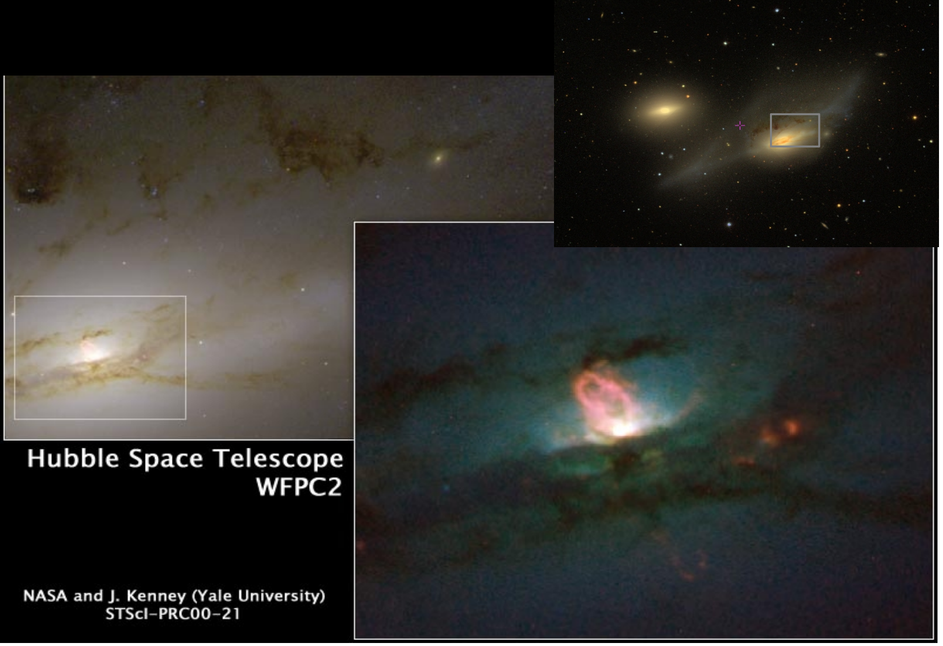


The AGN nature of LINER nuclear sources

Isabel Márquez (IAA-CSIC, Granada, Spain)

Coll.: J. Masegosa, O. González-Martín, L. Hernández García,
A. del Olmo, S. Cazzoli, M. Povic, H. Netzer

Padova, 4th April 2017

Overview

1. Introduction:
   - Properties
   - LINERs vs. LIERs

2. AGN LINERs
   - X-ray properties and variability
   - MIR spectroscopy
   - HST Hα imaging
   - The BLR in LINERs 1.9 revisited

3. Most luminous LINERS @ z=0.04-0.11

4. Conclusions

Introduction

LI**N**E**R**s: **L**ow **I**onization **E**mission-line **R**egions

Spectral Classification (Heckman 1980)

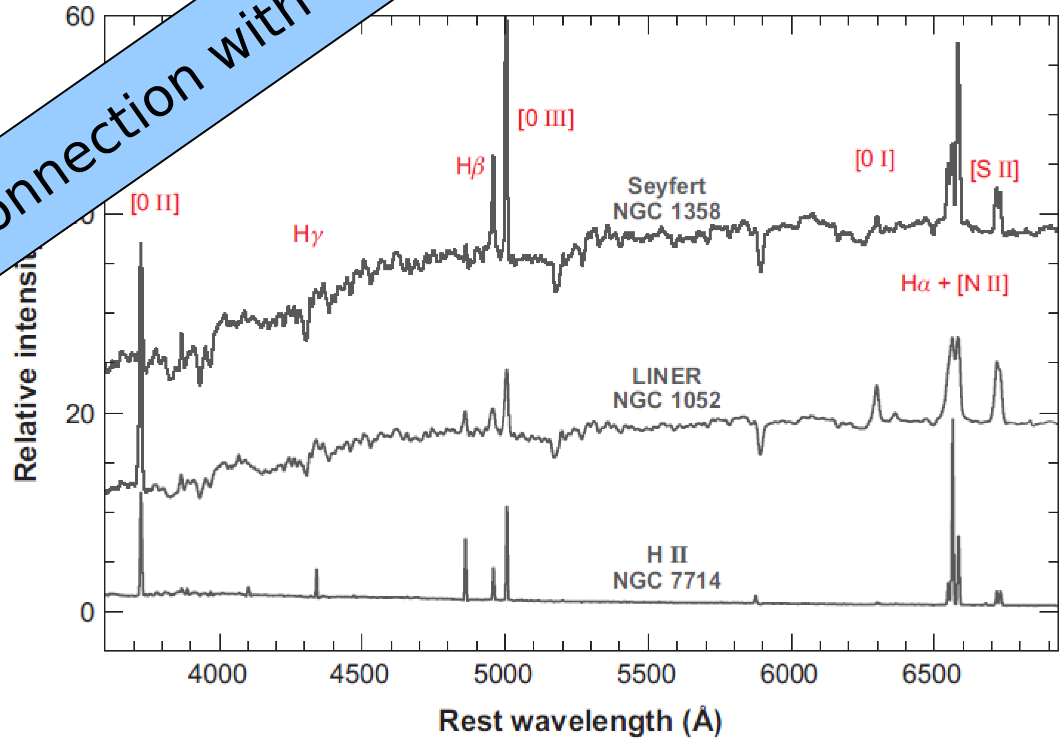
Connection with AGN

- Optical spectra dominated by emission lines from low ionization species ([OI],[NII][SII])

- Early types

- Lower luminosities than Seyferts

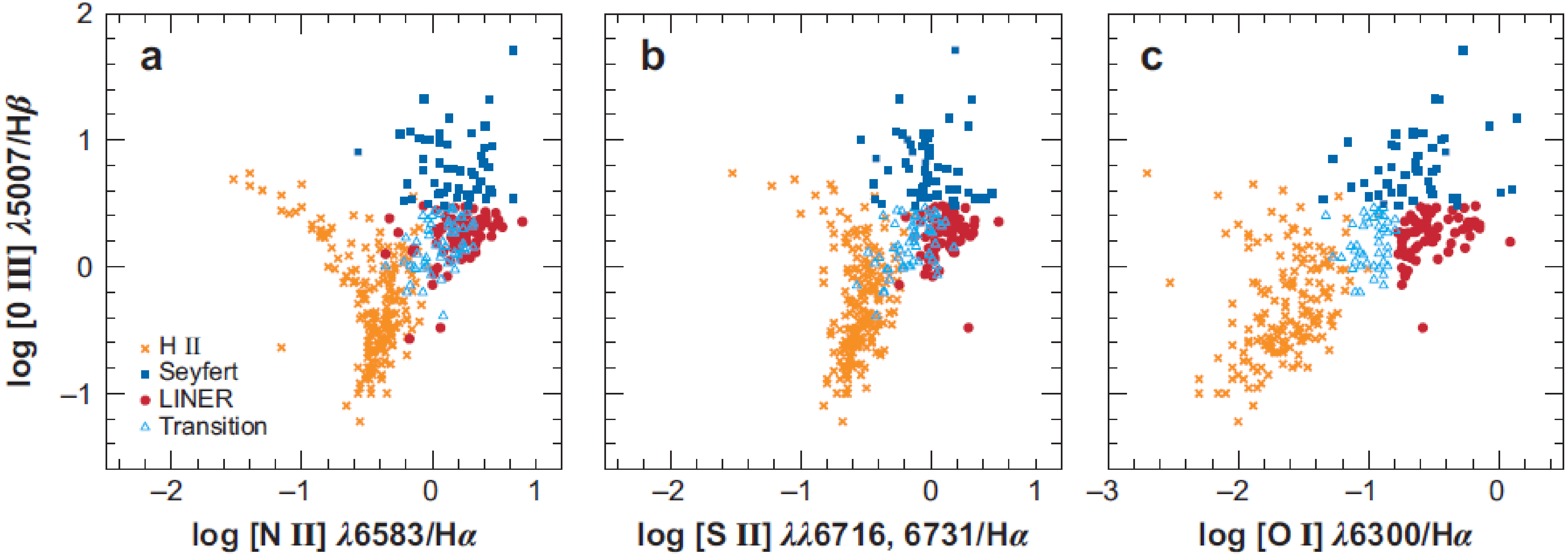
- Continuity ionization state and electron temperature



