Nuclear activity in Compact Groups Galaxies

M. Angeles Martínez (IAA)
Instituto de Astrofísica de Andalucía-CSIC
Granada-Spain
A. del Olmo (IAA), R. Coziol (Univ.Guanajuato,Mexico),
P. Focardi (Univ. Bologna,Italy) and J. Perea (IAA)

Overview

- Introduction
- Thesis project
- Hickson Compact Groups
  - Observations
  - Reduction procedures
- UZC-CG Sample
  - Archive data
  - Complete sample
- Analysis and results

Introduction

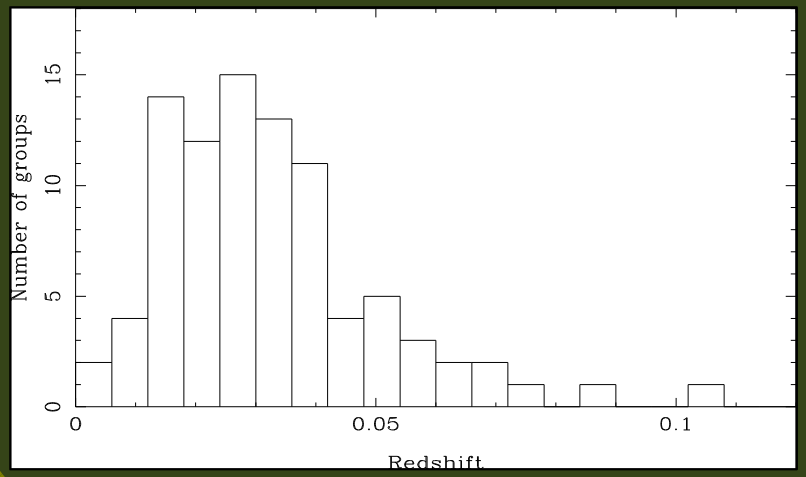
- The environment plays an important role on galaxy formation and evolution. Tidal torques: the mechanism to transport material to the centre
- Compact Groups:
  - Distance comparable to sizes
  - Continuous galaxy-galaxy interaction and merging
- Ideal place to study the effects of gravitational interaction and
- Hickson Compact Groups:
  - 92 groups
  - Medium resolution spectroscopy
- UZC-CG catalogue:
  - 291 groups with 986 galaxies
  - Data Archive

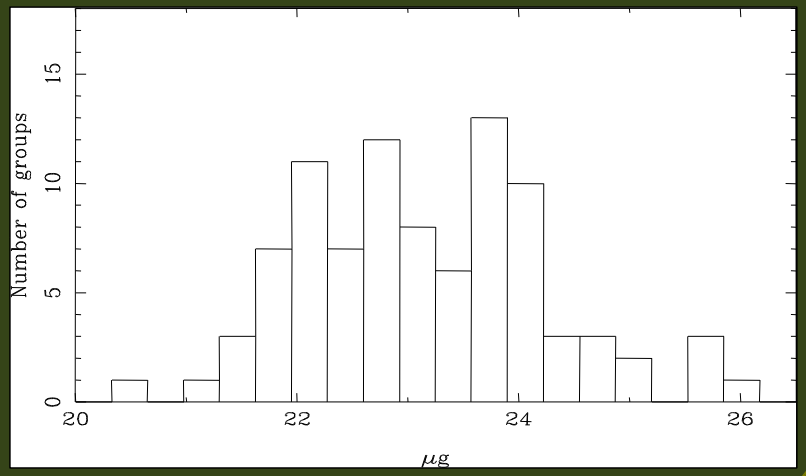
Project

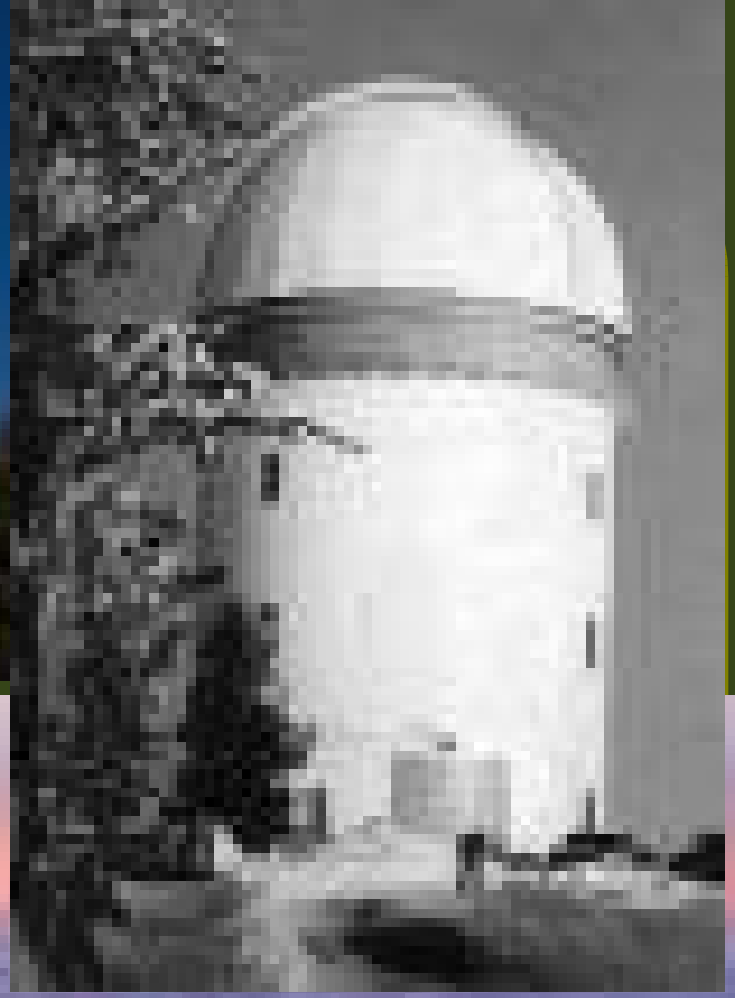
- Measure nuclear activity in galaxies belonging to compact groups
- Characterize this activity as a function of the properties of the host galaxies and parent group.
- Well-defined statistically complete sample
  HCG Catalogue (Hickson, 1982)
  UZC-CG Catalogue (Focardi & Kelm, 2002)
- Medium resolution spectroscopy
- Templates subtraction

