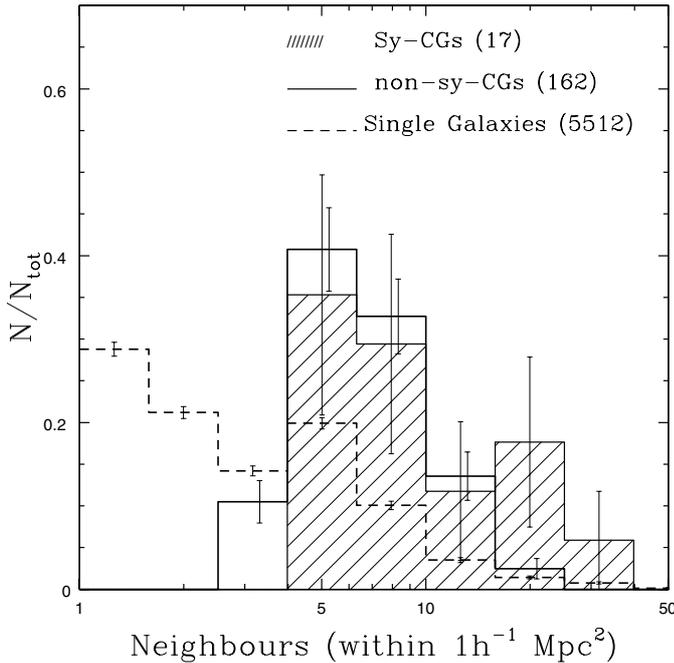
UZC-CG	Name	V&V	NED/Carrillo	Morphology	<i>cz</i>	$m_B$	Lum. rank	Inter	Other id.
4	NGC 51		L	S0 pec.	5342	14.6	1		
14	NGC 315	Sy3	L	E	4956	12.5	1		
16	NGC 410		L	E	5294	12.6	1		
25	NGC 536		AGN	SB	5251	13.2	2		HCG 10a
100	NGC 2911	Sy3	Sy	S	3217	13.6	1	Y	ARP 232
162	NGC 4175		AGN	Sbc	4019	14.2	2	Y	HCG 61c, KTG 42
169	NGC 4410	Sy3	L	Sab	7601	13.6	1	Y	MKN 1325
203	NGC 5318		AGN	S0?	4329	13.5	1	Y	
234	NGC 5851	Sy3	L	S?	6470	14.9	2	Y	
240	NGC 5982		L	E	2918	12.4	2		
252	NGC 6286		L	Sbpec.	5551	14.2	1	Y	Arp 293
	NGC 6285		L	S0	5691	14.6	2		
257	NGC 6482		L	E	3913	12.8	1		
259	NGC 6500	Sy3	L	Sab	2986	13.4	1		
284	NGC 7549		AGN	SBcd	4716	14.1	2	Y	HCG 93b, Arp 99
	NGC 7550		AGN	S0	5072	13.9	1		HCG 93a
290	NGC 7769		L	Sb	4197	12.9	1		

than non-Sy-CGs to be associated with a large number of companions i.e. they reside in a denser large-scale environment. Also shown in Fig. 2 is the large-scale neighbour distribution of UZC-single-galaxies (i.e. galaxies with no neighbour within  $200 h^{-1}$  kpc, see also Sect. 5), indicating that CGs (either with or without a Seyfert member) are embedded in systems denser than the environment of galaxies presenting no close neighbour.

Figure 3 shows the morphological distribution of galaxies in Sy-CGs (squares) and non-Sy-CGs (triangles). The differences are not significant, yet Fig. 3 suggests that Sy-CGs might

include a population rich in ellipticals and deficient in late spirals. Among Seyferts themselves, only one is an elliptical and accordingly the data indicate that Seyferts tend to be common when the fraction of late spirals among companions is low. The result is fully consistent with a scenario predicting that Seyferts are more common in large and rich groups (Monaco et al. 1994).