BUT, difficult detection due to extinction and contamination by circumnuclear star formation

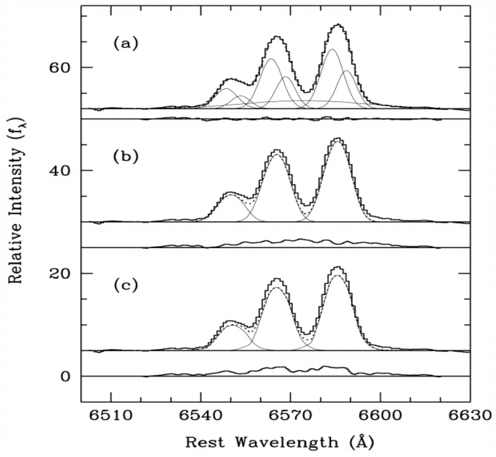
Introduction

Ho (2008)



Warning: broad line LINERs must be AGN powered

LINERs 1.9 (Ho et al. 1997)



Introduction

- **Non Stellar Photoionization**

(Osterbrock 1959, Ferland & Netzer 1983, Halpern & Steiner 1983,Ho,Filipenko & Sargent 1993, Groves,Dopita & Sutherland 2004)

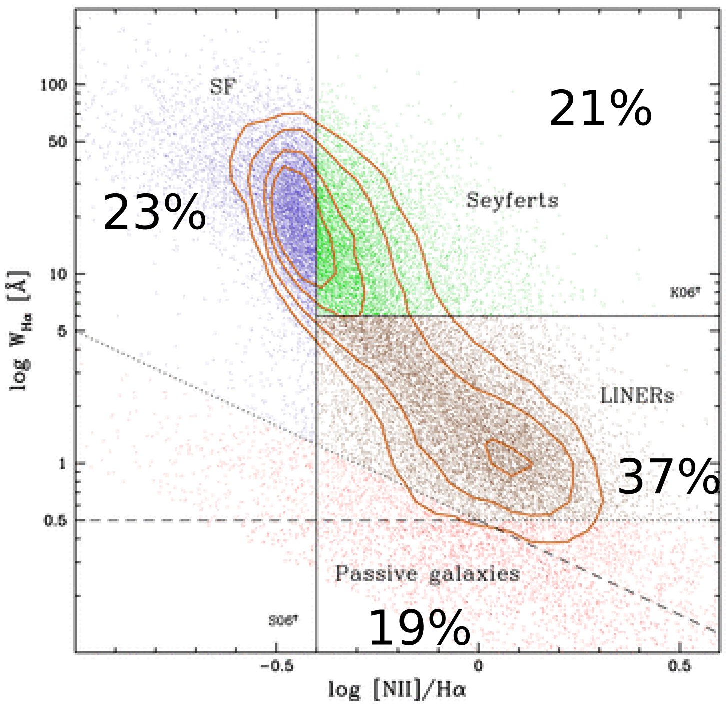
- **Shock induced**

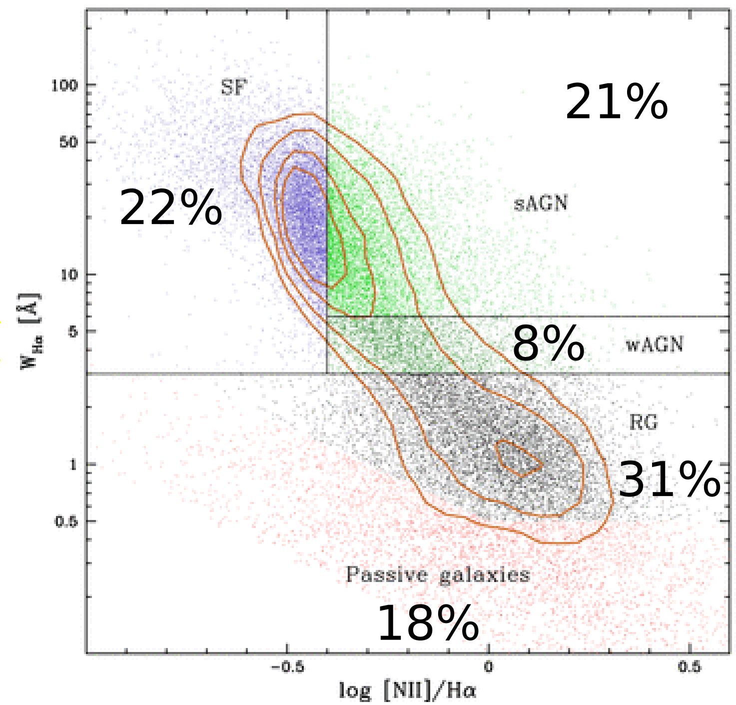
(Dopita & Sutherland 1996, Aldrovandi & Contini, Kewley+2001)

- **Stellar Photoionization**

(Terlevich, Melnick 1985, Binette+1994, Stasinska+2008, Sarzi+2010)

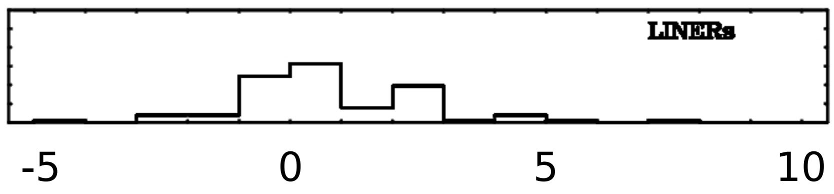
Cid-Fernandes+(2011)





Introduction

MORPHOLOGY

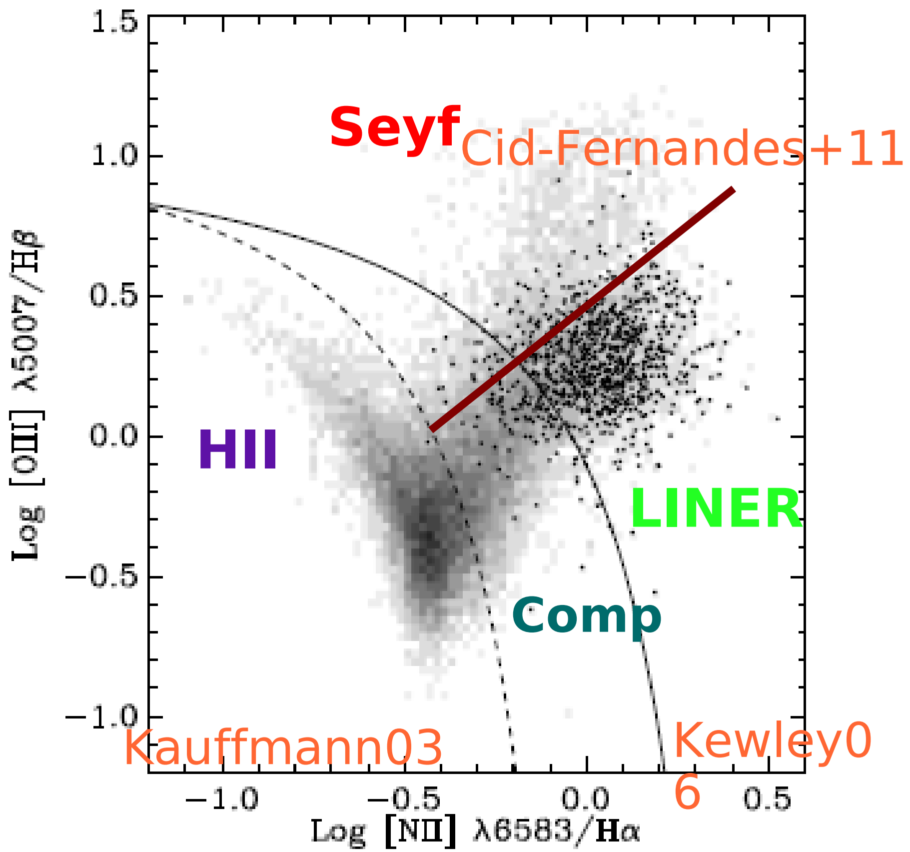


SAMPLE: Palomar Sky Survey

LINERs:from E to Sb,

irrespective of the interaction class

(Márquez et al. 2010)