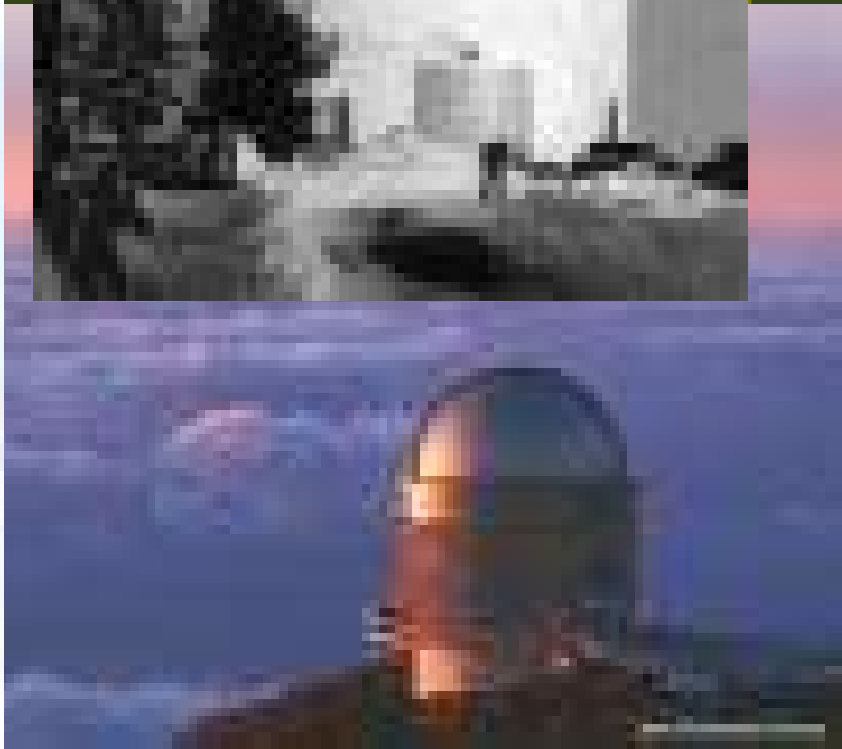
HCG sample

- Collaboration: A. Del Olmo, R. Coziol and J. Perea.
- Applying two selection criteria to the HCG Catalogue:
  - Group compactness: $\mu_G \leq 24.4$ mag/arcsec^2
  - Redshift completeness: $z \leq 0.045$
- We obtain a well-defined statistically complete sample of 65 groups with 283 galaxies.









We have obtain medium resolution spectroscopy in the range from 3600Å to 7200Å for 67% of the galaxies

TABLE2: TELESCOPES

Observatory	Telescope	Instrument	Grism	Espectral range	Dispersion
Calar Alto(CAHA)	2.2m	CAFOS	B100	3200Å-5800Å	2 Å/px
			G100	4900Å-7800Å	2.12Å/px
			B200	3200Å-7000Å	4.58Å/px
Sierra Nevada(OSN)	1.5m	ALBIREO	Red4	3600Å-7500Å	2Å/px
La Palma(RM)	2.5m	ALFOSC	GR4	3200Å-9100Å	3 Å/px
			GR8	5825Å-8350Å	1.24Å/px
San Pedro Martir(SPM)	2.1m	Boller-Chivens	R300	3800Å-7500Å	4.3Å/px

TABLE 3:CCD DETECTORS

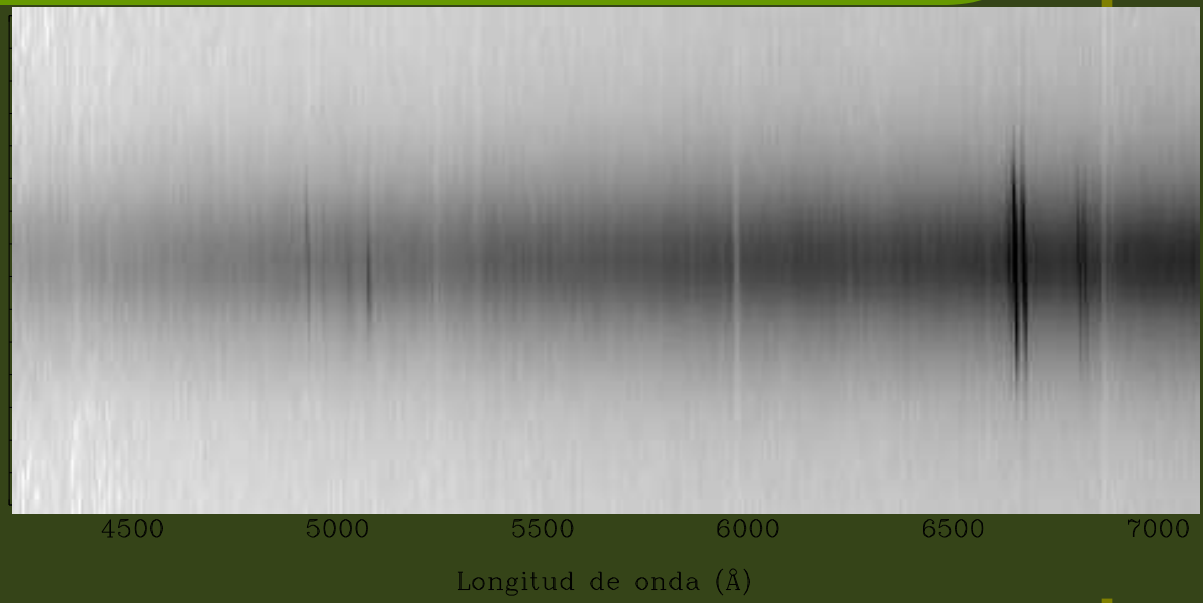
Observatory	Detector	Size	Dimensions	Scale
Calar Alto	SITE	24 μ_m/px	2048x2048	0.53arcsec/px
Sierra Nevada	Loral/Lesser	15 μ_m/px	2048x2048	0.9arcsec/px
La Palma	Loral/Lesser	15 μ_m/px	2048x2048	0.19arcsec/px
San Pedro Martir	SITE	24 μ_m/px	1024x1024	1.05arcsec/px

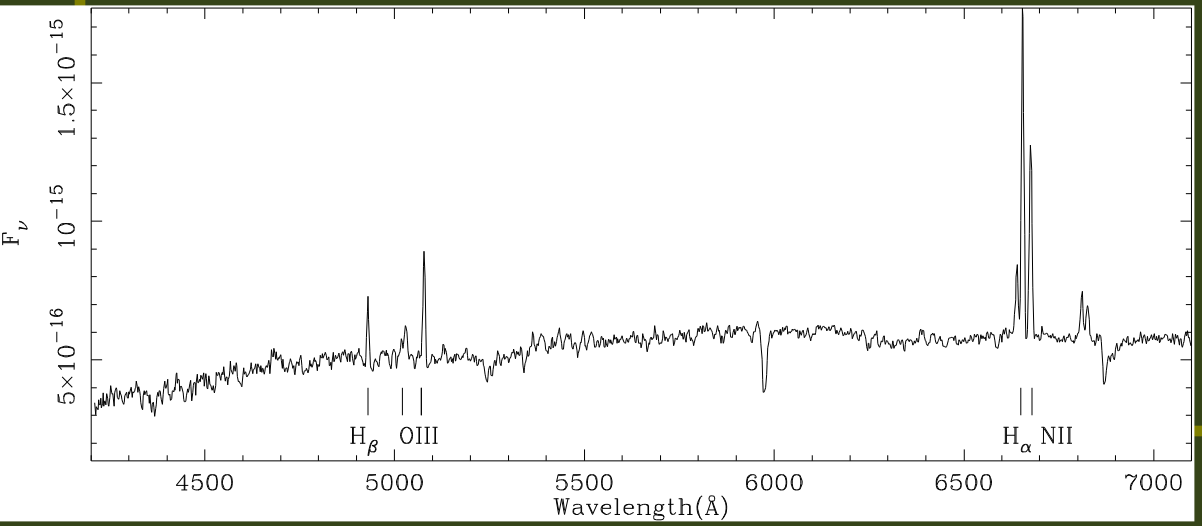
Observations

- We have observations for 191 galaxies, lots of them have been observed in more than one telescope:
  - CAHA:96
  - NOT: 58
  - SPM: 56
  - OSN: 39
- We take spectral data for 71 galaxies from the work of Coziol et al. 1998,2000 and 2004.
- We have found spectra for 4 galaxies more in 6df and ESO Archive.
- That makes 94% of the sample.

