LOW LUMINOSITY AGNs IN HICKSON COMPACT GROUPS

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OVERVIEW

1.- Introduction

2.- Hickson Compact Groups.

3.- The sample

4.- Observations and reduction procedures

5.- Analysis and first results

1.- INTRODUCTION

- The environment play an important role in the evolution of galaxies
- Study the relationship between low luminosity nuclear activity and gravitational interaction
- Tidal torques: the mechanism to transport material to the centre
- Compact groups: ideal places to study effects of gravitational interaction

2.- HICKSON COMPACT GROUPS

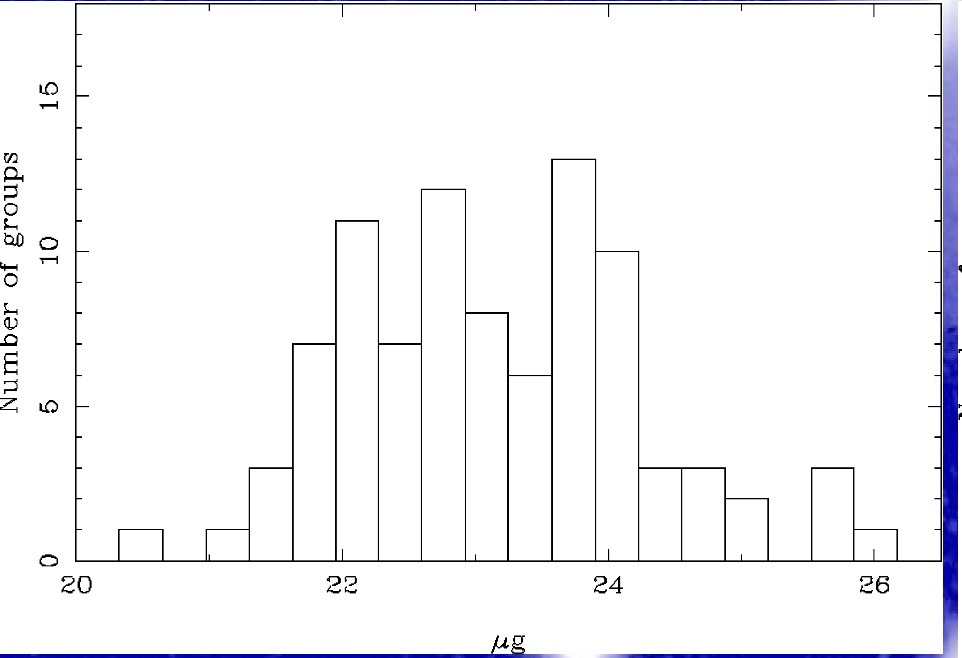
- 4-8 members
- Presence of all morphological type:49% of late-type of galaxies in HCGs,82% in the field (Hickson 1982,1997)
- High galaxies density similar to those observed in cluster cores
- Low velocity dispersions (200km/s)
- Crossing time $T_{cr} = \frac{\pi}{\sqrt{3}} \frac{R_H}{\sigma_z} \propto 10^8 - 10^9 \ years$
- Group M/L ~ 4-10 Galaxy M/L

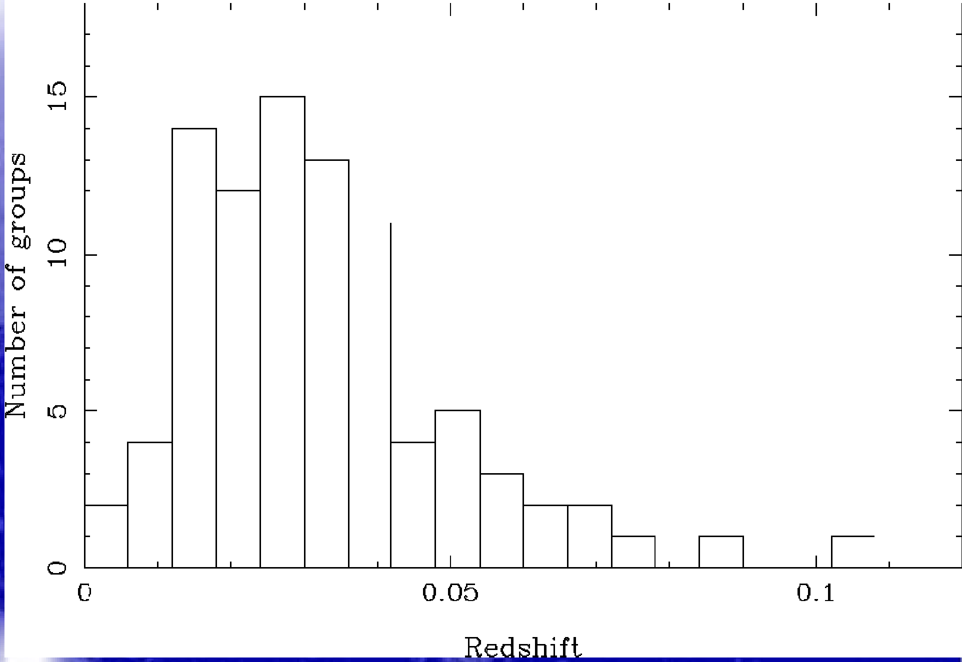
THE PROJECT

- 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
- Medium resolution spectroscopy in the range from 3600Å to 7200Å

3.- OUR SAMPLE

- Group compactness $\mu_B \leq 24.4$ mag/arcsec^2
- Redshift completeness $z \leq 0.045$
- 65 groups with 281 galaxies (223 North)