Passive red galaxies

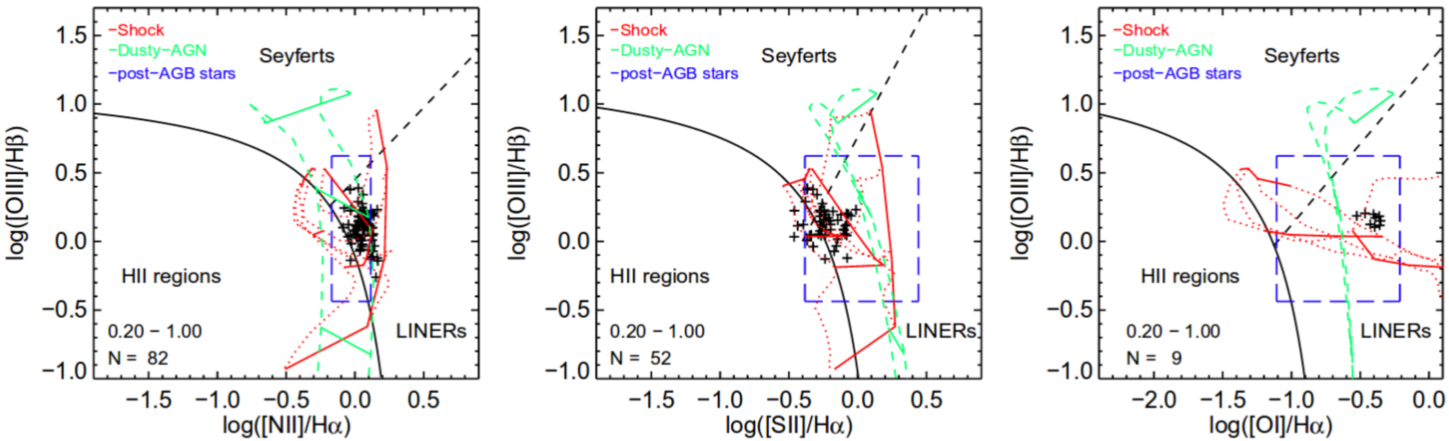
(0.09 < z < 0.1)

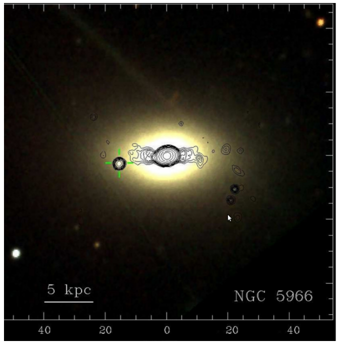
are mostly LINERs

(color-cut selected)

(Yan et al. 2012)

Introduction.LIERS (non-nuclear LINERs)

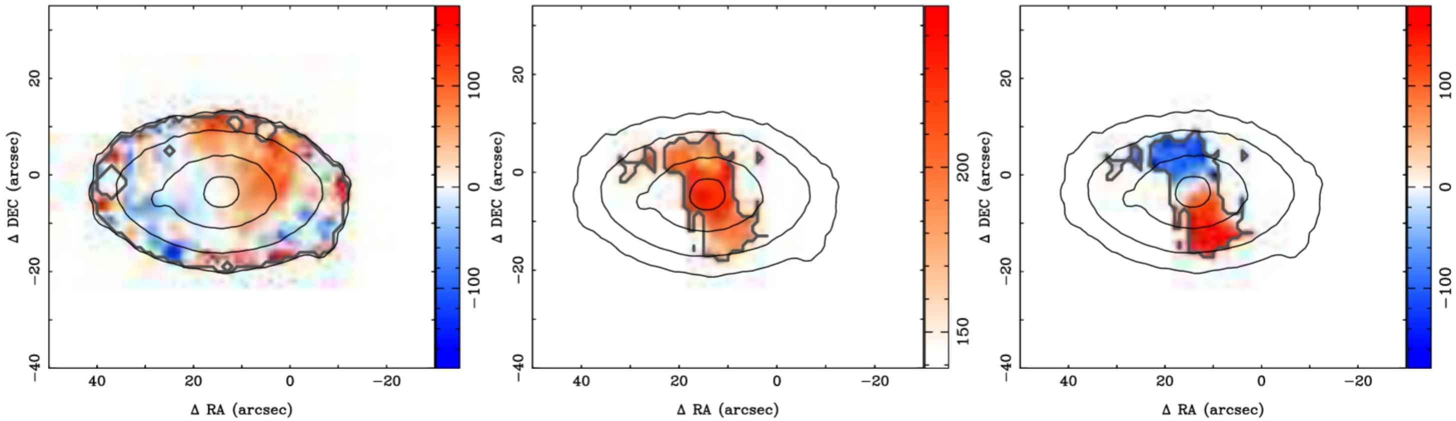




SB Kewley+01
Sy/LINER Kewley+06
Shock grid Allen+08
AGN phot. Grooves+04
pAGB Binette+94

NGC 5966 (Kehrig+ 12)

Vstars (km/s) σ(Hα) (km/s) v(Hα) (km/s)

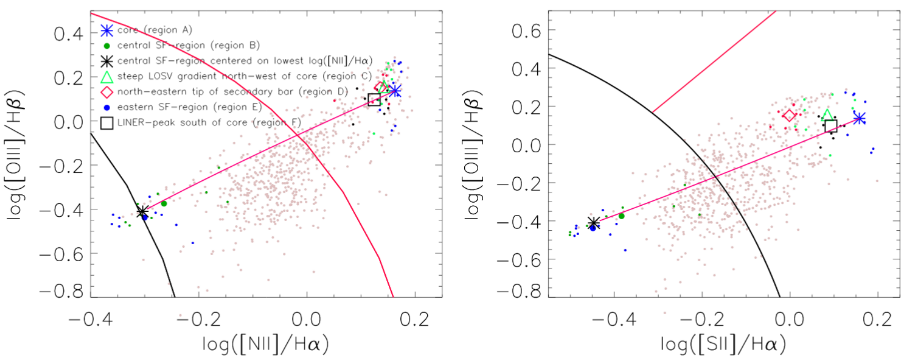


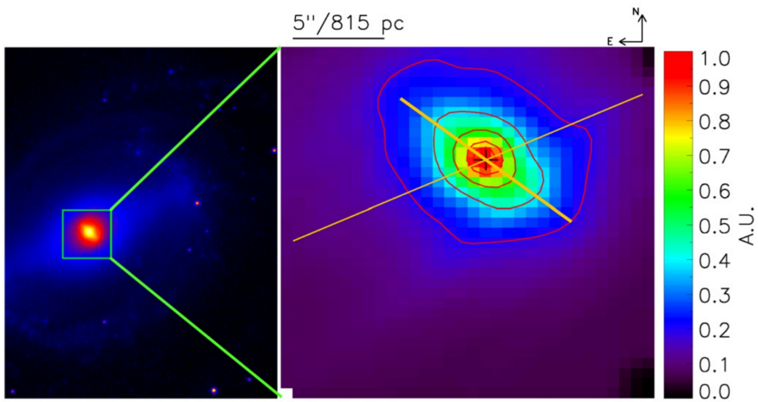
(see also

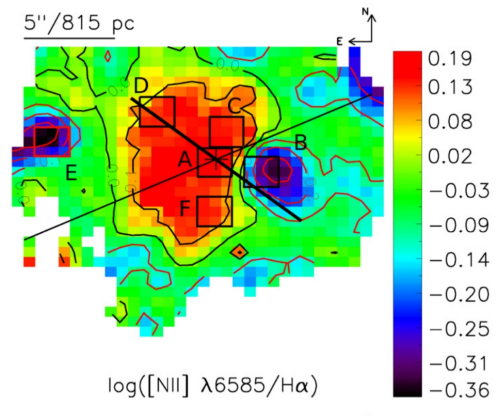
Papaderos+12,

Singh+ 13)