If galaxies rather than CGs were to be compared, the differences in Figs. 1 and 2 would become significant at the  $3\sigma$  level. Nevertheless, all differences between the samples are induced by having included in the Sy-CG sample a few



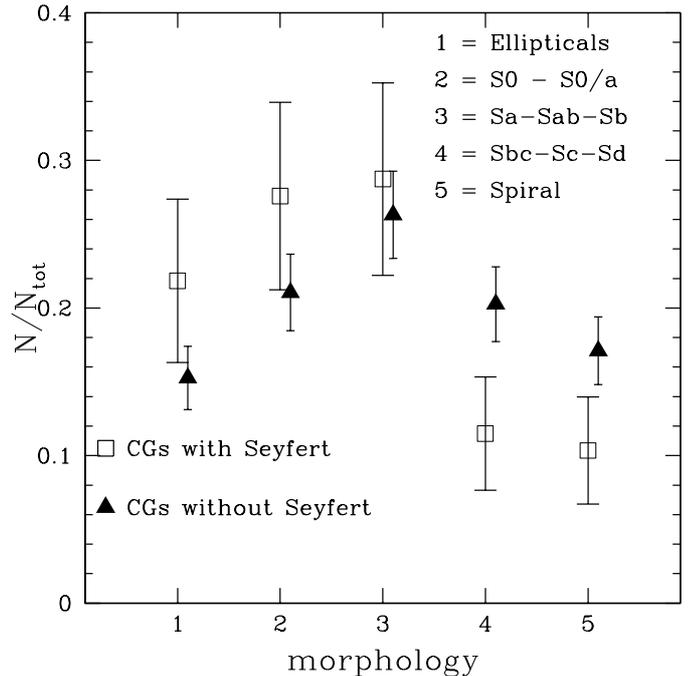
**Fig. 2.** Neighbour (within  $1 h^{-1} \text{Mpc}$ ) distributions for Sy-CGs (hatched) and non-Sy-CGs. The difference between the distributions is significant (98% cl according to the KS) indicating that Sy-CGs are more likely to be embedded in dense large scale environments. The neighbour distribution of UZC-galaxies presenting no close companion/s on the CG scale (single-galaxies) is also plotted.

early-type rich CGs which display a large velocity dispersion, a large number of neighbours and an excess of ellipticals. When the 20 CGs with the lower and the 20 CGs with the higher velocity dispersion are excluded from the UZC-CG sample the differences in  $\sigma$  and neighbour-density between both populations decrease below the 60% cl, and at the same time, halves the number of ellipticals in the Sy-CG sample. Hence, the present analysis indicates that Sy-CGs and non-Sy-CGs are not significantly different, except that 5 Sy2 are found in CGs which are unusual in terms of  $\sigma$ , neighbour and elliptical content, and closely resemble loose groups.

#### 4. Seyferts in HCGs

To check whether any differences between systems hosting or not a Seyfert member might be found in the HCG sample, we next compare the velocity dispersion and morphological content of HCGs hosting and not hosting a Seyfert. To be consistent with the selection criteria adopted for UZC-CGs, only the 31 HCGs in the radial velocity range  $2500\text{--}7500 \text{ km s}^{-1}$  are considered here. Seyferts in HCGs are identified according to the activity classification available in V&V. 7 HCGs are found to host a Seyfert: the total fraction of Seyferts in this HCG subsample is  $\sim 6\%$ .

Figures 4 and 5 show that Sy-HCGs and non-Sy-HCGs display similar velocity dispersions as well as similar morphological compositions, although there might be a tendency towards Seyferts preferring low- $\sigma$ , spiral-rich HCG hosts. This confirms that, in general, the presence of a Seyfert is not linked to specific CG properties. We stress that the HCG sample lacks

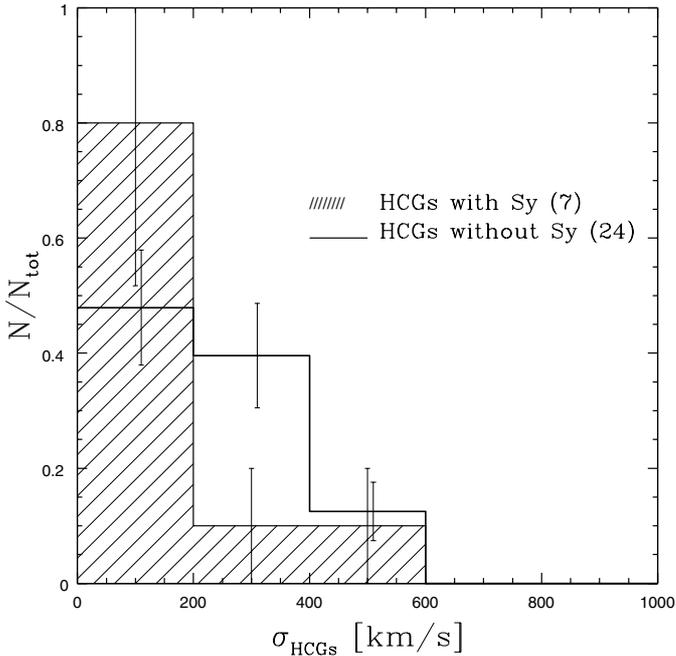


**Fig. 3.** Morphological distributions of galaxies in Sy-CGs (squares) and non-Sy-CGs (triangles). Distributions are not significantly different, however a trend possibly emerges indicating that late spirals are lacking in Sy-CGs.

