Relationship between AGNs and Environment. AGN Population in Compact Groups

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Introduction

- From the optical spectra of AGN we distinguish: those that show broad emission lines (BLAGNs) and those that show only narrow emission lines (NLAGNs).
- Within the unification model (Antonucci 1993) that assumes all AGNs to be intrinsically the same, the Broad Line Region (BLR) in NLAGNs is hidden behind and optically thick torus of gas and dust.
- Not all NLAGN observed through polarized spectroscopy have shown such structures (Tran 2001,2003;Laor 2003)
- One possible way to solve this dilema is to explore the connection between AGN activity and environment because according to the unification model, one does not expect to find different AGNs in different environments.
- We have carried out a survey to determine the frequency and the nature of the nuclear activity in two samples of Compact Groups:
  - UZC-CG Catalogue (Focardi & Kelm, 2002)
  - HCG Catalogue (Hickson, 1982)

Samples:HCGs

- 100 groups selected from POSS-I ($n \geq 4$, $\theta_n \geq 3\theta_G$, $\mu_G < 26$ mag/arcsec^2)
- 92 groups with 3-8 members with concordant redshift:
- Triplets represent 20% of the groups
- Applying two selection criteria to the HCG Catalogue:
  - Group compactness: $\mu_G \leq 24.4$ mag/arcsec^2
  - Redshift completeness: $z<0.045$
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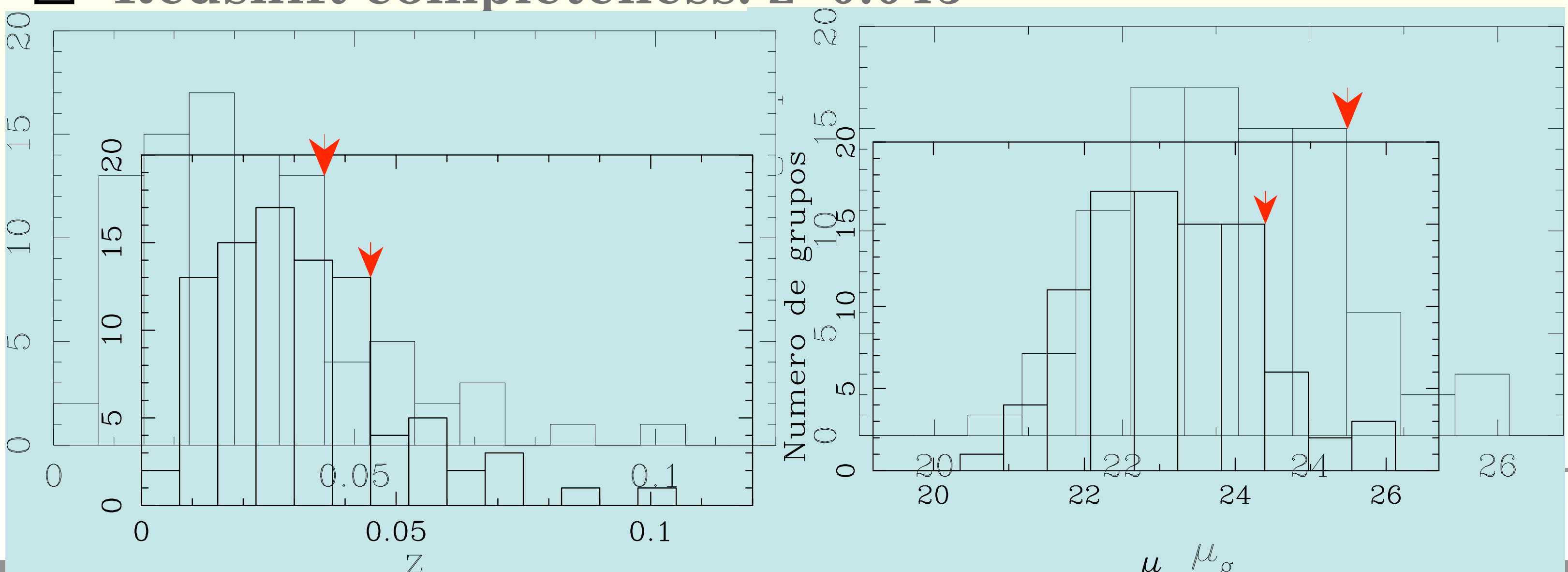