- B magnitude distribution of the whole sample and the North subsample

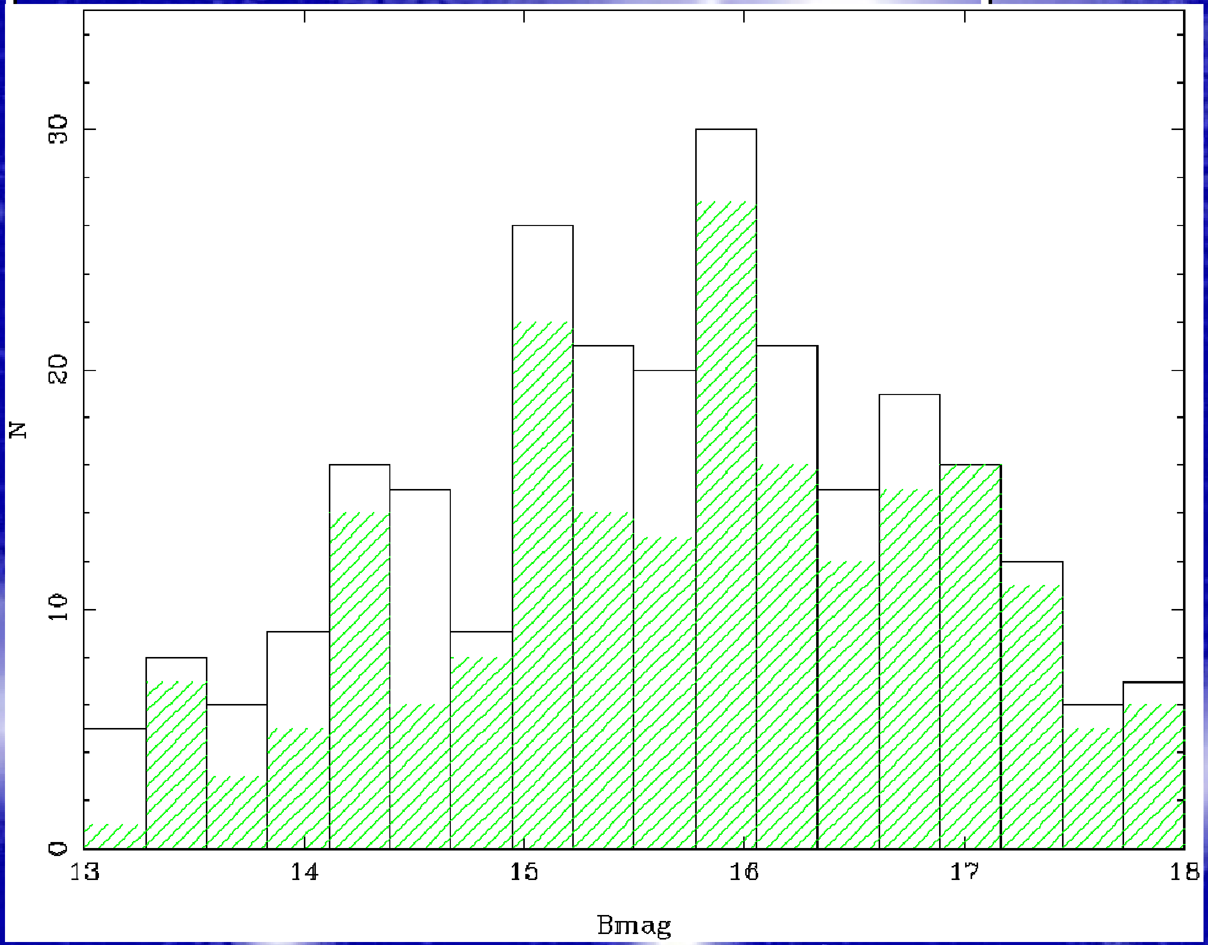


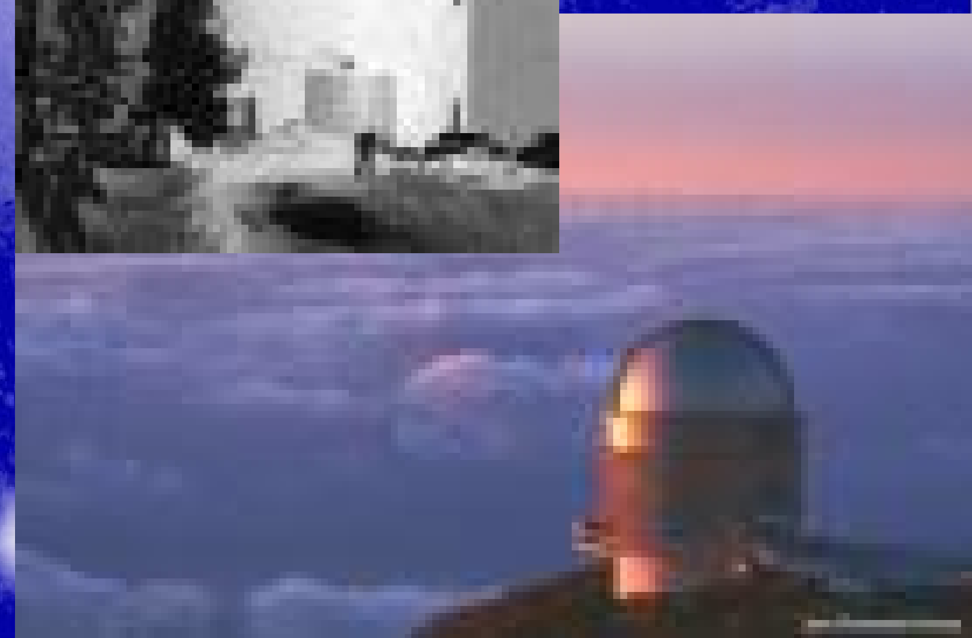
Table 1: The Sample

Name[1]	N.gal.[2]	z[3]	σ_V[4]	μ_G[5]	HI[6]	$log L_X$[7]	Radio[8]	L_{FIR}[9]
HCG1	4	3.39E-02	85.110	23.74	HI	<42.42	a	
HCG3	3	2.55E-02	251.19	23.83	HI	<41.71		c (a b d)
HCG4	4	2.80E-02	338.84	23.91	HI			a (c d)
HCG5	3	4.10E-02	147.91	22.15	HI	<42.54		
HCG6	4	3.79E-02	251.19	21.95	HI	<42.43		
HCG7	4	1.41E-02	89.130	23.81	HI	<42.03	a	a c (b d)
HCG10	4	1.61E-02	208.93	23.92	HI	<41.43	c	a c (b d)
HCG13	5	4.11E-02	181.97	23.92		<42.40	a	
HCG16	4	1.32E-02	123.03	22.86	HI	41.68	a,b,c y d	a c d (b)
HCG21	5	2.51E-02	112.20	23.90	HI	<42.33		a b (c)
HCG22	3	9.00E-03	43.650	22.62	HI	<41.15		c (a b)
HCG23	4	1.61E-02	169.82	24.08	HI	<41.72	a,b,d	
HCG24	5	3.05E-02	199.53	23.23	HI	<42.52		
HCG26	7	3.16E-02	199.53	22.72	HI	<41.95	a	
HCG28	3	3.80E-02	85.110	22.22		<42.70	b	
HCG30	4	1.54E-02	72.440	23.49	HI	<42.07		c (a b d)
HCG31	3	1.37E-02	56.230	21.90	HI	<41.93	a	ac b G
HCG32	4	4.08E-02	208.93	23.71		<42.51		
HCG33	4	2.60E-02	154.88	22.64	HI	41.77	c	c (a b d)
HCG34	4	3.07E-02	316.23	21.72	HI	<42.55	a,b,c	
HCG37	5	2.23E-02	398.11	22.65	HI	42.12	a b d	a b (c d e)
HCG38	3	2.92E-02	12.880	23.44	HI	<42.01		a bc (d)
HCG40	5	2.23E-02	147.91	21.18	HI	<41.73	a b c d	c d (a b e)
HCG42	4	1.33E-02	213.80	23.12	HI	42.16		
HCG43	5	3.30E-02	223.87	23.75	HI	<42.40	a b	
HCG44	4	4.60E-03	134.90	24.00	HI	<40.84	a c d	a c d (b)
HCG46	4	2.70E-02	323.59	23.71	HI	<42.25	a	(a b c d)
HCG47	4	3.17E-02	42.660	22.94	HI	<42.33	a b	
HCG48	3	9.40E-03	302.00	23.72	HI	41.58		b (a c d)
HCG49	4	3.32E-02	33.880	22.80	HI	<42.26	a b	
HCG51	5	2.58E-02	239.88	23.39	HI	42.99	c	
HCG52	3	4.30E-02	181.97	23.95		<42.50		
HCG54	4	4.90E-03	112.20	22.15	HI			a
HCG56	5	2.70E-02	169.82	22.44	HI	<42.23		b (a c d e)
HCG57	7	3.04E-02	269.15	23.73	HI	41.98	d	
HCG59	4	1.35E-02	190.55	22.74	HI	<42.00	a	a (b c d)
HCG61	3	1.30E-02	87.100	21.43	HI	<61.91	c	c (a d)
HCG62	4	1.37E-02	288.40	23.07	HI	43.04	a	b (a c d)
HCG63	3	3.11E-02	131.83	24.04		<42.49	d	
HCG64	3	3.60E-02	213.80	23.18	HI	<42.48		
HCG67	4	2.45E-02	208.93	22.82	HI	41.69	b c	b (a c d)
HCG68	5	8.00E-03	154.88	22.95	HI	41.27	a b c	a c (b d e)
HCG69	4	2.94E-02	223.87	22.22	HI	<42.33	a b	b (a c d)
HCG72	4	4.21E-02	263.03	21.80	HI	<42.54		
HCG74	5	3.99E-02	316.23	22.12	HI	<42.67	a	
HCG75	6	4.16E-02	295.12	22.74		<42.72	b	
HCG76	7	3.40E-02	245.47	23.52	HI	<42.66		
HCG79	4	1.45E-02	138.04	20.50	HI	<41.70	a	a (b c d)
HCG80	4	3.10E-02	269.15	22.38	HI	<42.16	a	
HCG82	4	3.62E-02	616.60	23.29	HI	42.29	c	
HCG85	4	3.93E-02	363.08	22.00	HI	42.27	a	
HCG86	4	1.99E-02	269.15	23.94		42.32		c (a b d)
HCG87	4	2.96E-02	120.23	21.91	HI	<42.36		a (b c d)
HCG88	4	2.01E-02	26.920	23.51	HI	<42.18	a	a c d (b)
HCG90	4	8.80E-03	100.00	22.07		41.48		a bd (c)
HCG91	4	2.38E-02	181.97	23.91	HI		a b	ad b (c)
HCG92	4	2.15E-02	389.05	22.25	HI	42.16	c d	b c (d e)
HCG93	4	1.68E-02	208.93	24.30	HI	<41.34	a b	
HCG94	7	4.17E-02	478.63	23.16	HI		a	
HCG95	4	3.96E-02	309.03	21.41	HI	<42.43	b c d	
HCG96	4	2.92E-02	131.83	21.94	HI	<42.11	a c	ac (b d)
HCG97	5	2.18E-02	371.54	23.71	HI	42.78		b (a c d e)
HCG98	3	2.66E-02	120.23	22.03	HI	<42.27		(a b c d)
HCG99	5	2.90E-02	263.03	22.73	HI	<42.34		c (a b d e)
HCG100	3	1.78E-02	89.130	22.91	HI	<41.99	a b	a c (b d)