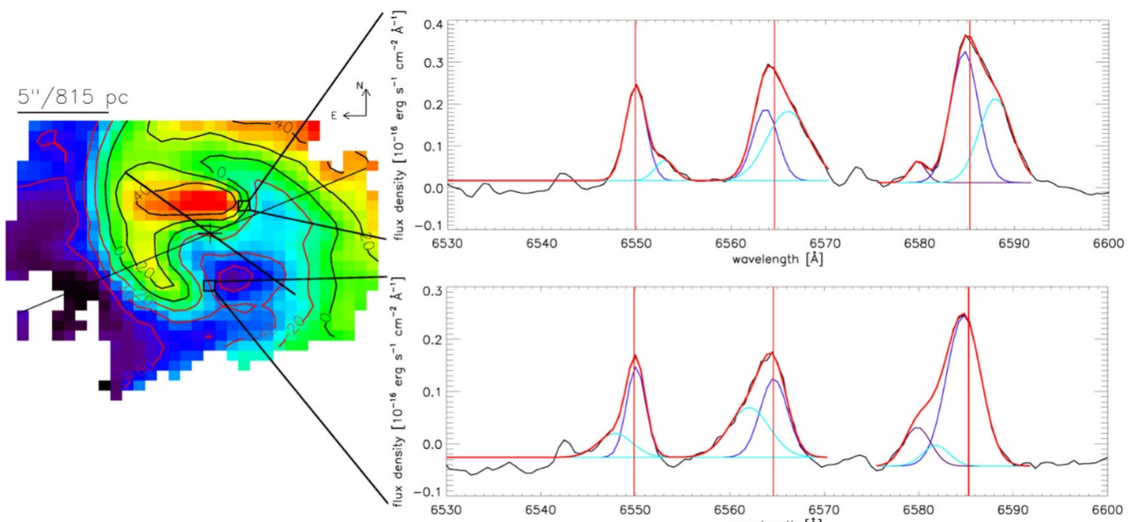
Introduction.LIERS (non-nuclear LINERs)







NGC 5850 **(Bremer+ 13)**



AGN-powered nucleus?

Line asymmetries

AGN LINERs: Xrays

SAMPLE: from multiwavelength catalogue of 476 LINERs **(Carrillo + 1999)**

82 LINERs

68 with *Chandra*,

54 with *XMM-Newton*

(40 in common)

Gonzalez-Martín's PhD thesis

González Martín et al. (2006a, 2009a, 2009b)

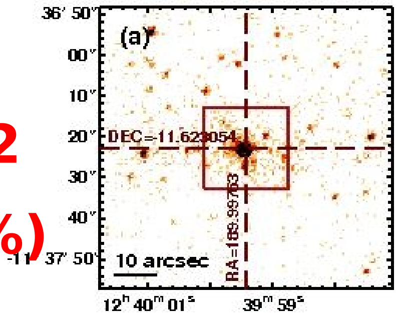
AGN LINERs: X-rays

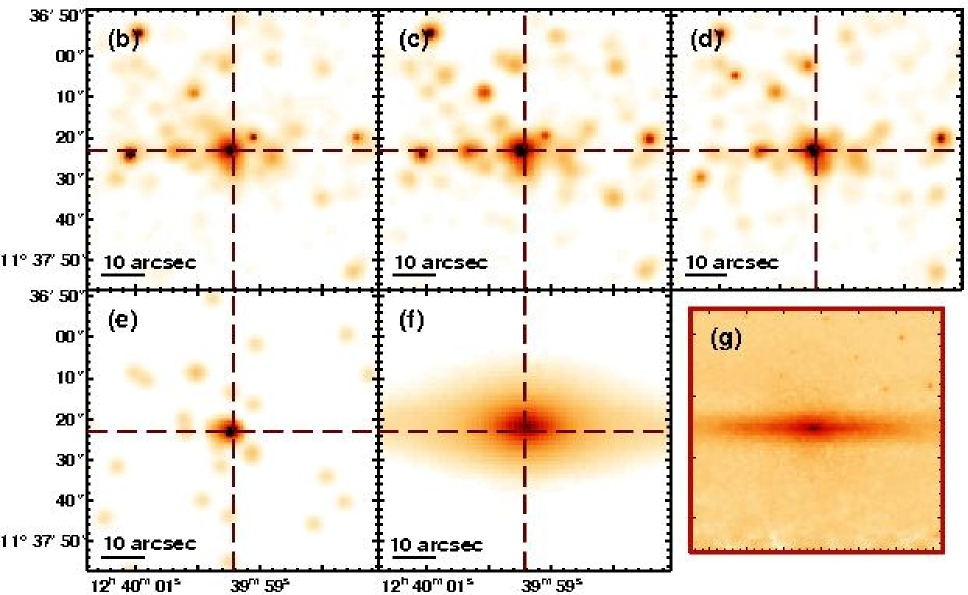
AGN candidate: With a **point-like source at 4.5-8.0 keV**

Non-AGN candidate: Without point-like source at 4.5-8.0 keV

48/82

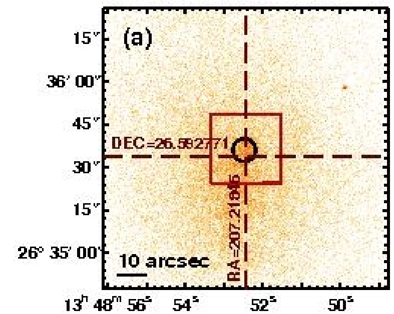
(60%)

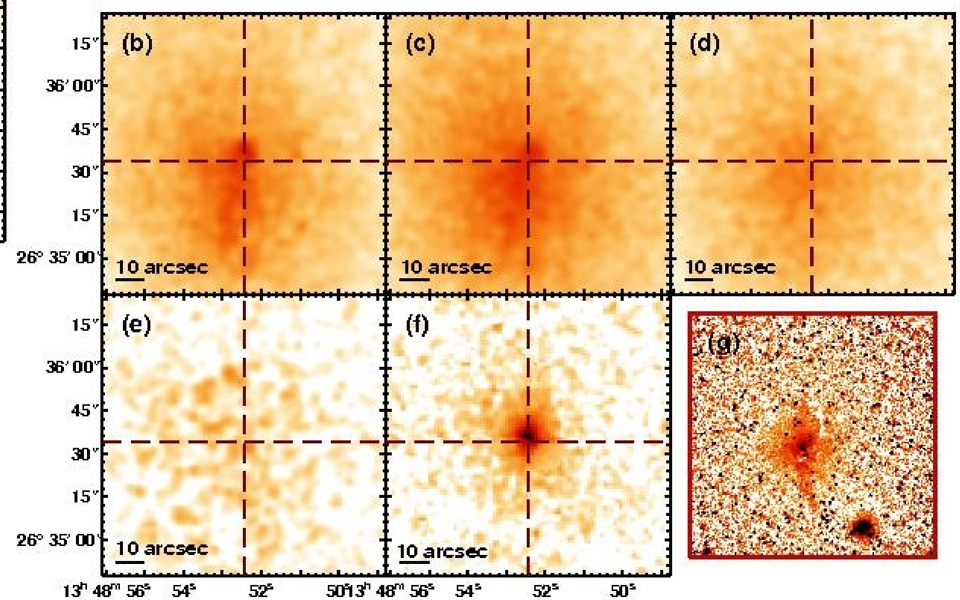




34/82

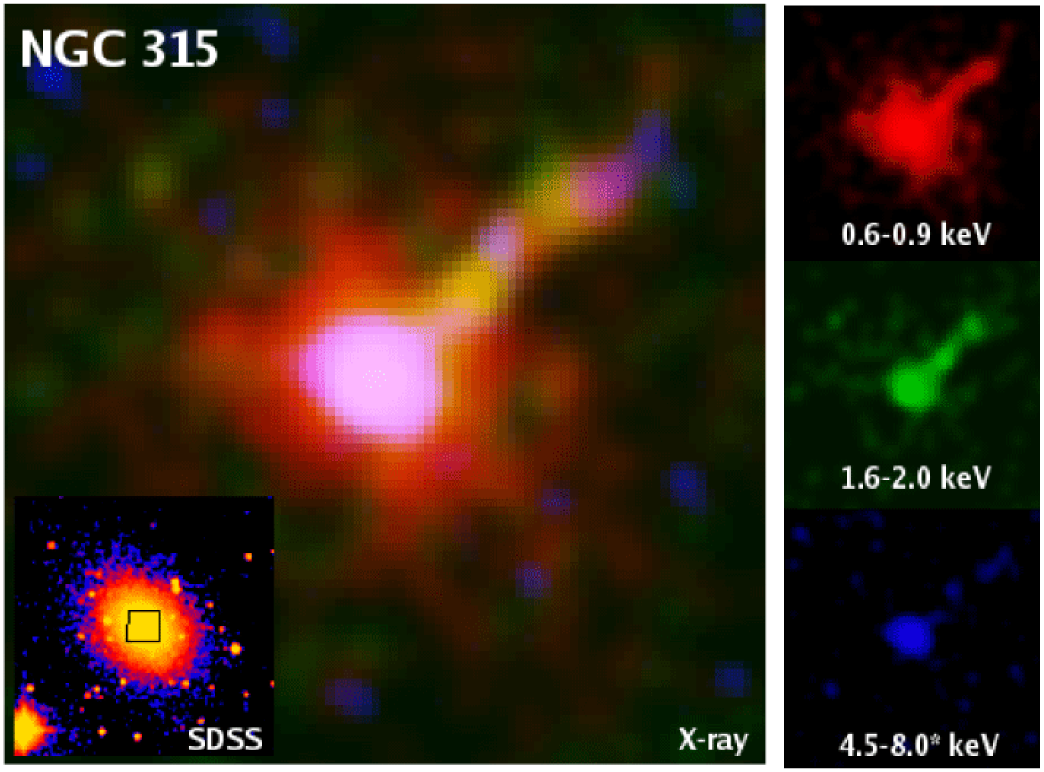
(40%)