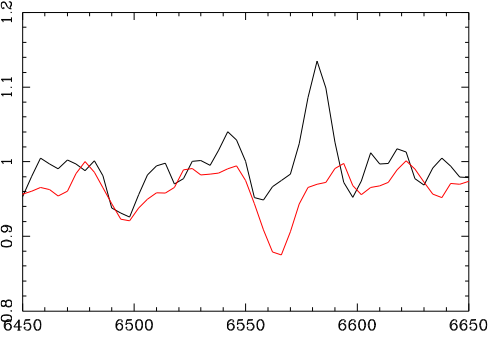
Reduced data

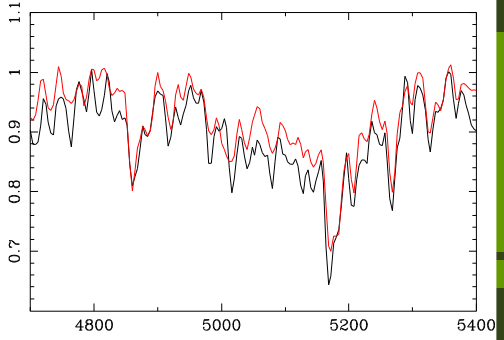
- Bidimensional spectra:
  - Emissions
  - Extension and location
  - Rotation Curves



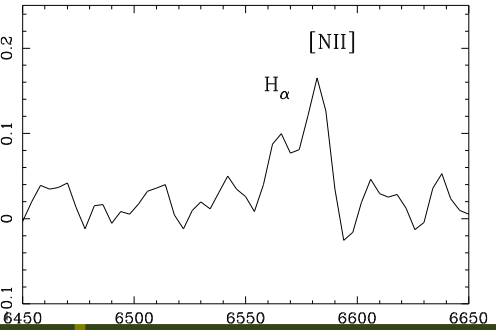


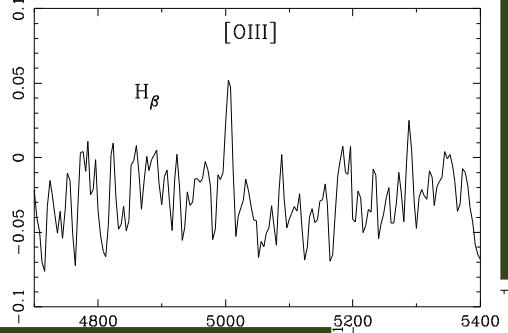
Unidimensional spectra:
- Emission and Absorption
- Flux estimations.
- Line ratios





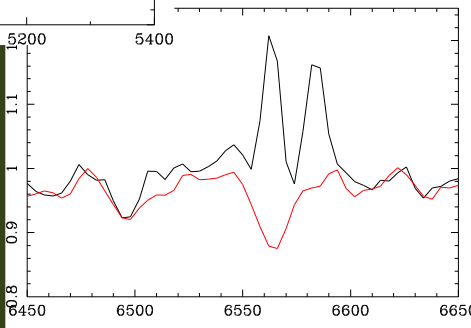
H99c

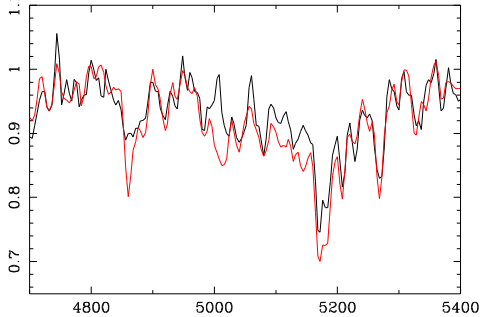




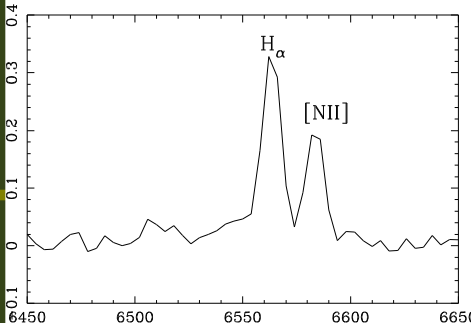
Subtraction of the stellar component using non emission line galaxies as templates

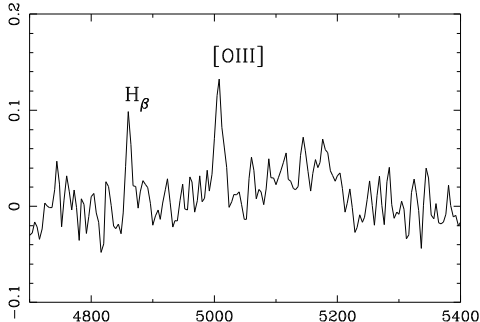
All AGNs continue to be classified as AGN and we found two new emission line galaxies in the SPM spectra.





H97b





Diagnostic Diagrams

NII-Diagram (log([OIII]/Hβ) vs log([NII]/Hα)

SII-Diagram (log([OIII]/Hβ) vs log([SII]/Hα)

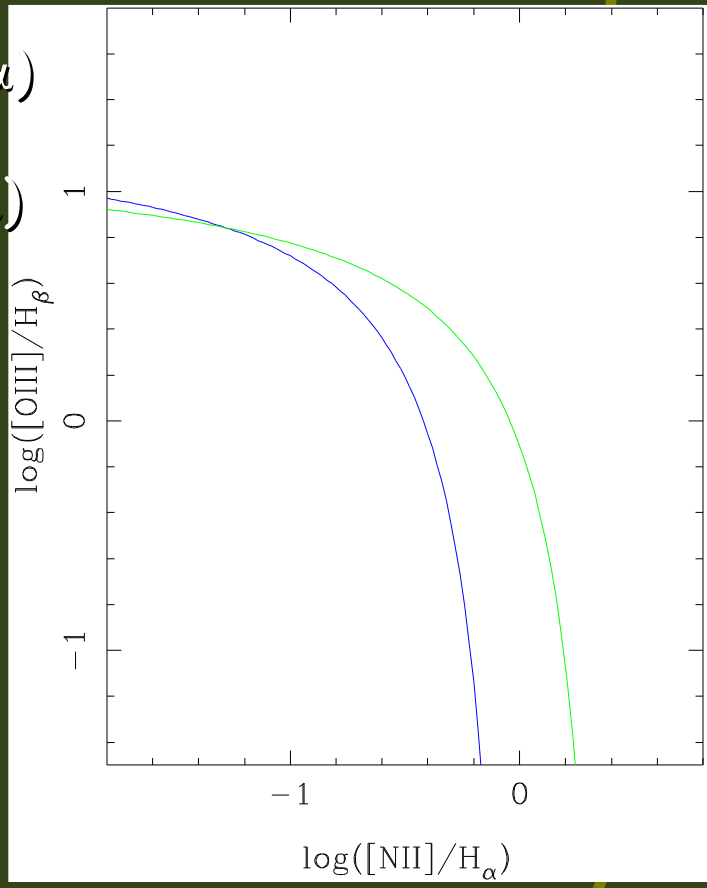
Kauffman et al. 2003 (Ka03):

log([OIII]/Hβ)=(0.61/(log([NII]/Hα)-0.05))+1.3

Kewley et al. 2001 (Ke01):

log([OIII]/Hβ)=(0.61/(log([NII]/Hα)-0.47)) +1.1
log([OIII]/Hβ)=(0.72/(log([SII]/Hα)-.32))+ 1.30