We have compiled data from our sample found in the bibliography:

- Redshift and velocity dispersion of the groups (Hickson et al.1992)
- Mean group surface brightness
- HI data (Verdes-Montenegro et al. 2001)
- Radio continuum (Menon&Hickson 1985,Menon 1995)
- X-ray observations (Ponman et al. 1996)
-FIR Luminosity (Verdes-Montenegro et al. 1998)

4.- OBSERVATIONS AND REDUCTION PROCEDURES



Telescopes and instruments

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

Observed groups

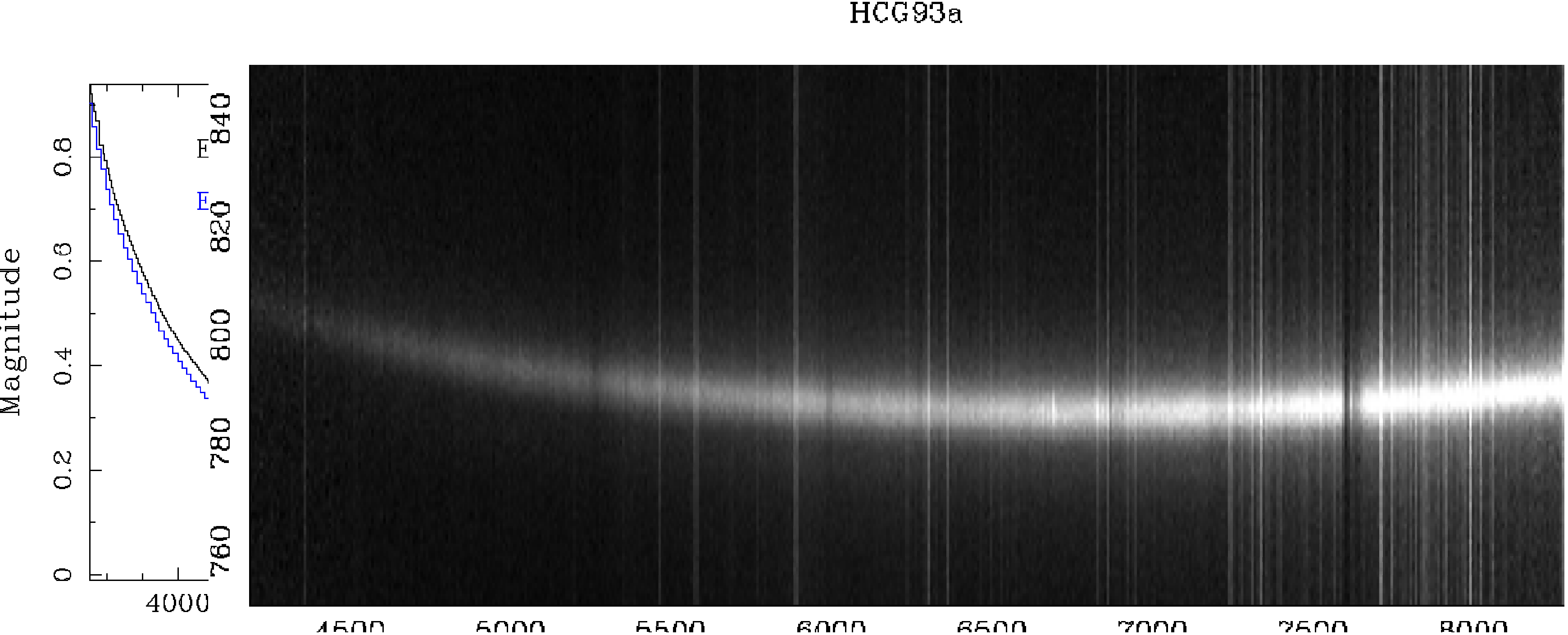
- We have observed in collaboration with Roger Coziol (Departamento de Astronomía-Universidad de Guanajuato) 78% (223) from the whole sample.
- This percentage rise up to 87% if we take into account only the North subsample.
- We expect to end up with the observations of the North subsample next year.

Tabla 4: Observed Groups.

Names	Obs.Gal	Observatories	Grisms
HCG1	a b c d	CAHA	B100+G100
HCG3	a b c d	NOT	GR4
HCG5	a b c d	CAHA	B100+G100
HCG6	a b c d	NOT	GR4
HCG7	a b c d	CAHA	B100+G100
HCG10	a b c d	CAHA & SPM	B100+G100 & R300
HCG13	a b c d	NOT	GR4
HCG23	a b c d	SPM& OSN	R300 & Red4(600)
HCG30	a b c d	CAHA	B100+G100
HCG31	a b c G Q	CAHA & RM	B100+G100 & GR4
HCG33	a b c d	CAHA	B100+G100
HCG34	a b c d	CAHA	B100+G100
HCG37	a b c d e	SPM & CAHA	R300 & B100+G100
HCG38	a b c	CAHA	B100+G100
HCG40	a b c d e	SPM & RM	R300 & GR4+GR8
HCG44	a b c d	SPM	R300
HCG46	a b c d	SPM	R300
HCG47	a b c d	CAHA	G100
HCG49	a b c d	RM	GR4
HCG51	a b c d e f (g)	CAHA & SPM	G100 & R300
HCG52	a b c	CAHA	G100
HCG54	a b c d	SPM & RM	R300 & GR4+GR8
HCG56	a b c d e	SPM	R300
HCG57	a b c d e f g(h)	CAHA & SPM	B100+G100 & R300
HCG59	a b c (d)	OSN	Red4(600)
HCG61	a c d	SPM	R300
HCG62	a b c	SPM	R300
HCG68	a b c d e	SPM & OSN	R300 & Red4(600)
HCG69	a b c d	SPM	R300
HCG72	a b c d f	CAHA & SPM	G100 & Red4(600)
HCG74	a b c d (e)	SPM	R300
HCG75	a b c d e f	SPM	R300
HCG79	a b c d	SPM & RM	R300 & GR4+GR8
HCG80	ab c d	OSN	Red4(600)
HCG82	a b c d	CAHA & SPM	G100 & R300
HCG85	a b c d	CAHA	B100+G100 & B200
HCG88	a b c d	SPM	R300
HCG92	b c d e	SPM	R300
HCG93	a b c d	CAHA	B100+G100
HCG94	a b c d (e f g)	SPM	R300
HCG95	a b c d	CAHA & RM	B100+G100 & R300
HCG96	(a) b c (d)	CAHA	B100+G100
HCG97	a b c d e	SPM & NOT	R300 & GR4
HCG98	a b c	SPM & OSN	R300 & Red4(600)
HCG99	a b c d e	SPM & CAHA	R300 & B100+G100
HCG100	a b c d	CAHA & OSN	B100+G100 & Red4(600)