AGN candidates: **90% when including other wavelengths**

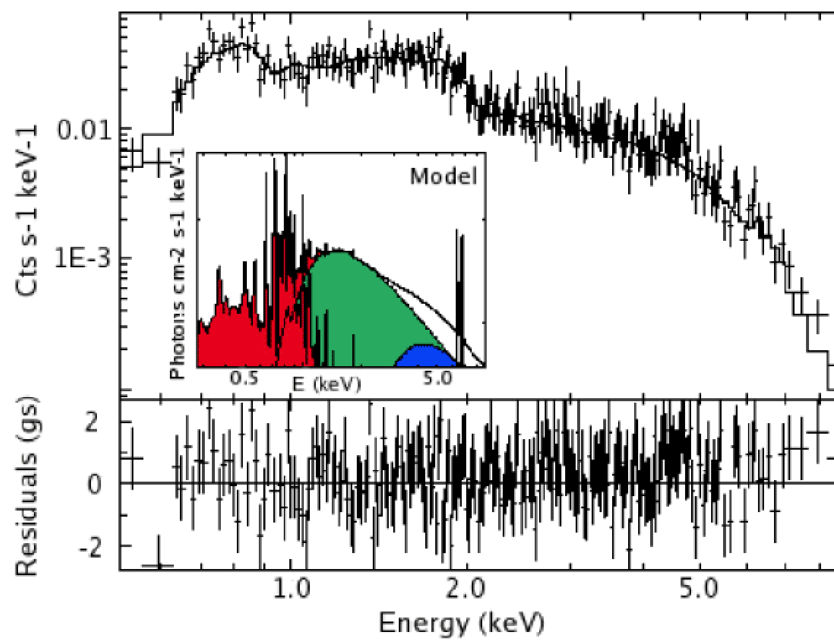
AGN LINERs: X-rays



X-ray spectral fitting:

MEPL, two absorbers
Γ = 2.11 (σ =0.52)
kT = 0.54 (σ =0.52)

log NH1 = 21.32 (σ =0.71)
log NH2 = 21.93 (σ =1.36)

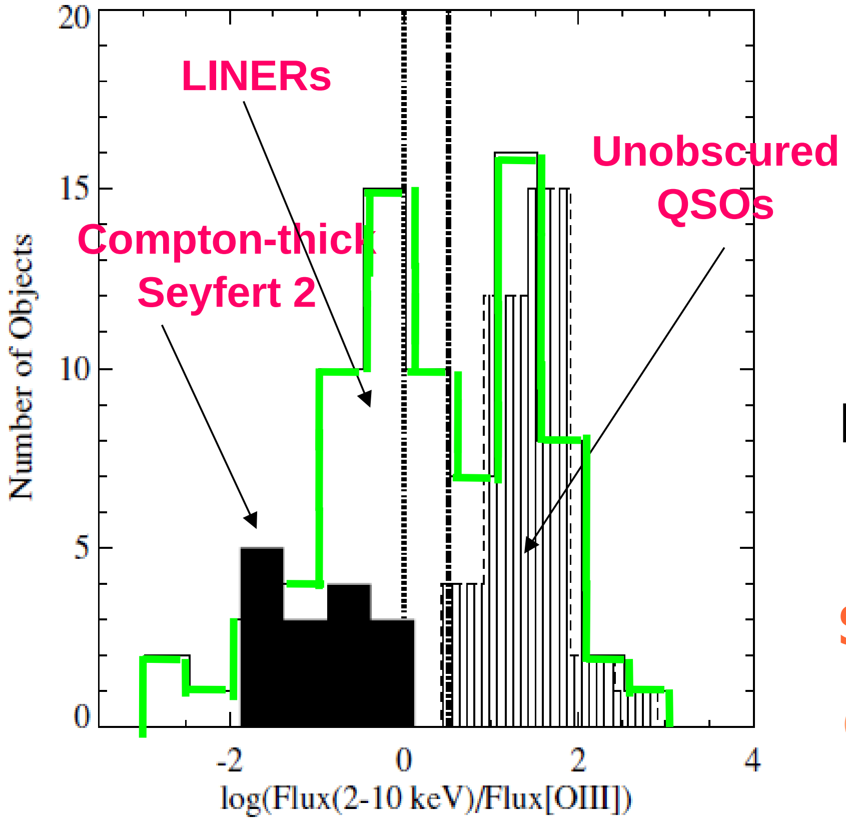


Front cover A&A

(González-Martín+2009a)

AGN LINERs: X-rays

Why LINERs are so Dim with M_BH of 10^8 - 10^9 Mo ?



Compton thick indicator

✓ L([OIII])/L(2-10 keV)

LINERS: **63%** Compton-thick

(52/82)

Seyfert 2: 23% Compton thick

(Panessa et al. 2006)

The origin of such obscuration is crucial to relate LLAGN to HLAGN

(González-Martín+2009b)

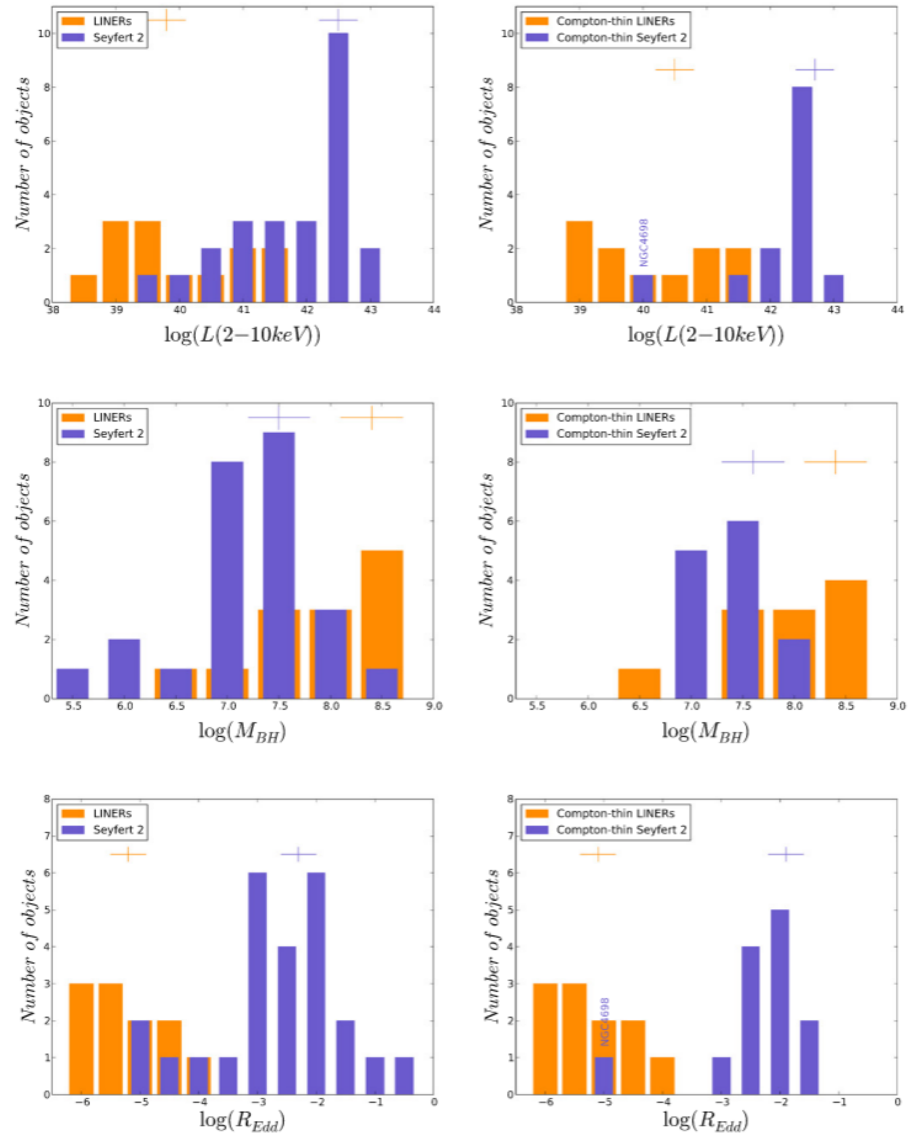
AGN LINERs: X-rays

LINERS *versus* Seyfert 2s

LINERS have

- lower X-ray luminosities

- lower Eddington ratios



(Hernández-García+2016)