Kewley et al. 2006, Stasińska et al. 2006

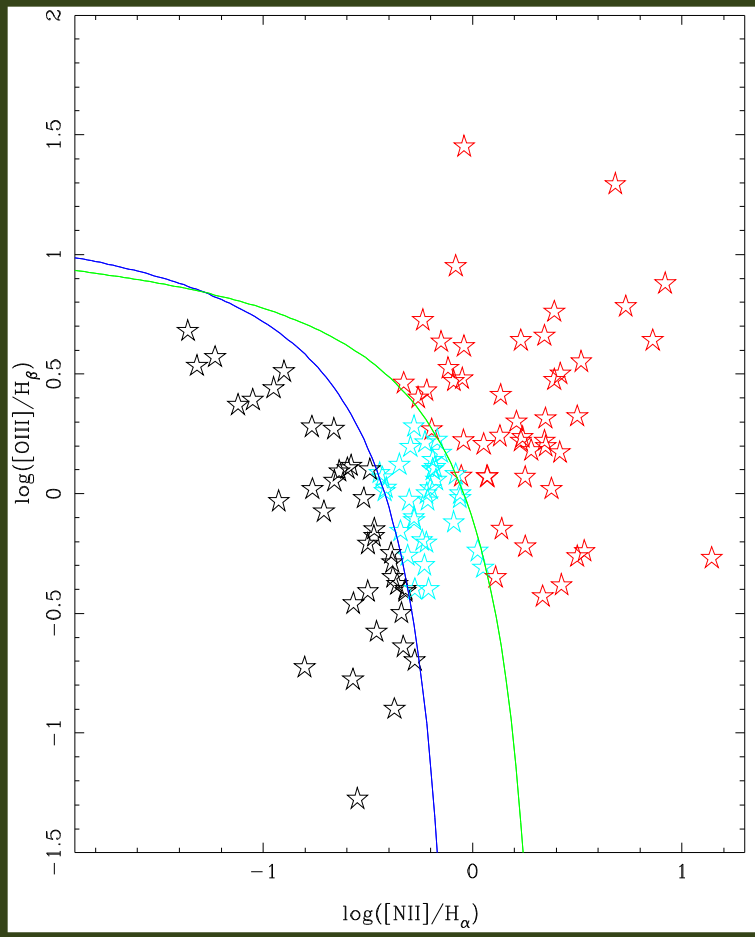


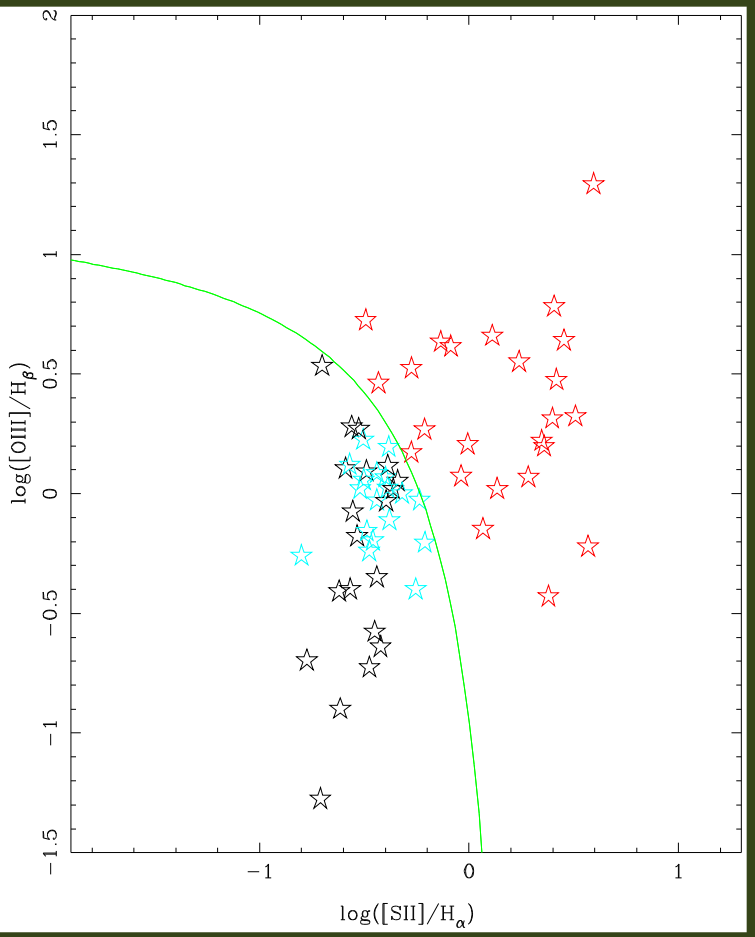
For galaxies where use of diagram it is possible:

HII: bellow Ka03

AGN : above Ke01

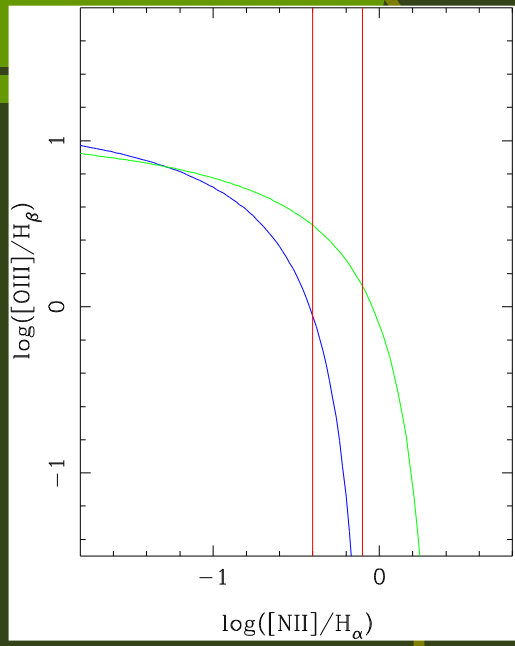
TO : between Ke01 and Ka03.





- Galaxies with at least the log([NII]/Hα) ratio:
  - HII: log([NII]/Hα)≤ -0.4
  - AGN: log([NII]/Hα)> -0.1
  - TO: log([NII]/Hα) Є (-0.4,-0.1]

- Galaxies with only [NII] emission line LLAGNs (Coziol et al. 2000)



From the 164 reduced galaxies:
No emission (NoE): 59 (36%)
- Emission lines galaxies:
  - 60 AGNs (57%)
  - 18 TO (17%)
  - 27 HII (26%)

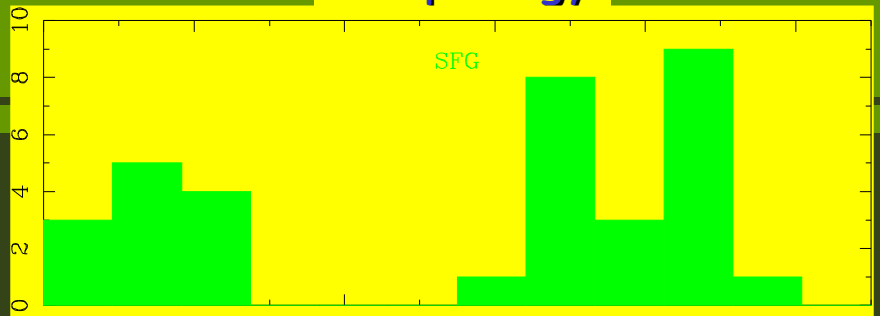
Adding 74 from the literature:
No emission (NoE): 82 (35%)
- Emission lines galaxies: 156
  - 76 AGNs (49%)
  - 37 TO (24%)
  - 43 HII (27%)