the extreme CG population (high velocity dispersion, many neighbours and a significant early-type galaxy content) present in UZC-CGs, which we have shown to be responsible for the difference between Sy-CGs and non-Sy-CGs samples.

The fraction of Seyferts in the  $2500\text{--}7500 \text{ km s}^{-1}$  HCG sample is larger than the fraction we find in UZC-CGs. This is certainly due to the extensive spectroscopy performed on HCGs. However, HCGs are also biased towards luminous galaxies compared to UZC-CGs (Kelm & Focardi 2004) because they are selected according to a surface brightness enhancement criterion ( $\mu_G < 26$ ) which led Hickson to select less compact groups of very luminous galaxies. Nearby HCGs include many bright spirals, which are the most likely hosts of Seyferts. The fraction of Seyferts in UZC-CGs actually rises to 8% when restricting computations to the brightest spirals only.

The Seyfert fraction on the whole HCG sample (383 galaxies) drops to  $\sim 2.6\%$ , a value close to the one previously reported in Kelm et al. (1998). This fraction is much lower than fractions quoted by Coziol et al. (2000) and Shimada et al. (2000) as they have performed accurate deep spectroscopy allowing them to detect extremely faint emission lines. Even excluding LLAGNs, Coziol et al. (2000) quote (in their Table 6) a 18% AGN fraction in HCGs and a 19% AGN fraction in SCGs, but these fractions still include a large number of LINERs. Shimada et al. (2000) claim that a high AGN fraction is not typical of HCGs alone, as a similar AGN fraction is found in a comparison field sample. The analysis by Ho et al. (1997) has revealed that 43% of the objects in their complete sample (486 galaxies with  $m_B \leq 12.5$ ) could be classified as AGN. This indicates that active galaxies are common,



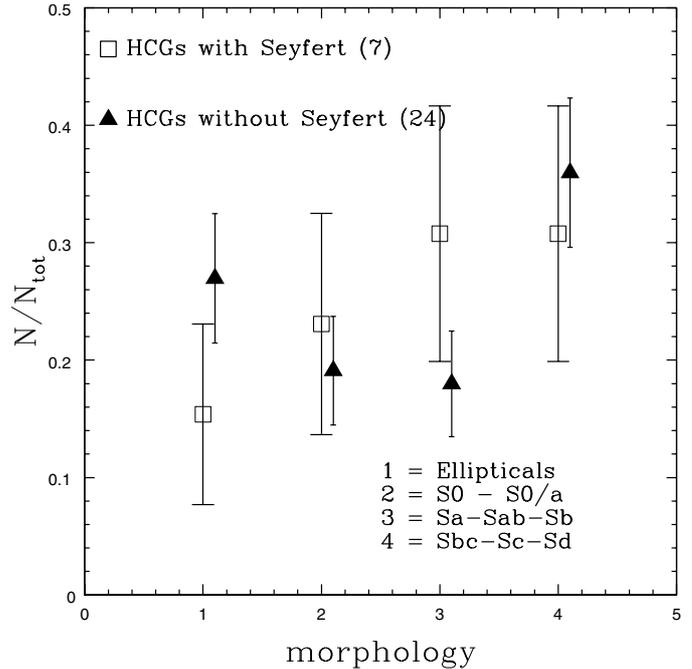
**Fig. 4.** Velocity dispersion distributions for HCGs including (hatched) and non including a Seyfert member. The difference between the distributions is only marginally significant (92% cl according to the KS test) indicating that HCGs with a Seyfert typically display a low velocity dispersion.

and indirectly disfavors any AGN fueling mechanism that is seldom observed. Likewise, it appears rather usual for LLAGNs to be associated to early-type hosts (Ho et al. 1997; Kauffmann et al. 2003) whatever the environment of the galaxy, suggesting that the association between AGNs and early-type galaxies in CGs (Coziol et al. 2000; Shimada et al. 2000) is not a specific feature of CGs.