AGN LINERs: X-ray variability

Sample: **17 AGN–LINERs with multiepoch XMM–Newton and/or Chandra observations**

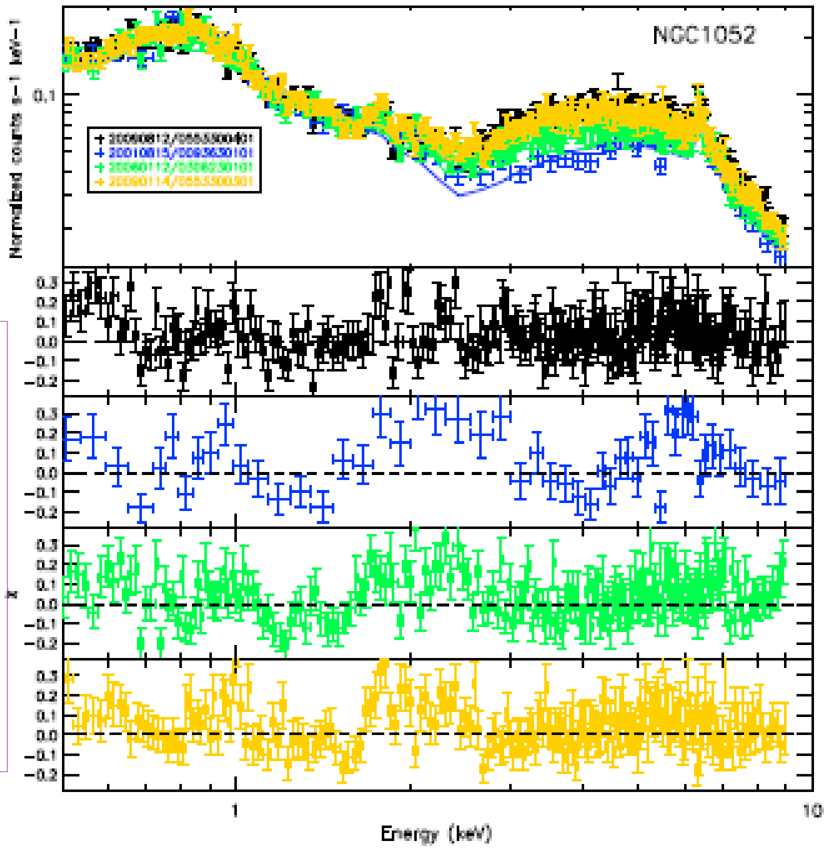
Long and short term variations studied

Model:

wabs[NHgal](zwabs[NH1]*mekal[kT,Norm1] +

zwabs[NH2]*plaw[gamma,Norm2])

- No short-term variations
- 50% with long-term variations
- **Flux variations due to Norm2 and NH2** (one case)
- **Variable at UV**



Hernández-García +2013, 2014, 2016

AGN LINERs: X-rays

LINERS *versus* Seyfert 2s

Variations due to **absorbers at hard X-ray** energies are much **more frequent in Seyfert 2s** than in LINERs

No LINER changing-look candidates have been reported

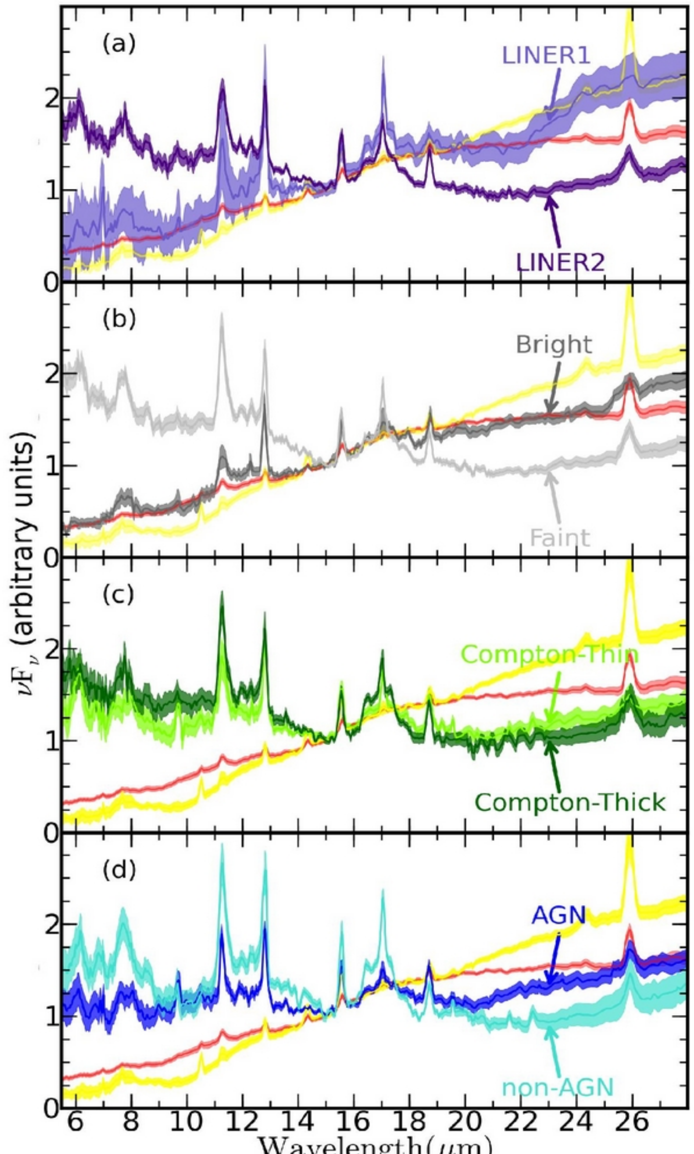
UV long-term variations are common in LINERs
(not detected in Sey2)