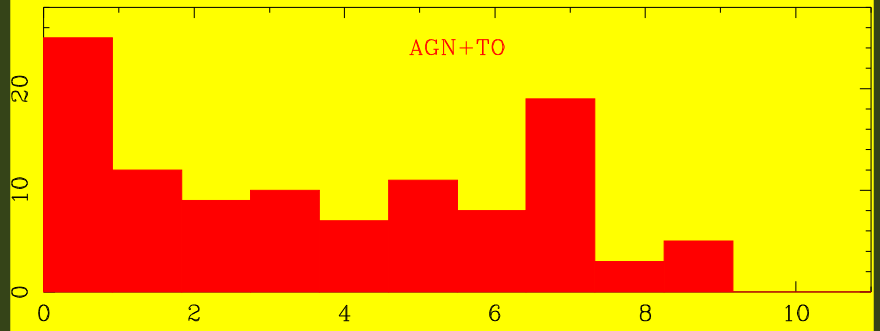
Activity and Host Galaxy

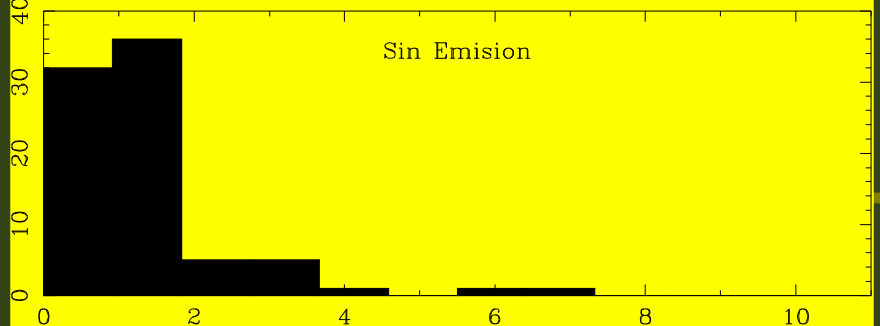
- Early-type galaxies are dominated by Non emission galaxies and AGN nuclei.
- We found emission line in all late-spiral and HII is the most common activity
- In early-spirals predominate AGNs.

	NoE	AGNs	TO	HII
131 Early: E-SO	57%	28%	8%	7%
73 Early-Spiral:Sa-Sbc	11%	45%	25%	19%
34 Late-Spiral: ≥Sc	0%	20%	18%	62%

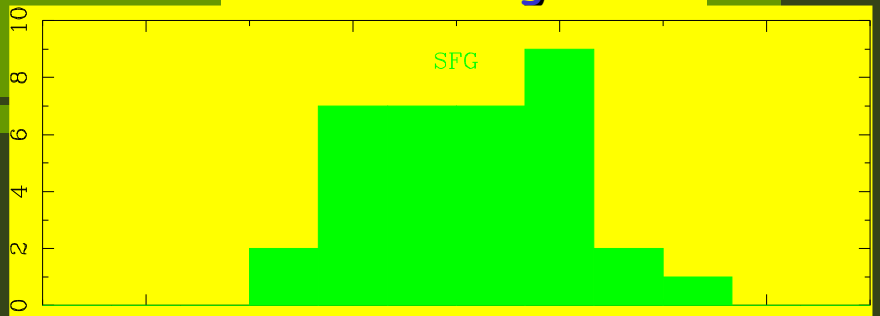
Morphology

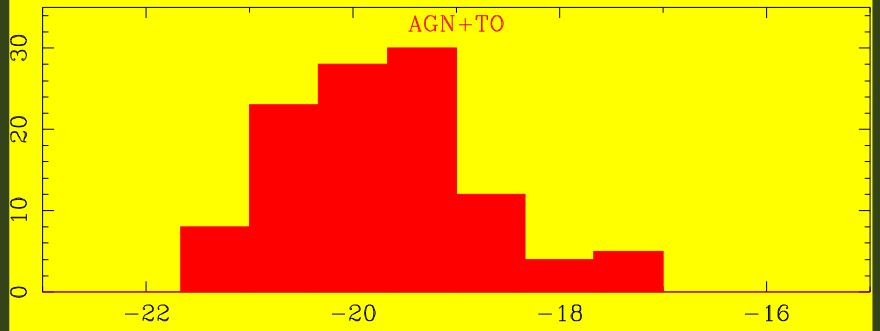


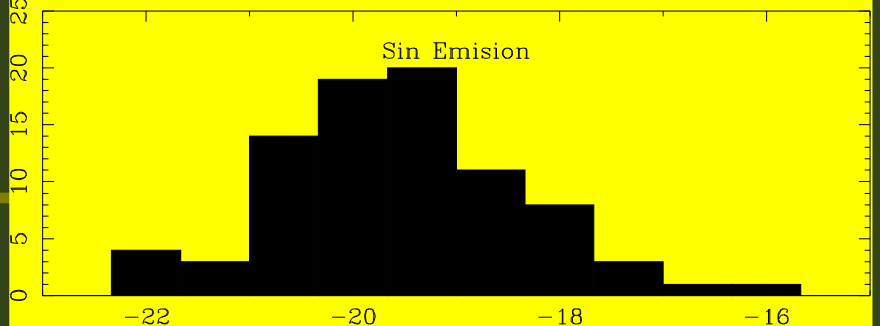




Absolute Magnitude







Galaxy properties and parent group

	Morphology	Radial Vel.	M_B
AGN	Sa	8192	-20.44
AGN+TO	Sa	7906	-20.43
HII	Sc	7430	-19.33
No Emission	SO	8581	-20.12

Dominated Groups:	Redshift	σ_v	Rp
Non Emission (6)	5325	275.7	39.1
AGNs+TOs (20)	7950	169.8	38.1
HII (3)	4110	56.23	8.1

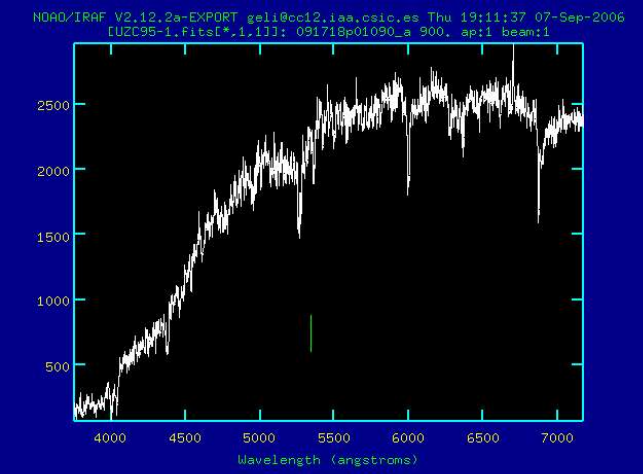
Summary for the HCG sample

- Over the 238 classified galaxies:
  - We found emission in 65% of galaxies
- From emission galaxies and using the optical diagnostic diagrams for the classification we found:
  - (49%) host an AGN
  - (24%) TOs
  - (27%) HII
- According to the host galaxy:
  - AGNs are located mainly in early type and bright galaxies (E-Sa)
  - HII are hosted mainly in late spiral and fainter galaxies.

UZC-CG Catalogue

- Collaboration: A. del Olmo, P. Focardi and J. Perea
- We have searched in three Database Archives:
- 868 spectra from the 986 galaxies in 291 groups.
- Z-Mach: 652 spectra, 376 emissions
- Sloan: 221 spectra, 175 emission galaxies
- Fast: 246 spectra, 136 with emissions
- Taking common spectra: Sloan and Fast detect 30% more emission lines than Z-Mach.