Observation strategy

- 3 blue and 3-4 red spectrophotometric standard stars each night
- 3-4 lamp calibration exposures
- 20 bias
- Internal and Sky flats
- 1-2 radial velocity standard stars
- Non-emission galaxies.
- Some galaxies of the sample were observed in different telescopes



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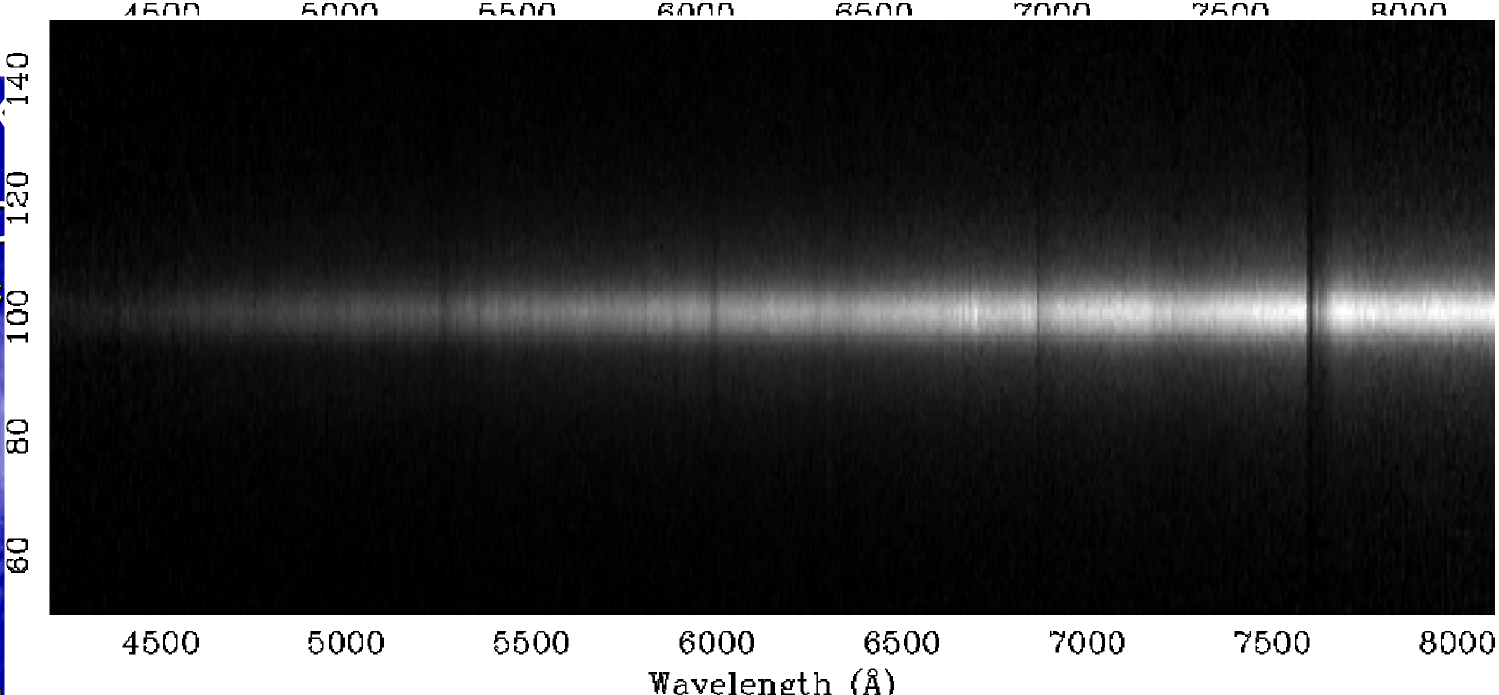

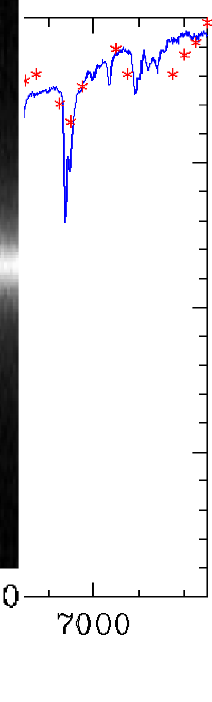

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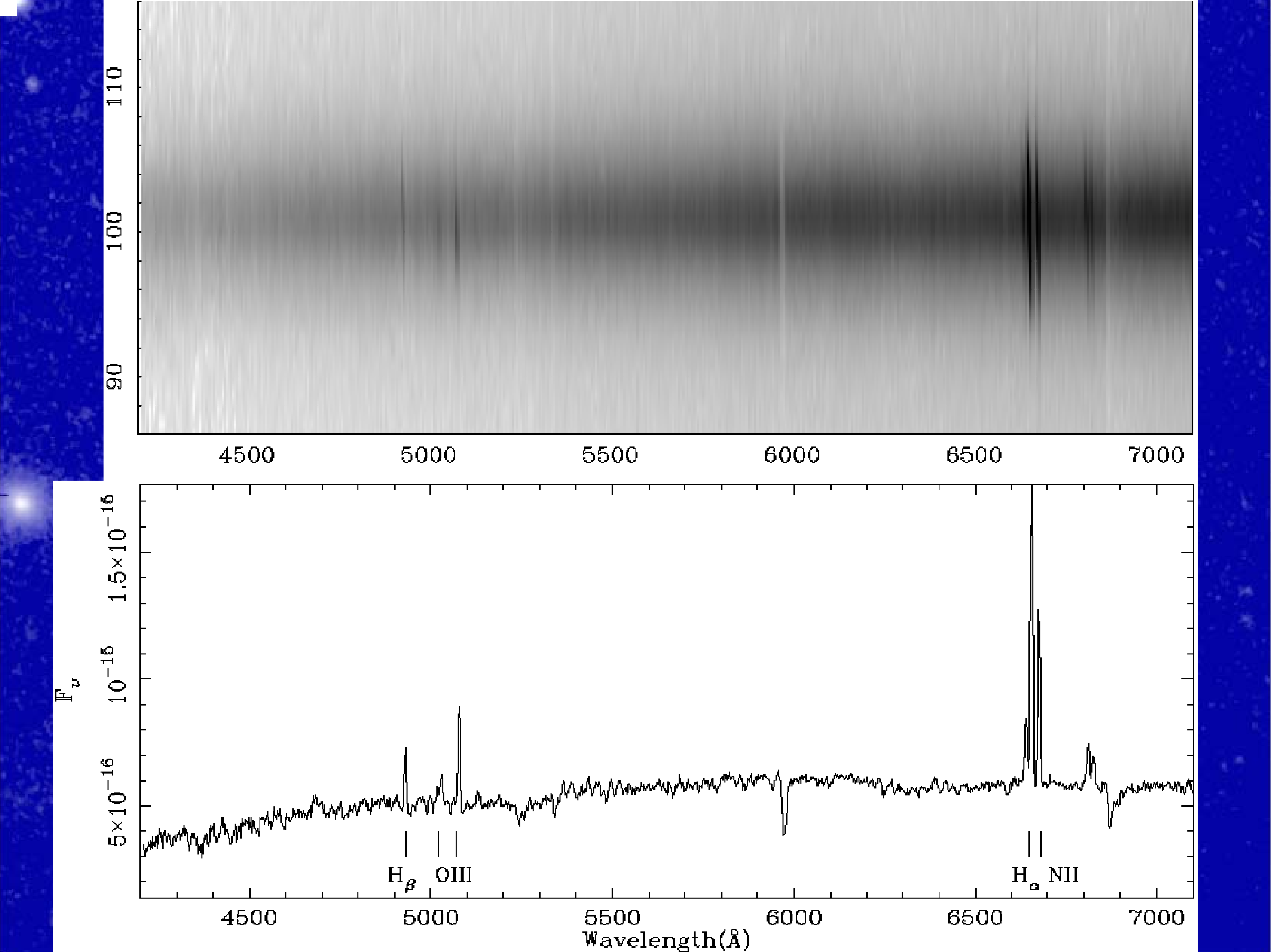