Samples:HCGs

- New spectroscopic observations for 200 galaxies, some of them observed in more than one telescope:
  - 2.2m in CAHA (Almería, Spain): 96
  - 1.5 m in OSN (Granada, Spain): 68
  - 2.5 m (NOT) in ORM (La Palma, Spain): 56
  - 2.12 m in SPM (Baja California, Mexico): 55
- Archive Spectra: 5 from ESO, 6 from 6dF.
- Literature: line ratio for 59 galaxies more (Kim et al.1995; Aoki et al.1996; de Carvalho et al. 1997; Verdes-Montenegro et al. 1997; Coziol et al.1998, 2000, 2004)
- Spectroscopic information for 270 galaxies (63% show emission lines)

Samples:UZC-CG

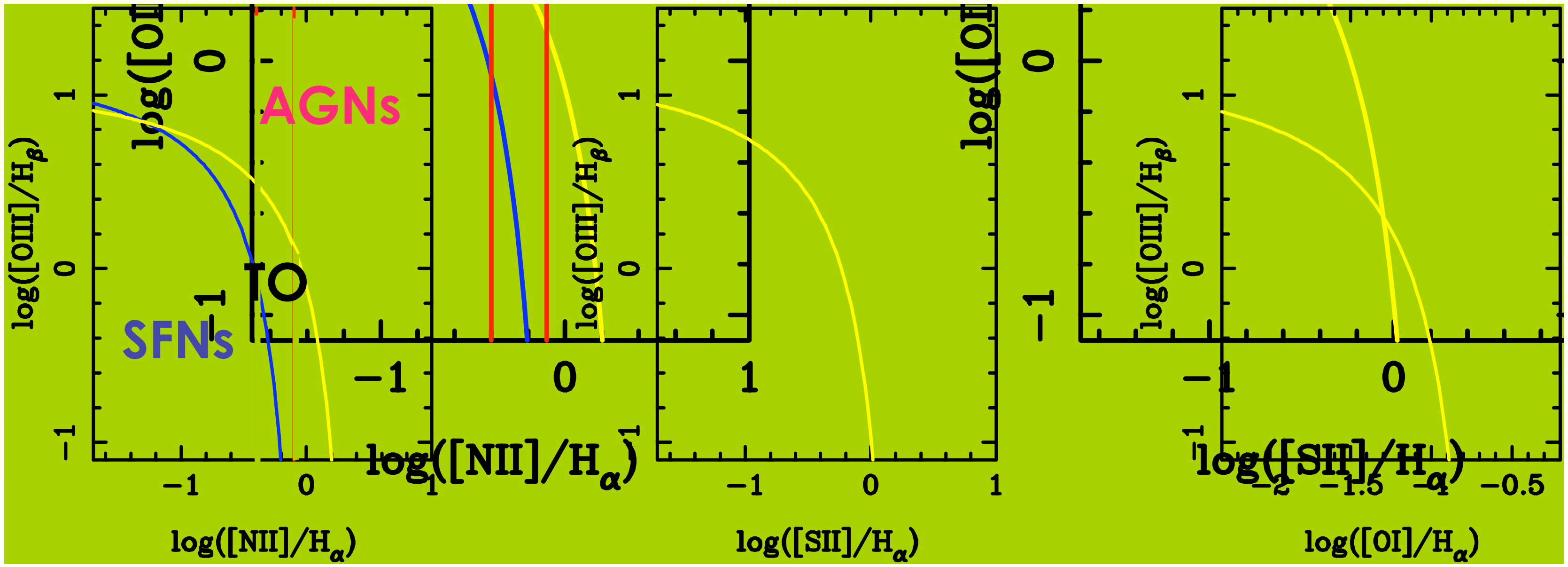
- Selected by Focardi and Kelm (2002) applying an automatic neighbor search algorithm to the 3-D UZC catalogue (Falco et al. 1999). Galaxies $m_B \leq 15.5$
- 291 compact groups with 986 galaxies
- Minimum of 3 members within a region of 200 h^{-1} kpc and $\Delta v = \pm 1000$ km/s
- Triplets constitute 76% of the sample
- Three Database Archives:
  - Z-Machine. 3.2arcsec fiber spectra with 4.8Å/px, 4300-6900Å
  - Fast Spectrograph. Long slit, width 3” and resolution 6Å, 4000-7000Å
  - SDSS-DR4. 3arcsec fiber spectra. 3800-9000Å