Compl.	Groups	Galaxies	Spectra	Emissions
C	215	720	720	485
RC	47	171	120	75
I	29	95	29	20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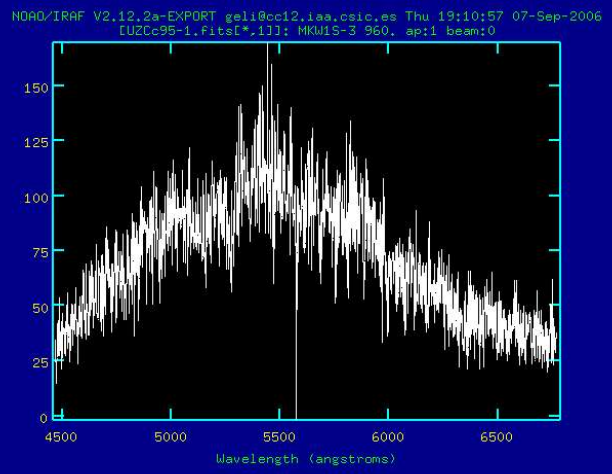
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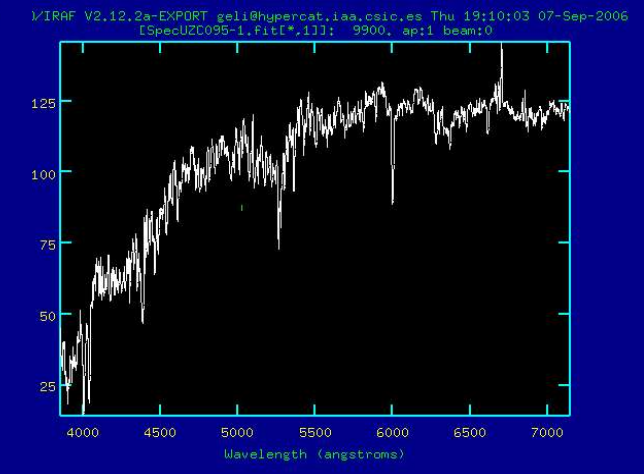
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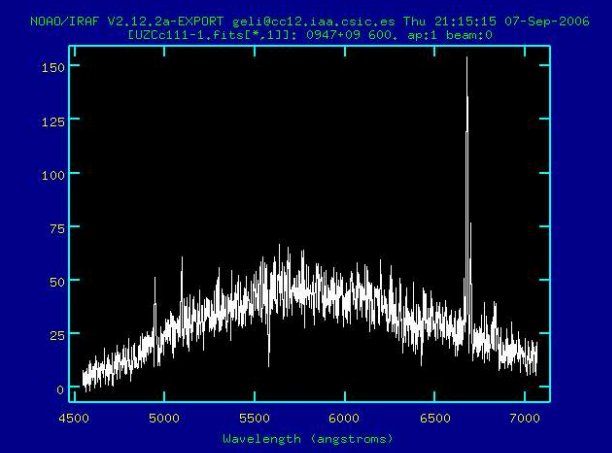
FAST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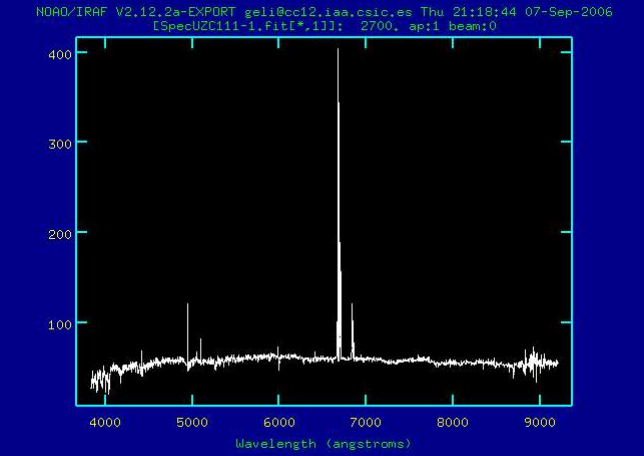
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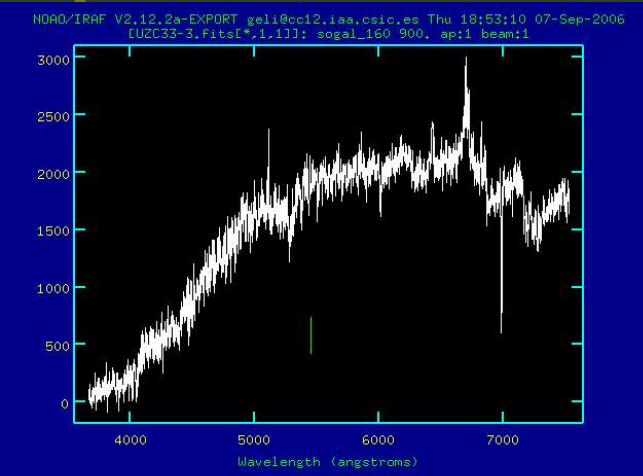
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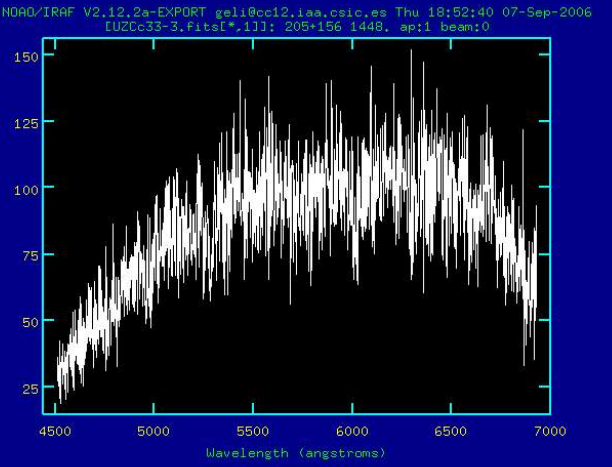
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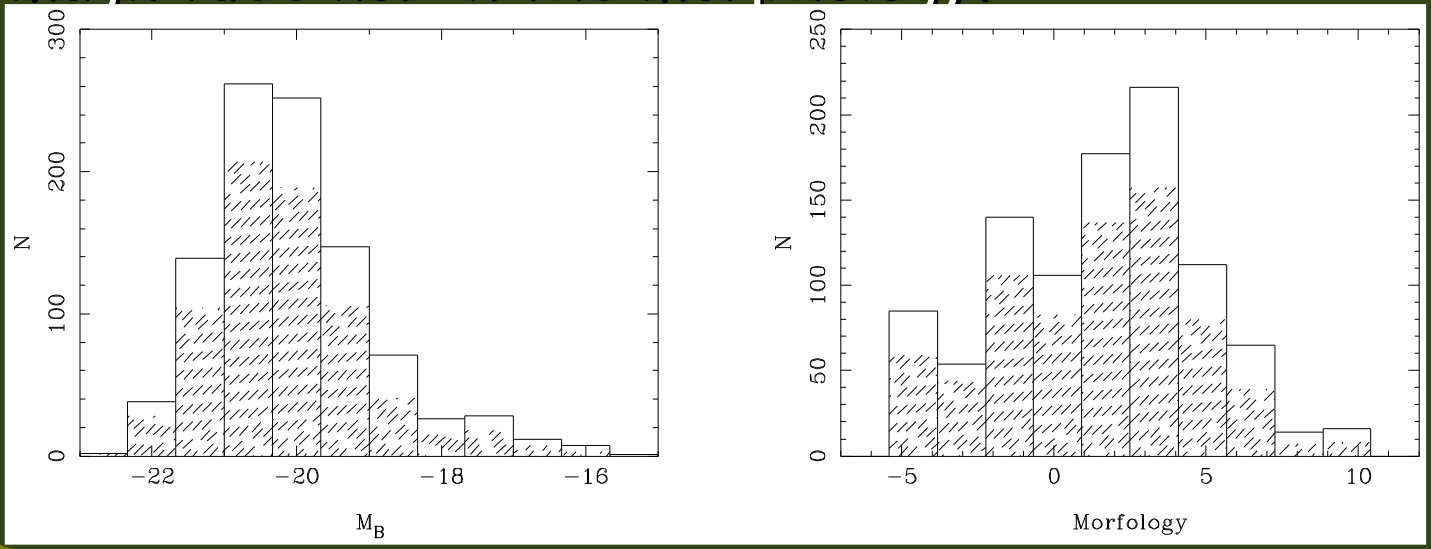
Wavelength (angstroms)