### 5. Are CGs a preferential site for Seyfert galaxies?

In UZC-CGs 17 Seyferts are found, giving a total fraction of Seyferts over galaxies of 2.7%. For comparison Huchra & Burg (1992) find a 2% Sy fraction in the CFA1 survey, Hao & Strauss (2003) a 5% Sy fraction in the SDSS, and Ho et al. (1997) a 11% Sy fraction in a complete ( $m_B \leq 12.5$ ) RSA subsample. Maia et al. (2003) report a 3% Sy fraction in their SSRS2 sample. The Sy fraction in UZC-CGs slightly rises when computation is restricted to spiral hosts (3.3%) or to the brightest galaxy subsample (8%), indicating that Seyferts are commonly associated to bright spiral hosts. Counting also LINERS/Sy3 (see Table 2) in UZC-CGs enhances the AGN fraction to 5.5%.

To evaluate whether the fraction of Seyferts in UZC-CGs is large, we have cross-correlated the V&V and the UZC catalogue in the 2500–7500  $\text{km s}^{-1}$  radial velocity range. We find 98 galaxies out of 8488 ( $\sim 1.2\%$ ) to be Sy1 or Sy2. To further investigate whether the excess of Seyferts in the UZC-CG sample is related to their locally high density we have selected in UZC all galaxies that are single on the CG scale (i.e. no close neighbour/s within  $200 h^{-1}$  kpc and  $|\Delta cz| \leq 1000 \text{ km s}^{-1}$ ). In UZC there are 5512 single galaxies; 55 ( $\sim 1\%$ ) of these are Sy1 or Sy2 in V&V. Table 3 lists the total number and



**Fig. 5.** Morphological distributions for HCGs including (squares) and non including (triangles) a Seyfert member. Distributions are not significantly different, however a trend possibly emerges indicating that in Sy-HCGs ellipticals are underabundant while early-spirals being overabundant.

**Table 3.** Seyferts in UZC, UZC-CGs and UZC-single-galaxy samples.

Sample	$N_{\text{tot}}$	$N_{\text{Sy}}$ (%)	$N_{\text{Sy1}}$	$N_{\text{Sy2}}$	Sy2:Sy1
UZC-all	8488	98 (1.2%)	33	65	2:1
UZC-CGs	639	17 (2.7%)	3	14	5:1
UZC-single	5512	55 (1.0%)	22	33	3:2

relative fraction of Seyferts in UZC, in UZC-CGs and in the UZC-single-galaxy samples. The fraction of Seyferts in UZC-CGs is clearly larger than the fraction of Seyferts found in the UZC-single-galaxy sample.

However, one should consider that in the UZC (2500–7500  $\text{km s}^{-1}$ ) sample most Seyferts (56%) are single galaxies, while only 17 (20%) are in CGs, meaning that in a generic Seyfert sample, at least half of the galaxies display no close neighbour/s. Further, because the absence of close companions seems strongly related to the number of large-scale neighbours (as shown in Fig. 2), many of the single Seyferts are expected to exhibit only few distant neighbours. Indeed, nearly half of the single Seyferts (24 in 55) have zero/one galaxy out to a  $1 h^{-1}$  Mpc distance. The preference for low-density environments displayed by Seyferts is fully consistent with the outcome from new large redshift surveys such as the 2dFGRS (Lewis et al. 2002; Balogh et al. 2003; Bower & Balogh 2003) and the SDSS (Gomez et al. 2003; Hogg et al. 2003; Kauffmann et al. 2003), all indicating that emission-line galaxies (SB+AGNs) are less frequent in dense environments, and that this does not simply correspond to a lack of emission-line galaxies in clusters.

The number of Seyfert galaxies in UZC-CGs is only 17. Although this number is larger than in the HCG subset we have to be careful in interpreting observational results based on such small number statistics. It is interesting therefore that the fractions of Seyferts in UZC-CGs and in UZC-single-galaxy systems are rather consistent with the outcome of Maia et al. (2003). The authors report a 44% isolated Seyfert fraction and a 28% triplet+group fraction in the SSRS2, though their systems are defined according to criteria different from ours.

A large number of isolated Seyferts is not compatible with strong galaxy interactions (De Robertis et al. 1998; Shlosman et al. 1990) being a common AGN-triggering mechanism. Conversely, it provides indirect support to the minor-merger-AGN-triggering scenario (Taniguchi 1999).