90
100
110
4500
5000
5500
6000
6500
7000
F_ν
5×10^{-16}
10^{-15}
1.5×10^{-15}
H_β
OIII
H_α
NII
Wavelength(Å)

5.- ANALISYS AND FIRST RESULTS

- Unidimensional spectra:
  - Emission and Absorption lines
  - Test redshift of the galaxies
  - Flux estimation of emission lines
  - Line ratios
- Bidimensional spectra:
  - Emission
  - Extension and location
  - Rotation Curves

Diagnostic Diagrams

- We use diagnostic diagrams to classify the activity presents in our sample:

-Ionized gas by O,B hot stars (HII regions)

-Non-thermal continuum

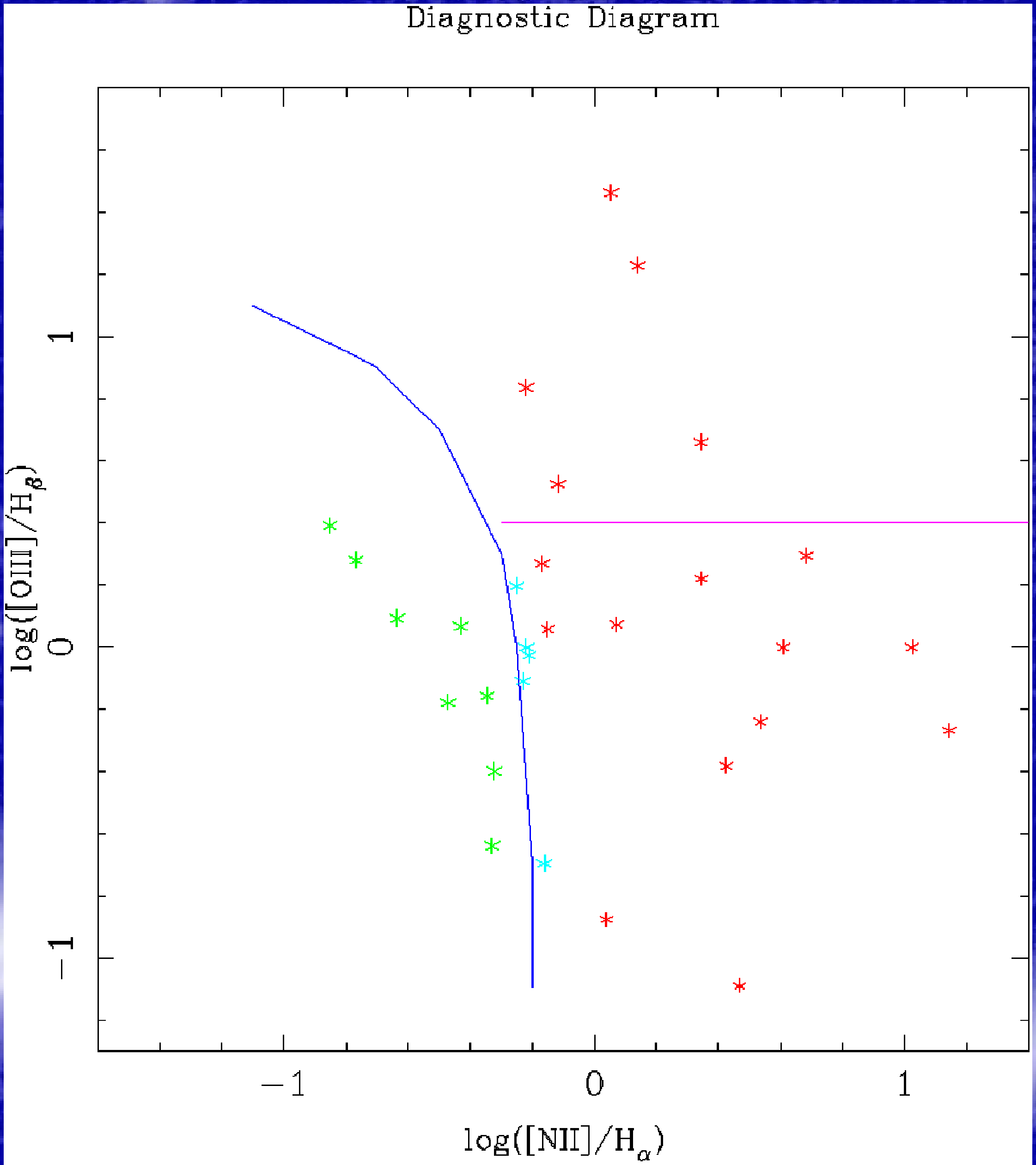
-Shock waves hot gas

- The most useful are:

- Log([OIII](5007Å)/Hβ) vs Log([NII](6583Å)/Hα)
- Log([SII](6717Å+6731Å)/Hα) vs Log([NII]/Hα)
- Log([OIII](5007Å)/Hβ) vs Log([OI](6300Å)/Hα)

TABLE 5:EMISSION LINES

Line	Wavelength(Å)
[OII[	3726/28
H_γ	4340
H_β	4861
[OIII]	4959
[OIII]	5006
[OI]	6300
[NII]	5648
H_α	6563
[NII]	6583
[SII]	6717
[SII]	6731