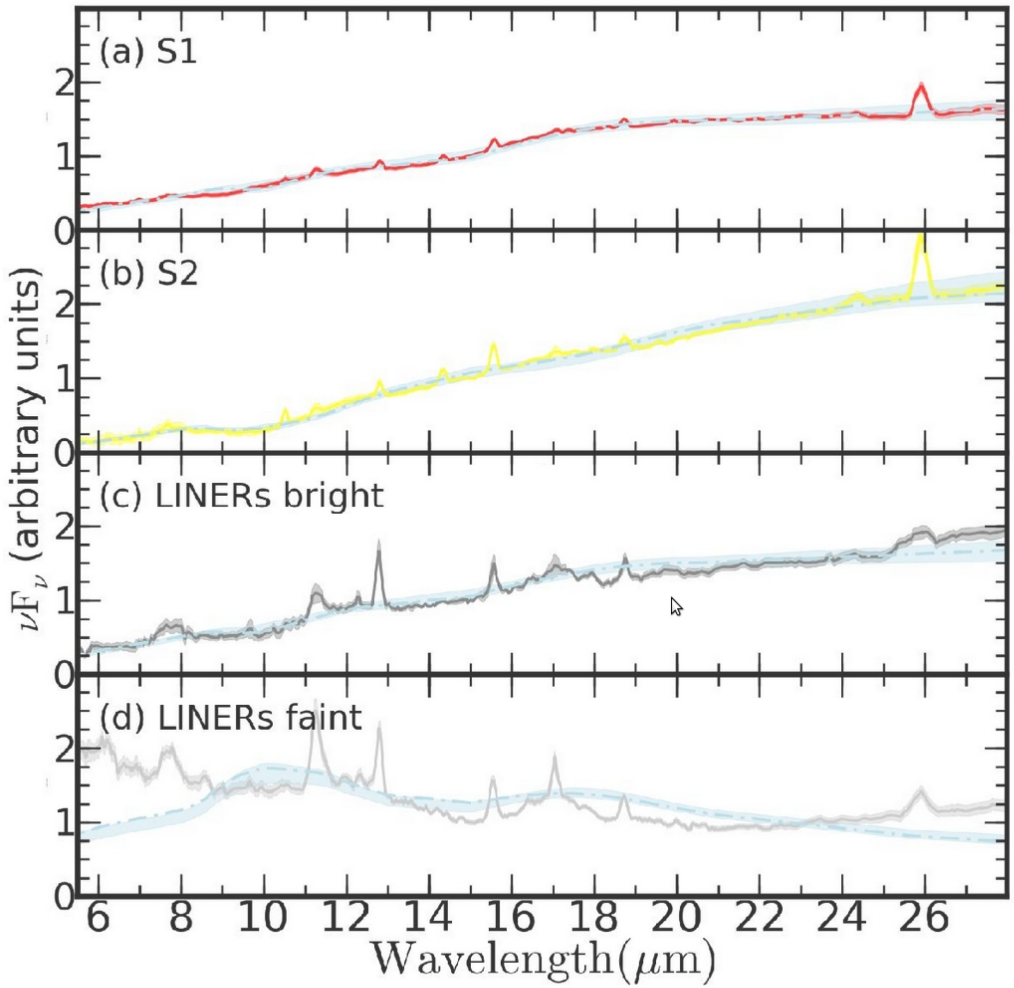
	LINER	**Seyfert 2**
Short-tem var.	No	No
Long-term var.	Yes	Yes
Variable parameters	Norm2 (NH2 in one case)	Norm2 NH2
Long-term UV	Yes	No

(Hernández-García+2016)

AGN LINERs: MIR spec.

Bright LINERS L_X(2-10 keV) > 10^{41} erg/s





(González-Martín et al. 2015)

AGN LINERs: MIR spec.

- Spectral decomposition: torus, ISM, stellar

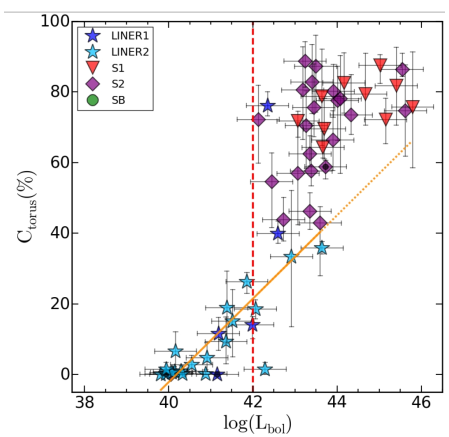
- High resolution MIR images, Xray luminosity

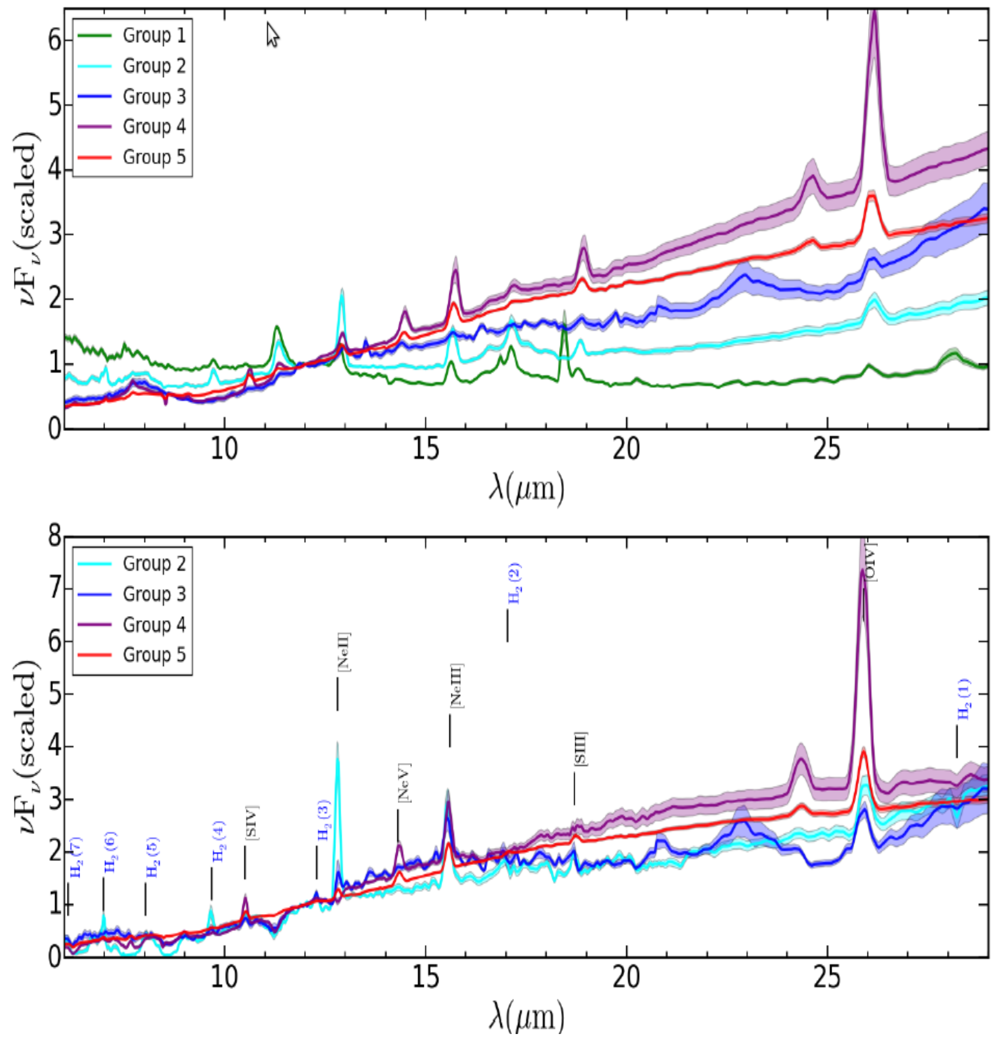
- Affinity propagation method for grouping

- LINERS in groups 1 and 2

- Torus contribution negligible $L_{BOL} \sim 10^{41}$ erg/s

NEW





(González-Martín et al. 2017)

IONIZED GAS IN LINERs

Hα HST imaging:

32 LINERs

Hα imaging

of (multi-λ)