Samples: UZC-CG

- Spectra for all the member galaxies in 215 groups
- 481 emission galaxies (67% sample)
- Emission line detection depends on spectra quality.
- Z-Machine: 58% emission galaxies (376/652)
- SDSS-DR4 and FAST similar emission line detection
- Taking common spectra: 131 Z-Machine/SDSS-DR4 and 80 Z-Machine /Fast
  - - Sloan and Fast detect 20% more emission lines than Z-Mach
  - - 90% of them host an AGN → Fraction of emission galaxies, AGN in particular, is a lower limit estimation
- To carry out this study we take only into account SDSS and FAST spectra. That means 397 galaxies for which 274 (69%) show emission lines.

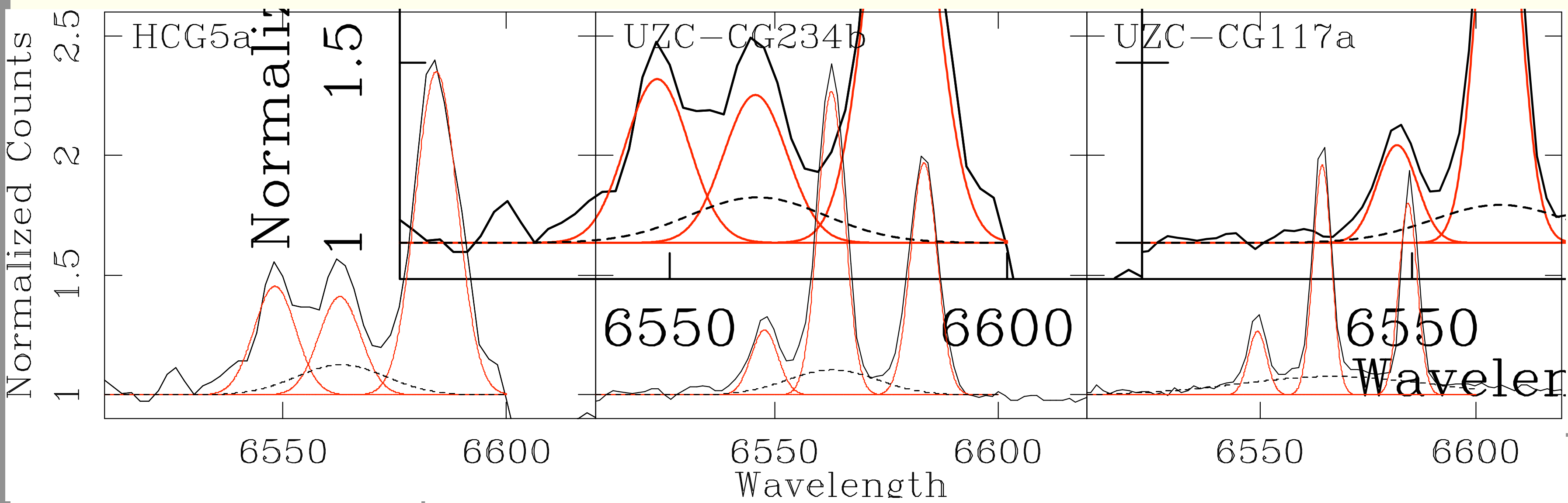
Classification Criteria

- Using diagnostic diagrams we classified narrow emission line spectra:
  - SFN below Kauffmann et al (2003) sequence
  - AGNs above Kewley et al.(2001) sequence
  - TO between the two lines



The broad component

- The identification of the broad component was done by fitting a multicomponent Gaussian on the emission lines using the IRAF task NGAUSSFIT.
- The FWHM of [SII] has been used to model the narrow component of the Ha and [NII] lines.
- When a broad fourth component was necessary, it was centered on Ha.