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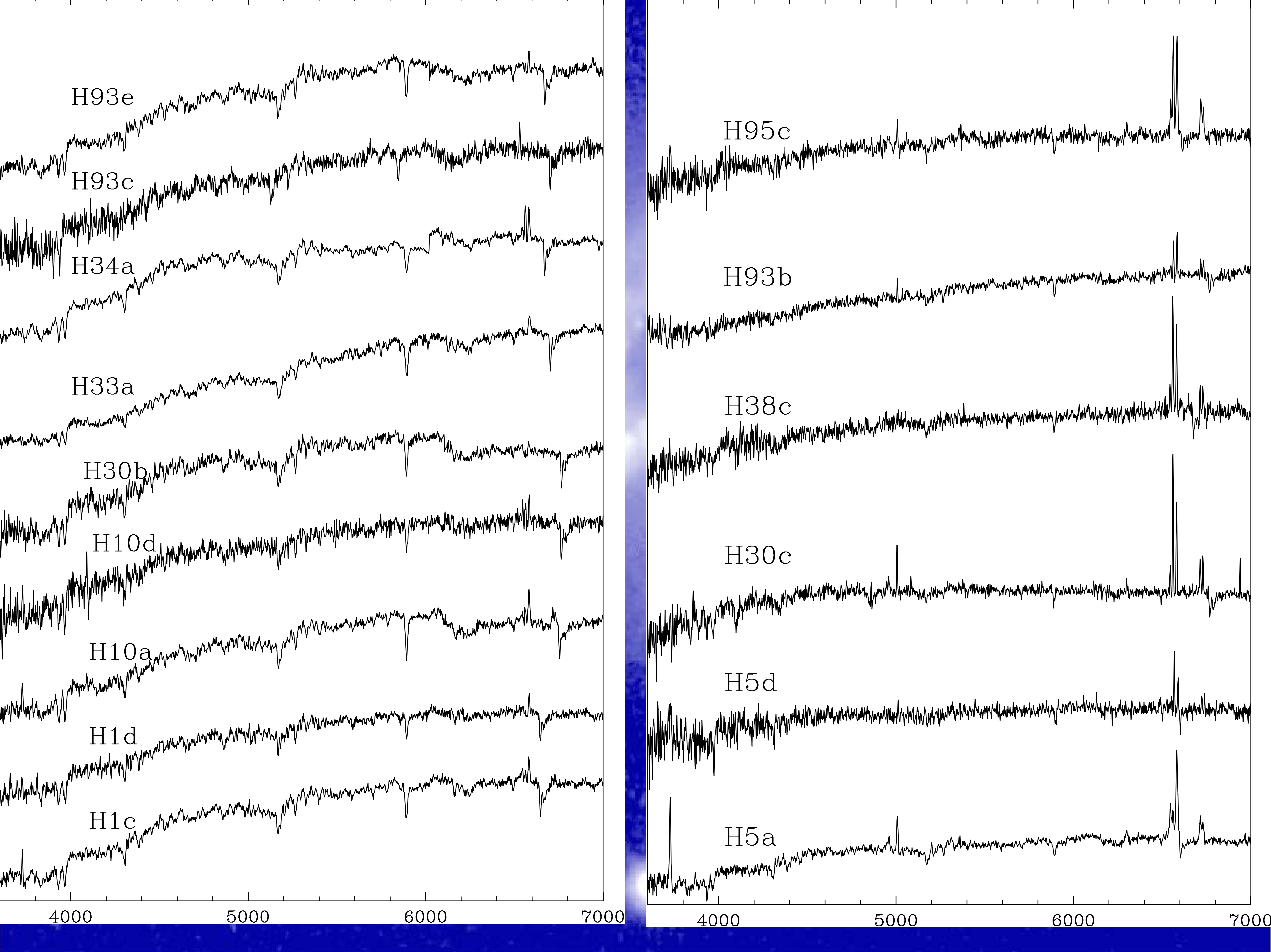
H93e
H93c
H34a
H33a
H30b
H10d
H10a
H1d
H1c
4000
5000
6000
7000
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H93b
H38c
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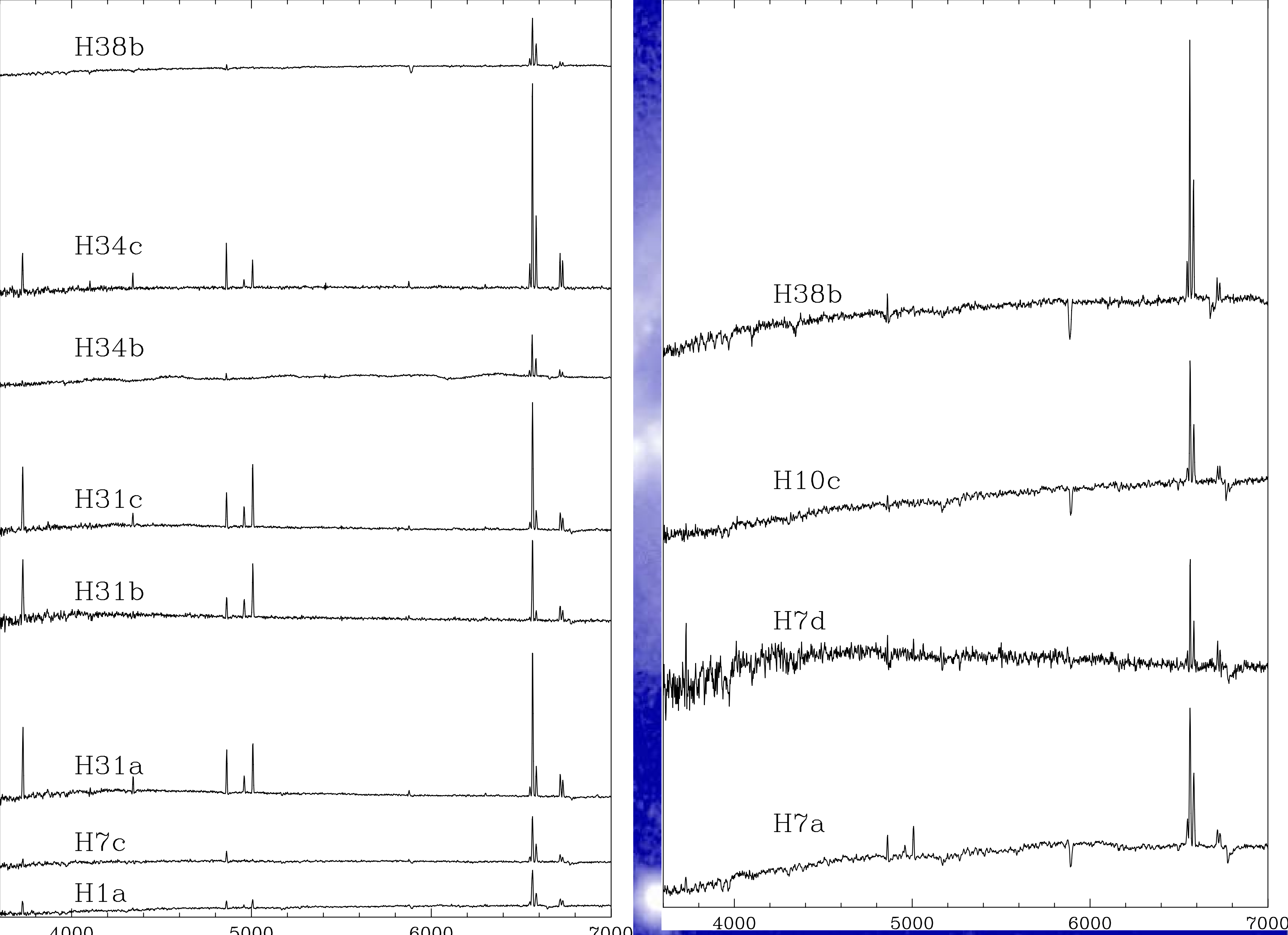
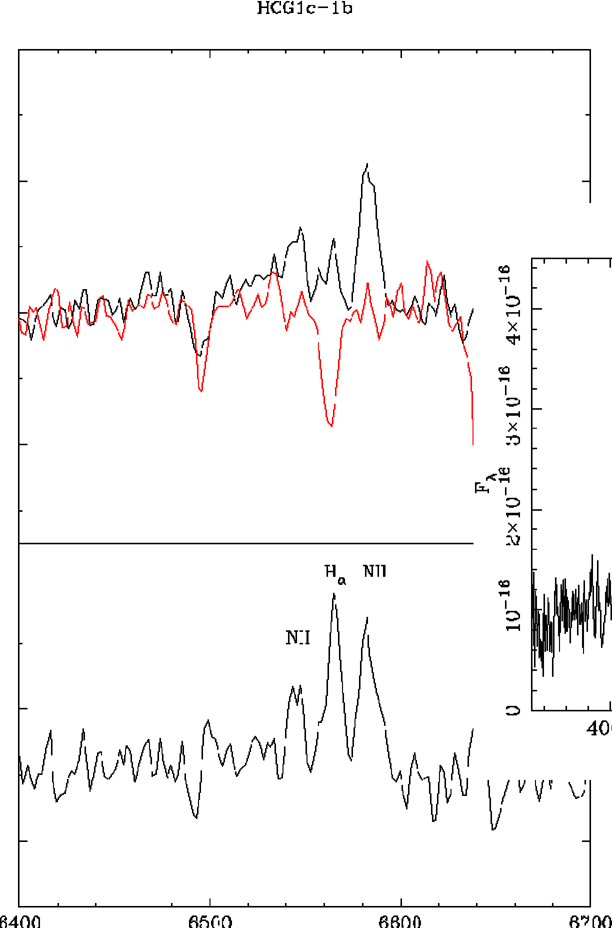
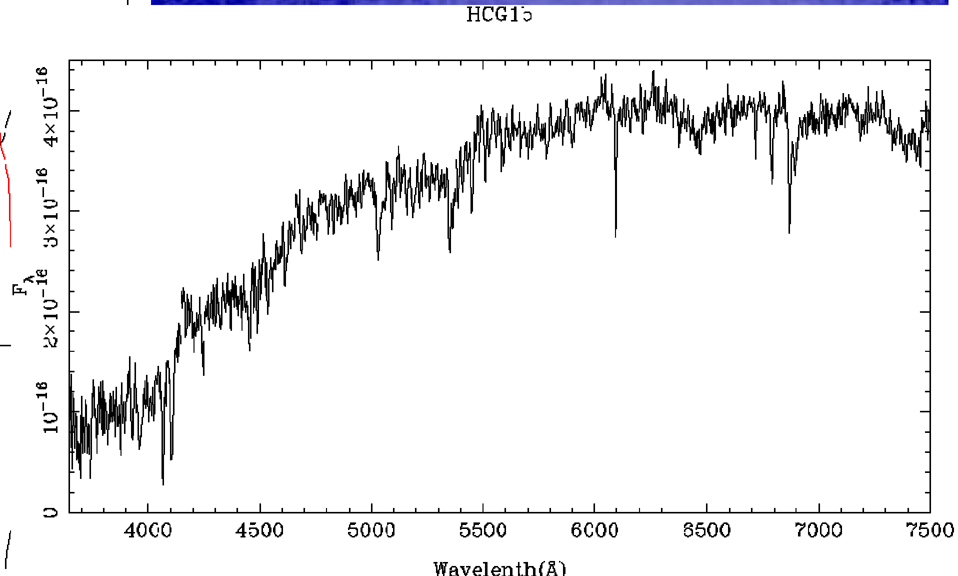
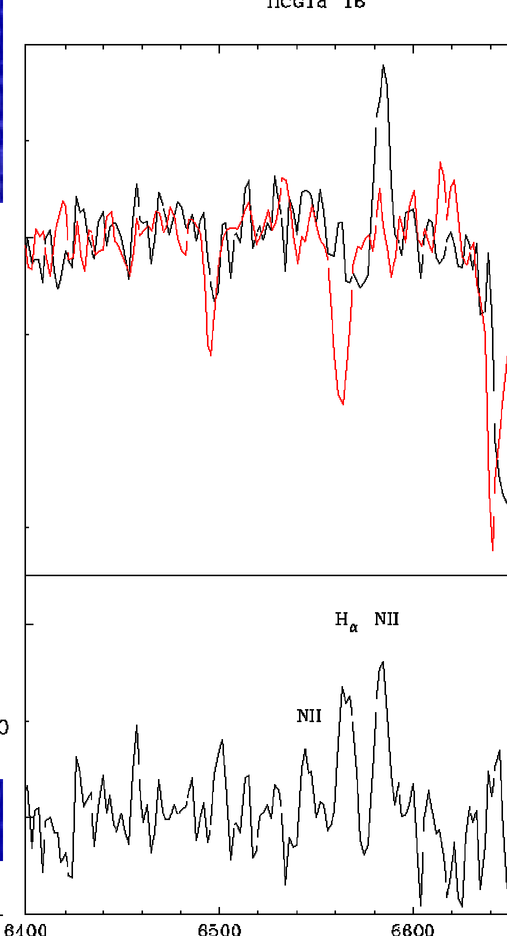
H5d
H5a
4000
5000
6000
7000