SLOAN

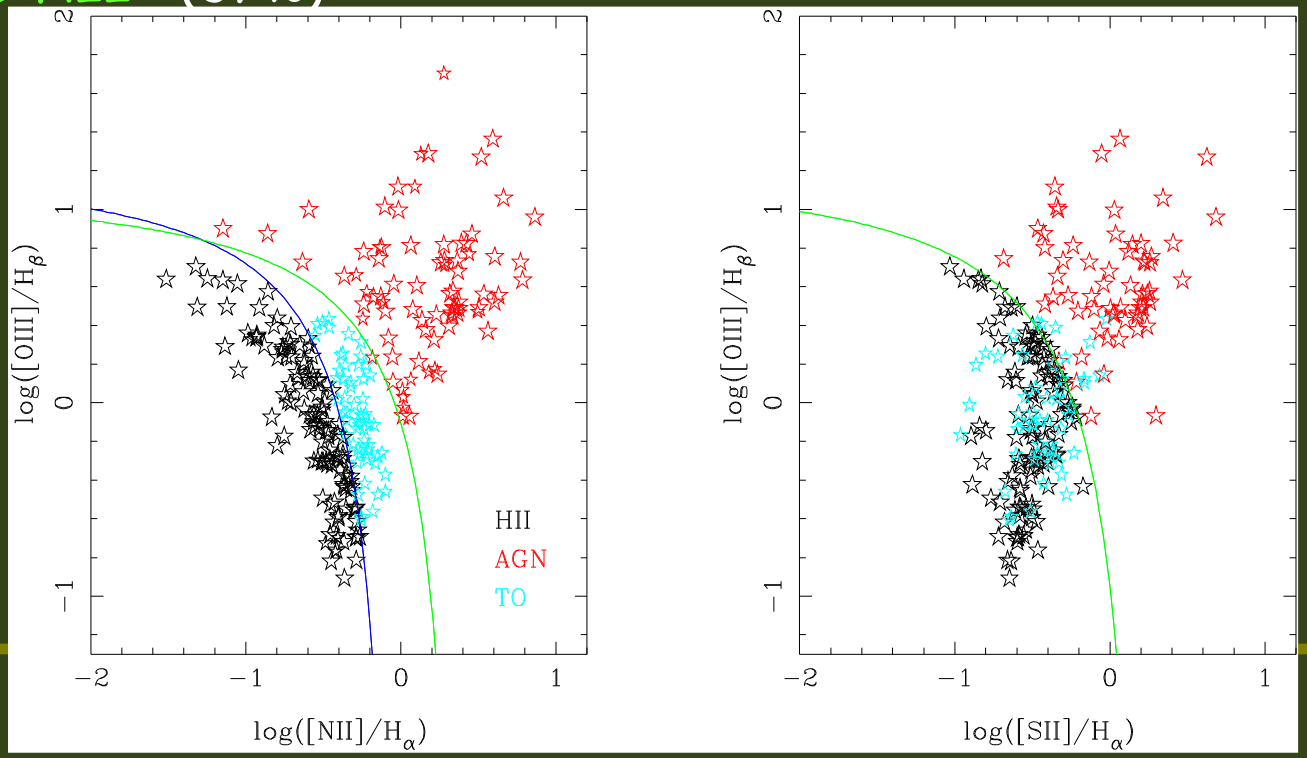
UZC-CG Sample

- 215 groups with 720 galaxies.
- 75% triplets (77% in the UZC-CG).
- 720 spectra: 335 Z-Mach+210 Sloan+175Fast
- No significant differences neither in the absolute magnitude nor in the morphology.



Nuclear classification

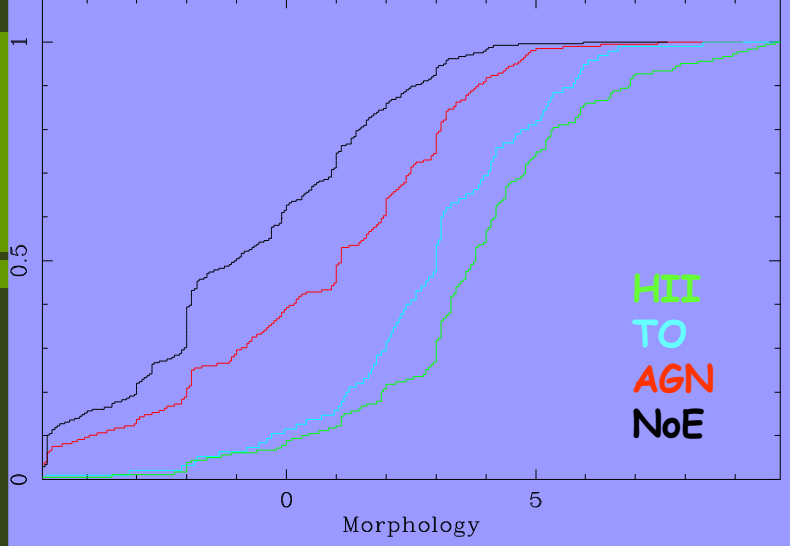
- No emission (NoE): 234 (33%)
- Emission lines galaxies : 486 (67%)
  - 212 AGNs (43%)
  - 95 TO (20%)
  - 179 HII (37%)