## 6. Sy1 and Sy2 in CGs and in the single-galaxy sample

In our UZC-CG sample we find 14 Sy2 and 3 Sy1 galaxies (see Table 3). Likewise, among the 7 Seyferts in the HCG subsample (see Sect. 4) only 1 is a Sy1. A similar paucity of type 1 Seyferts is found in the SCG sample (Coziol et al. 2000). In the UZC-CGs the Sy2:Sy1 ratio appears rather high, as values reported in the literature range from 1:1 (Huchra & Burg 1992; Rush et al. 1993) to 4:1 (Maiolino & Rieke 1995). Maia et al. (2003) find a ratio of 3:1, Hao & Strauss (2003) using data from the SDSS claim that narrow-line AGNs are in a ratio of 2:1 to broad-band AGNs.

We stress that the high ratio of Sy2:Sy1 detected in UZC-CGs is not a generic property of the UZC sample. The Sy2:Sy1 ratio in UZC (in the radial velocity range  $2500\text{--}7500\text{ km s}^{-1}$ ) is 2:1, comparable to the ratios found in other samples. In the single-galaxy sample there are 33 Sy2 and 22 Sy1, strongly suggesting that the Sy2:Sy1 ratio is not only a function of luminosity (Hao & Strauss 2003) but also of environment, the two parameters possibly being related (Schmitt 2001).

The excess of Seyferts in CGs discussed in the previous section turns out therefore to be an excess of Sy2 only. In general, a dense environment is not typical of Seyferts; while Sy1s avoid dense systems,  $\sim 25\%$  Sy2 are in CGs. A similar conclusion was reached by Laurikainen & Salo (1995) and it is not clear whether this is responsible for the excess of companions generally associated with Sy2 and not with Sy1 (Dultzin-Hacyan et al. 1999) or whether it might be linked to the idea that two different Sy2 populations exist (Storchi-Bergmann et al. 2001; Krongold et al. 2002). The asymmetry between Sy1 and Sy2 in CGs does not rule out the unified AGN model (Antonucci & Miller 1985; Antonucci 1993), which claims the Sy1-Sy2 dichotomy to be solely due to the viewing angle. It has been suggested that differences in the covering factor of the dusty material arise as a consequence of differences in the star-formation history of galaxies (Malkan et al. 1998; Oliva et al. 1999; Mouri & Taniguchi 2002). If this is the case, the excess of Seyfert 2s in dense galaxy systems simply relates to an excess of circumnuclear starbursts in CG galaxies. Spatially resolved optical spectra of Seyferts in

UZC-CGs could confirm whether CG-Sy2 do indeed present a circumnuclear starburst.

## 7. LINERs in CGs

In the UZC-CGs there are 17 galaxies (in 15 CGs) classified as LINERs/Sy3/AGN (Table 2). LINERs typically have lower nuclear luminosities than Seyferts (Heckman 1980; Kauffmann et al. 2003), and it appears that the stellar populations in the nuclei of weak AGN are older than in Sy2 (Cid et al. 2001; Jouguet et al. 2001; Ho et al. 2003). Schmitt (2001) claims the percentage of galaxies with nearby companions to be higher among LINERs than among Seyfert galaxies, with differences however disappearing when only equal-morphology galaxies are compared.

If we group together CGs including LINERs and Seyferts (30 CGs) in the comparison performed in Sect. 3, the differences between CGs hosting and not hosting an active galaxy become more significant (96% cl when comparing  $\sigma$  and 98% cl when comparing the neighbour density), suggesting that LINERs tend to be found in richer and more massive groups. This corresponds to LINERs being more likely associated with early-type galaxies, along with the tendency for all luminous galaxies to display some emission line when deep spectroscopy is achieved.

There are many studies in the literature that indicate a positive correlation between AGN power and host galaxy luminosity; more powerful AGNs are located preferentially in more massive host galaxies. The brightest galaxies in UZC-CGs could therefore be expected to be more likely to host a Seyfert/LINER. However, when considering the luminosity rank (Col. 8) of Seyferts it emerges that only 8 are first ranked. Sy1 are always first ranked galaxies, but the statistics are clearly insufficient to claim the result to be significant. LINERs in UZC-CGs appear more likely to be first ranked galaxies (11 in 15 CGs) than Sy2 (5 in 11). It remains then to be clarified if the difference in luminosity rank between Sy1, Sy2 and LINERs is simply a consequence of the luminosity/morphology segregation or whether and to which level the environment might have played a role in causing the segregation.