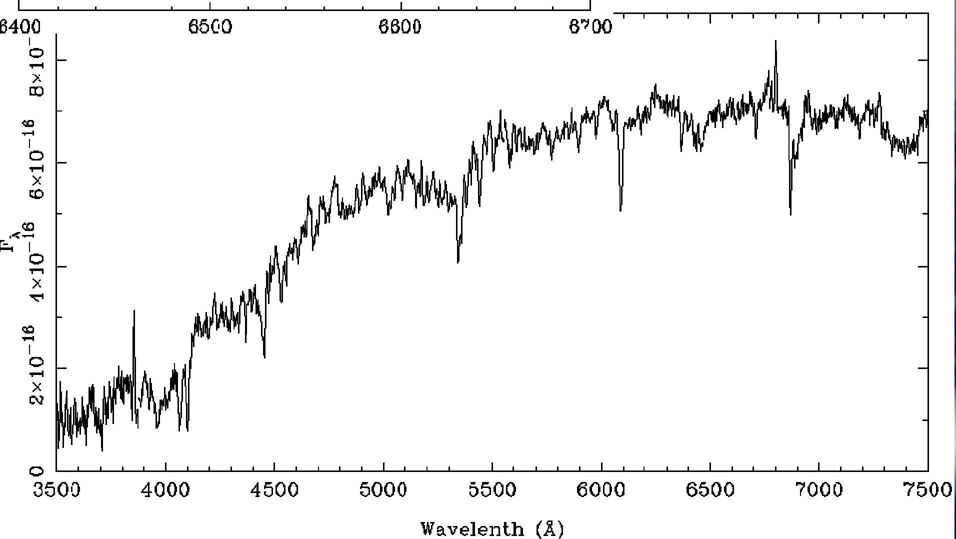

H38b
H34c
H34b
H31c
H31b
H31a
H7c
H1a
4000
5000
6000
7000
H38b
H10c
H7d
H7a
4000
5000
6000
7000

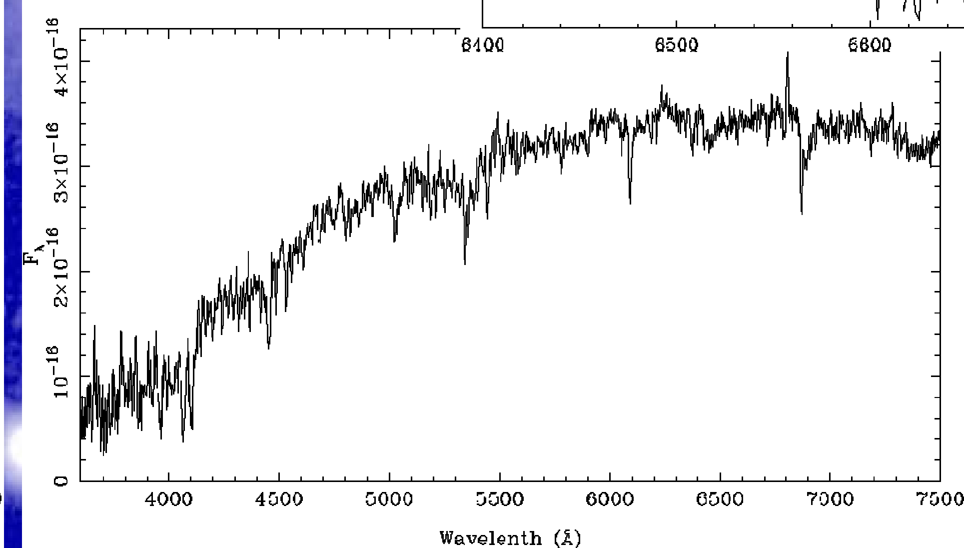
Spectra


HCG1c-1b
Hα NII
NII
6400
6500
6600
6700


HCG1b
F_λ
0
10^{-16}
2×10^{-16}
3×10^{-16}
4×10^{-16}
4000
4500
5000
5500
6000
6500
7000
7500
Wavelenth(Å)