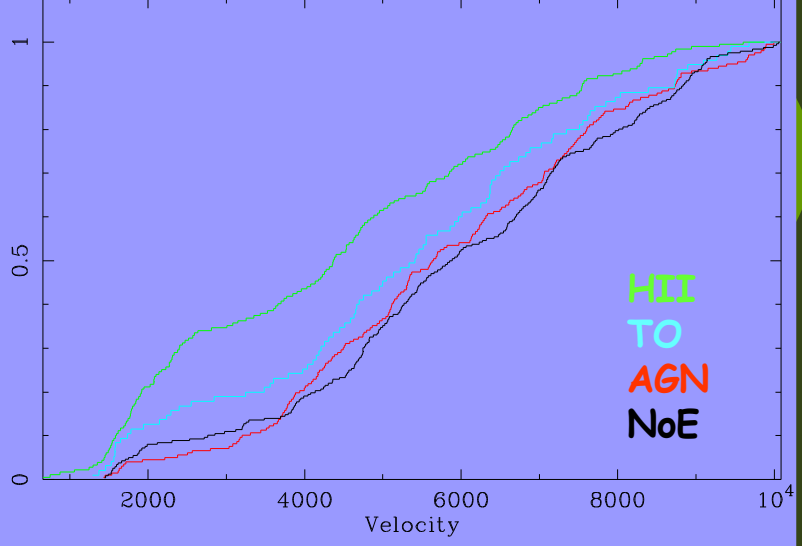


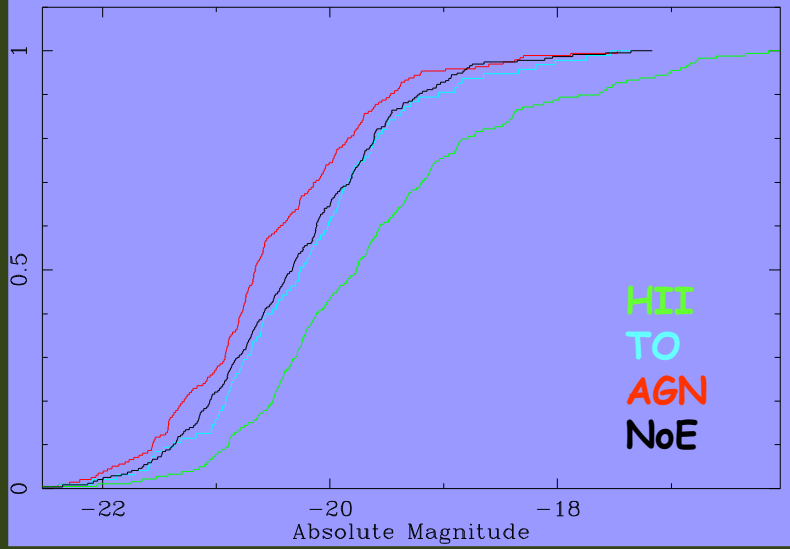
Activity and Host Galaxy

- Early-type galaxies are dominated by Non emission galaxies and AGN nuclei.
- We found emission line in 99% of late-spiral and HII is the most common activity
- In early-spirals predominate AGNs but with an important content of TO and HII nuclei

	NoE	AGNs	TO	HII
Early(E-SO;244)	59%	32%	3%	6%
Early-Spiral(SOa-Sbc;397)	22%	30%	17%	31%
Late-Spiral(≥Sc;79)	1%	10%	23%	66%



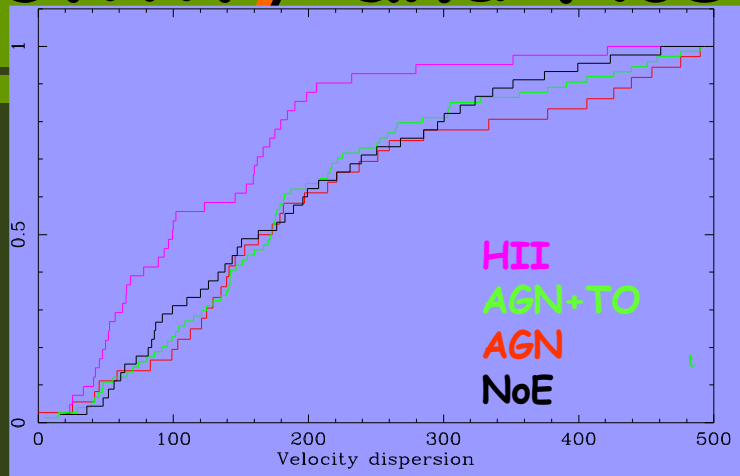


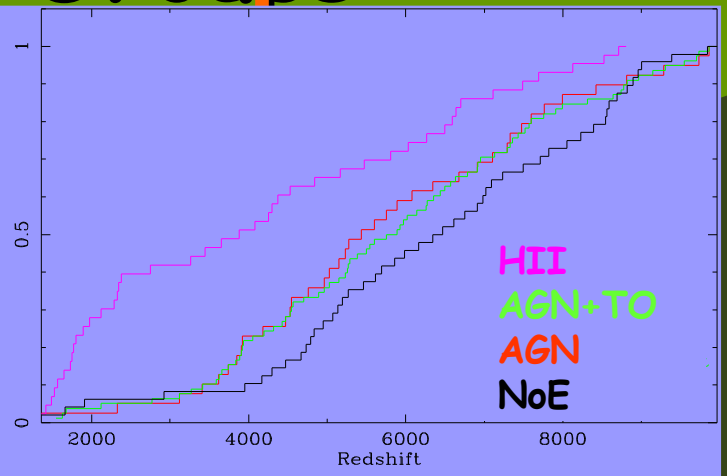


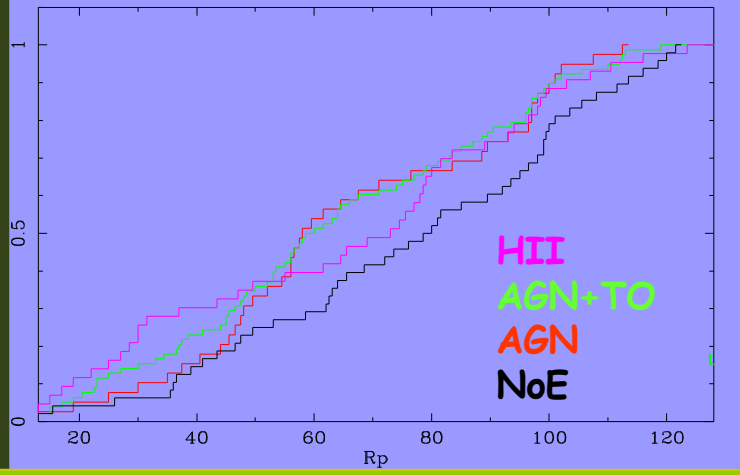
	Morph.	Vel.	M_B
NoE	-1.0(SO)	5887	-20.3
AGN	1.1(Sa)	5628	-20.6
TO	3.0(Sb)	5408	-20.3
HII	3.8(Sbc)	4367	-19.8

- AGNs are located in bright early-type and early spirals
- HII are found in fainter and later types
- TO are in late-types but with high luminosity

Activity and Host Groups







	Rp	Vel.	σ_v
AGN(41)	58	5569	181
AGN+TO(75)	60	5892	175
HII(45)	74	3918	100
NoE(48)	80	6468	183

- AGN dominated groups tend to show larger velocity dispersion and lower pair wise separation even if we include TOs
- HII groups have the lowest velocity dispersion and larger size.

Conclusions

- According to the nuclear classification we can say:
  - AGNs are located in earlier morphological types than TO or HII galaxies.
  - HII-nuclei galaxies are fainter than AGNs or TO, regardless the morphology.
  - TO are in earlier types than HII and with lower luminosity than AGNs.
- According to group properties:
  - Groups dominated by AGNs or AGNs+TO have larger velocity dispersion than groups dominated by HII activity, regardless the dominant morphology.
  - Multiplets (M) have lower emission line rate than Triplets (T) but inside the emissions M have higher proportion of AGNs than T. This effect is also independent of morphology and is more obvious if we select 1st ranked.

Comparison

- The spectral classification could be very sensitive with the spectral and spatial resolution.
- In compact groups we found a high percentage of emission line galaxies (~65%)

	HICKSON	SCG	UZC-CG	Ho et al.
AGNs	49%	49%	42%	35%
TOs	24%	21%	19%	16%
HII	27%	30%	39%	49%
AGN+TO	73%	70%	63%	51%

- The predominant class of activity in compact groups galaxies is LLAGN ($L_{H\alpha}$= ~10^{39}).

Thank you!

geli@iaa.es