Name	Origin	Type	FWHM(Hα)	FWHM(Hβ)
H5a	CAHA	1.9	1056	
H91a	6dF	1.2	3271	3516
U84c	SDSS	1.9	2727	
U89b	SDSS	1.9	2159	
U109b	SDSS	1.8	1902	1499
U117a	SDSS	1.9	2351	
U132b	FAST	1.9	3055	
U139b	SDSS	1.9	1941	
U232c	SDSS	1.8	2258	1689
U234b	FAST	1.9	1328	

AGN population in CGs

- HCGs:
  - No emission (NoE): 101 (37%)
  - Emission lines galaxies : 169 (63%)
    - 76 AGNs (45%) : 2BLAGNs +74NLAGNs
    - 39 TOs (23%)
    - 54 SFNs (32%)
- UZC-CGs:
  - No emission (NoE): 123 (31%)
  - Emission lines galaxies : 274 (69%)
    - 141 AGNs (52%) : 8BLAGNs+133NLAGNs
    - 50 TOs (18%)
    - 83 SFNs (30%)

23% of AGNs in isolated galaxies (Sabater talk)

Comparing with the field

Sample	Total	SFN	TO	Sy2	LINER	LLAGN	BLAGN	BLAGN/ NLAGN (%)	Sy1/Sy2 (%)
HCG	169	54	39	24	35	15	2	2.7	8.3
UZC-CG	274	83	50	43	11	79	8	6.0	18.6
HFS97	353	124	75	46	80		28	22	61
H05	42435	8700	7626	2424	650		1317	43	54
SRR06	57952	6061		1104			725	-	66

HFS97: Ho, Filippenko & Sargent (1997)
H05: Hao et al.(2005)
SRR06:Sorrentino, Radovich & Rifatto (2006)

BLAGN ratio is extremely low in CGs comparing with other environments.

Biases and Detection Limits

- We verify that the lack of BLAGNs in CGs cannot be induced by differences in observation, reduction or analysis method.
- UZC-CG and H05 data comes from the same source. If we consider only SDSS spectra in the UZC-CG we obtain a BLAGN/NLAGN=8% which is far from 43% in H05.
- Spectral resolution can be excluded using HFS97 and their tests with low resolution set-ups (5Å and 10) Å similar to our own observations (CAHA & OSN 4Å, NOT & SPM 8Å).
- S/N continuum levels of differents surveys are comparable S/N~60.

Biases and Detection Limits

- No evidence for higher galaxy contaminati… HFS97 with lower (0.5kpc) and H05 with higher … contamination show similar results. T… subtraction alleviates the diference…

Sample		E-S0			S0a-Sbc		Sc-Irr
	fE	BLAGN/ NLAGN	Sy1/Sy2	fSe	BLAGN/ NLAGN	Sy1/Sy2	fL
HCG	53			32	6	18	15
UZC-CG	36	2	8	55	9	25	9
HFS97	27	25	86	40	19	33	36

- We have … etecction limits and sensitivity than HF…

There exist no … differences in reductio… …nd

The Disappearance of BLRs in CGs

- In the unification model a torus of mater is assumed to be responsible for hiding the Broad Line Region.
- The amount of gas that has reached the center was consumed into stars, building larger bulges (de Carvalho & Coziol 1999).
- The fact that the average luminosity of the AGNs in CGs is low is another argument in favor of the dissolution hypothesis for the BLR.
- According to Nicastro(2000) and Nicastro et al.(2003) low accretion rates rather than smaller mass black holes are responsible in explaining the absence of BLRs in LLAGNs which is fully compatible with our observations.

The Disappearance of BLRs in CGs

- Bian & Gu (2007) found that AGNs without BLR present Lbol/Ledd lower than 0.043. All HCG AGN and all but two UZC-CG AGNs with galaxy velocity dispersion available are bellow this limit where no hidden BLR have been found.
- Using Zhang et al.(2007) we can calculate the BLR radio for LLAGNs and consequently the corresponding FWHM of the broad component in Hα. We obtain 1114 to 2818km/s in HCGs and 1280 to 2704km/s for UZC-CGs which would be detect.
- According to Kaspi et al.(2005) the size of the BLR is also correlated to the optical luminosity. We are in the lower luminosity part of the Perterson et al.(2004) where few objects with broad lines have been observed.

Conclusions

- Based on the above statistic, we confirm that there is a remarkable deficiency of BLAGNs as compared to NLAGNs in CGs.
- Broad Line Regions in CG AGNs can be directly affected by tidal or group interaction effects, which make them shrink below detection or disappear.
- In CGs environment, galaxies are undergoing morphological transformations due to tidal interactions and mergers.
- Combined effects of these two mechanism can induce an important decrease in the amount of gas that can reach the nucleus to form a BLR in AGNs.

Thank you!

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