Hα NII
NII
6400
6500
6600

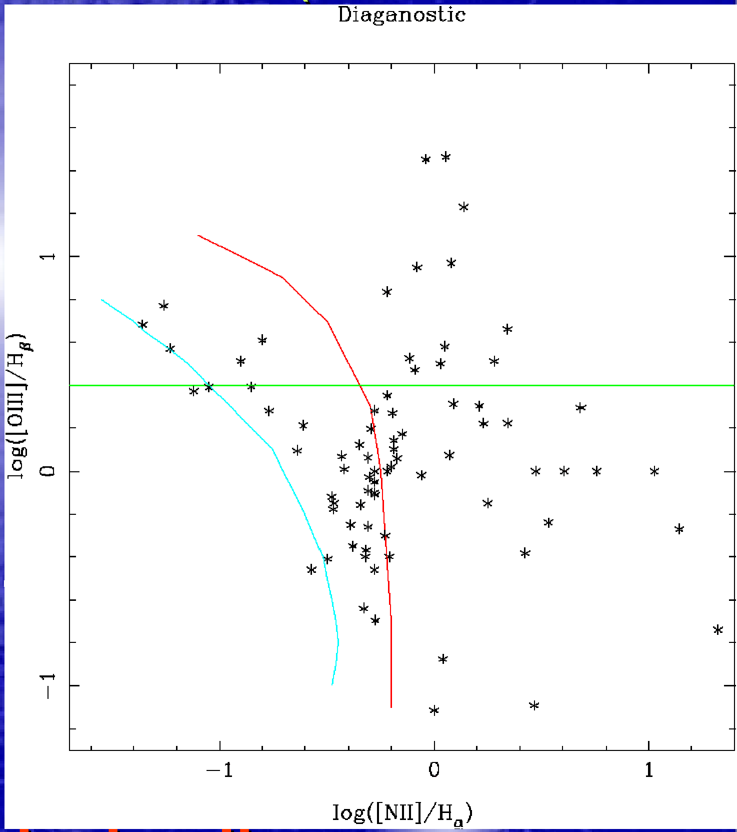

F_λ
0
2×10^{-16}
4×10^{-16}
6×10^{-16}
3500
4000
4500
5000
5500
6000
6500
7000
7500
Wavelenth (Å)


F_λ
0
10^{-16}
2×10^{-16}
3×10^{-16}
4×10^{-16}
4000
4500
5000
5500
6000
6500
7000
7500
Wavelenth (Å)

Conclusions

- From the 42 observed galaxies, 31of them show clear emission lines (74%)
- From these 31:
  - *8 (26%)could be classified as HII-region*
  - *17 (55%)show spectra of LLAGN (Sy2, LINER)*
  - *only one galaxy has wide Hα and Hβ components*
  - *the remaining 5 (16%)are transition objects between HII/LINER*

- Adding the 68 classified galaxies by R. Coziol (Coziol et al.1998,2004)
- 65% galaxies with emission lines
  - 19 are HII/SFG galaxies (43%)
  - 22 LLAGN (50%)
  - 3 no clear classification, HII/AGN



- Over the 110 analyzed sample

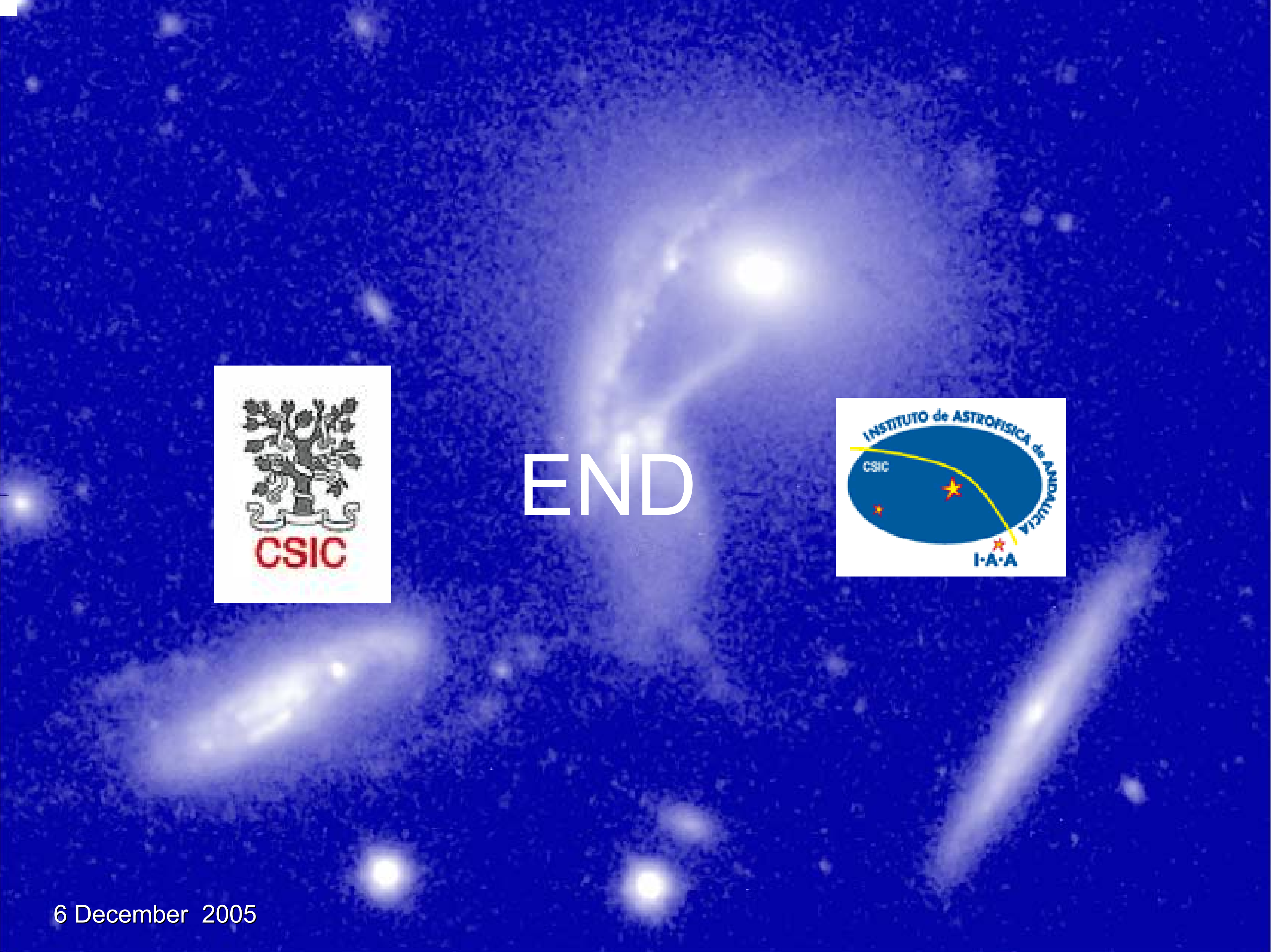
about 70% of the galaxies have emission lines.

.- 36% classified as HII/SFG

.- At least 53% could be classified as hosting an AGN.

Future work

- End up with the observations, reduction and classification of the nuclear activity in the North subsample.
- Characterization of the Stellar population and substraction using theoretical templates
- Nuclear activity as a function of the properties of the host galaxies and the parent group.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