## 8. Interaction patterns in CGs

It has often been speculated that star-formation and AGNs are both triggered by close companions. Recent results (Lewis et al. 2002; Gomez et al. 2003; Hogg et al. 2003) do however suggest that a locally dense environment seems to suppress processes responsible for emission-line spectra, and that this holds true also in the field. It appears that a companion efficiently triggers SB-AGN phenomena in a galaxy only in a low density environment, i.e. in an isolated pair (Lambas et al. 2003; Tanvuia et al. 2003; Sorrentino et al. 2003; Bergvall et al. 2003). This possibly explains why ULIRGs, which are nearly all ongoing mergers between spirals, are typical field systems rather than CG members. It is still unclear whether a dominant AGN is needed at all to fuel these sources or whether they

will ever go through an optical QSO phase (Genzel et al. 2001; Tacconi et al. 2002; Farrah et al. 2003; Ptak et al. 2003).

Consequently, one might expect two concurrent mechanism to operate in CGs, both caused by companions; one triggering the AGN fueling process, the other suppressing it. Our data suggest that Sy1-triggering mechanism are generally suppressed in CGs, while those triggering Sy2 are activated.

To investigate whether galaxy-galaxy interaction is responsible for the excess of Sy2 in CGs, we have inspected DSS images searching for major optical interaction patterns in UZC-CGs. We find no Sy1, 3 Sy2 and 7 LINERs that display major interaction patterns. The fraction of Sy-CGs with a disturbed Seyfert turns out to be 18%, those with a disturbed LINER nearly 50%, but the samples are presently too small to assess any difference to be significant.

The fraction of non-Sy-CGs hosting a disturbed/interacting galaxy is (51/162) 32%, and a similar value is found for non-Sy-HCGs. Hence, it appears that CG presenting obvious interaction patterns are not more likely to host a Seyfert galaxy. This is consistent with the results of earlier works (Moles et al. 1995; Keel et al. 1996; Ho et al. 1997) all finding no clear relationship between the presence of nuclear activity and detailed morphological properties.

Recent studies of large samples of Seyfert galaxies have shown that Sy and non-Sy are equally likely to present a bar (Mulchaey & Reagan 1997; Peletier et al. 1999; Knapen et al. 2000; Combes 2003). Among Seyferts in UZC-CGs only 2 (12%) present a bar. The fraction of galaxies with a bar in Sy-CGs and non Sy-CGs is 26% and 18% respectively, indicating that CGs with and without a Seyfert are equally likely to induce bars in their member galaxies.

Because no evidence is found for Sy-CGs to present higher level of galaxy-galaxy interaction, any triggering mechanism responsible for the excess of Sy2 observed in CGs does not seem to arise because of the strong interaction between two galaxies. In general it is difficult, however, to find firm observational evidence for dwarf companions because their dynamical disturbance is weak.

## 9. Conclusions

We have investigated the occurrence of Seyfert galaxies in a nearby sample of 192 UZC-CGs. We find 17 Seyferts among the 639 member galaxies, indicating that only a minor fraction (~3%) of UZC-CG galaxies host a Seyfert.

When comparing velocity dispersion, number of large scale neighbours and morphological content of Sy-CGs and non-Sy-CGs, no significant differences are found, although some Seyferts (5 Sy2) appear associated with “extreme” CGs, presenting large  $\sigma$  ( $>400 \text{ km s}^{-1}$ ), many neighbours and an unusually high number of Elliptical members.

This suggests that Sy-CGs and non-Sy-CGs are drawn from the same parent population, and that the presence of the Seyfert is not linked to specific CG properties.

We also find the fraction of Sy in CGs (3%) to be significantly higher than the fraction of Sy in a single-galaxy sample (1%). Curiously, the enhanced fraction of Seyferts in CGs reflects the behaviour of Sy2 alone: while 14 Sy2

and 3 Sy1 (5:1) are found in UZC-CGs (the ratio is 6:1 in HCGs), in the single-galaxy sample there are 33 Sy2 and 22 Sy1 (3:2), suggesting that the location within a group potential and the triggering of type 2 Seyferts are related.

No excess of interacting galaxies or barred galaxies is found among Sy-CGs, indicating that strong galaxy-galaxy interaction is not a common Seyfert fueling mechanism (De Robertis et al. 1998; Shlosman et al. 1990) in CGs. But any minor merging (between a galaxy and a satellite/dwarf companion) fueling mechanism (Taniguchi 1999) is not ruled out. The large number of isolated Seyferts we find in our analysis, indirectly supports the minor-merging mechanism.

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