confirmed AGN

favours

core-halo

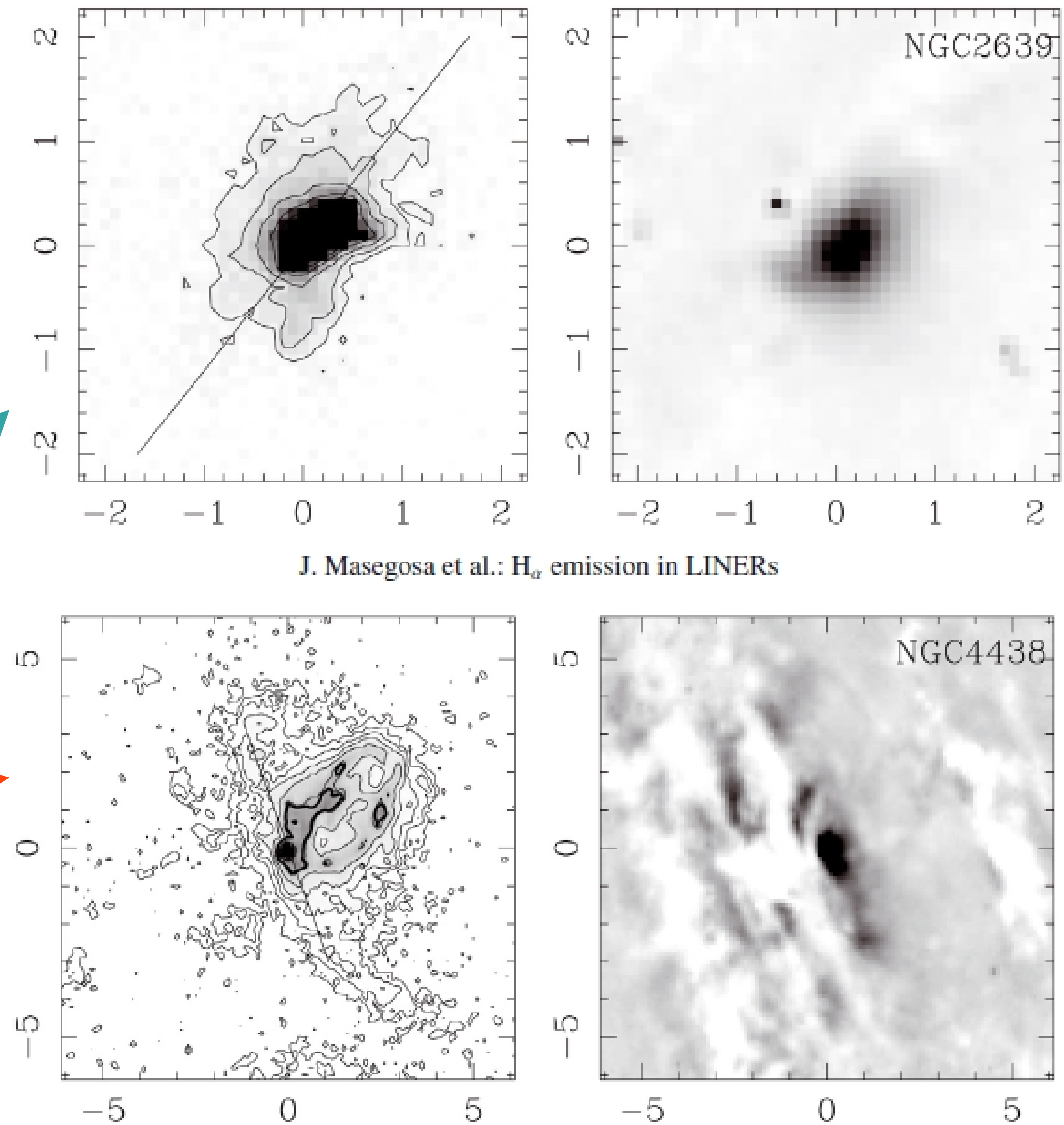
and

outflow

morphologies

(65%)

(Masegosa+2011)

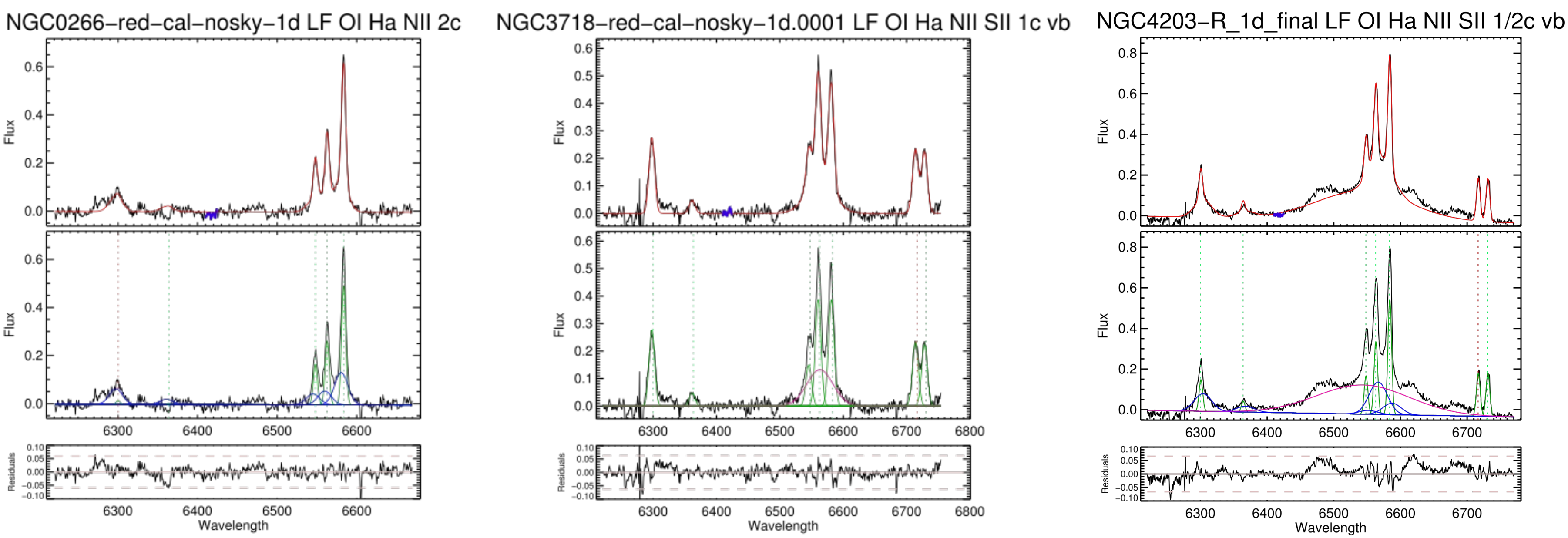


The BLR in LINERs 1.9 revisited

All 22 LINERs 1.9 from Ho et al. (1997) observed with TWIN@CAHA, (dispersion ~ 0.55 A/px, 0.56”/px)

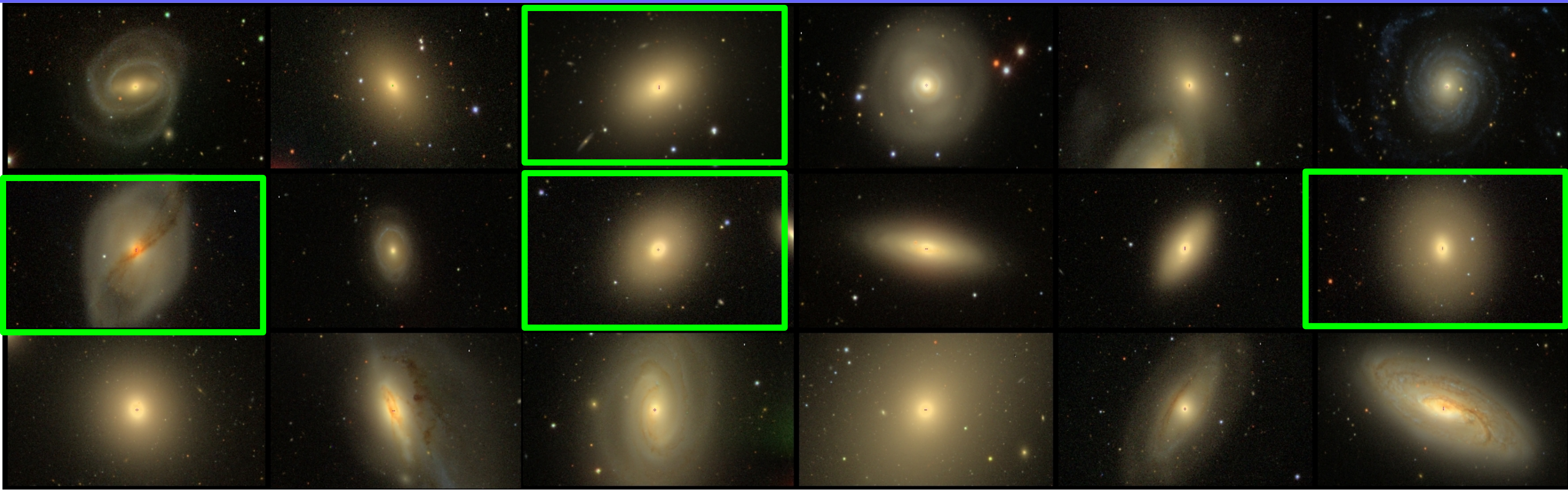
Stellar population carefully subtracted (Starlight and Ppfx)

Fitting of the narrow emission lines [SII], [OI]



(Márquez+, in prep.)

The BLR in LINERs 1.9 revisited



Generally narrow lines with several components, [SII] different from [OI]

Very broad Hα component not required in 15 LINERs

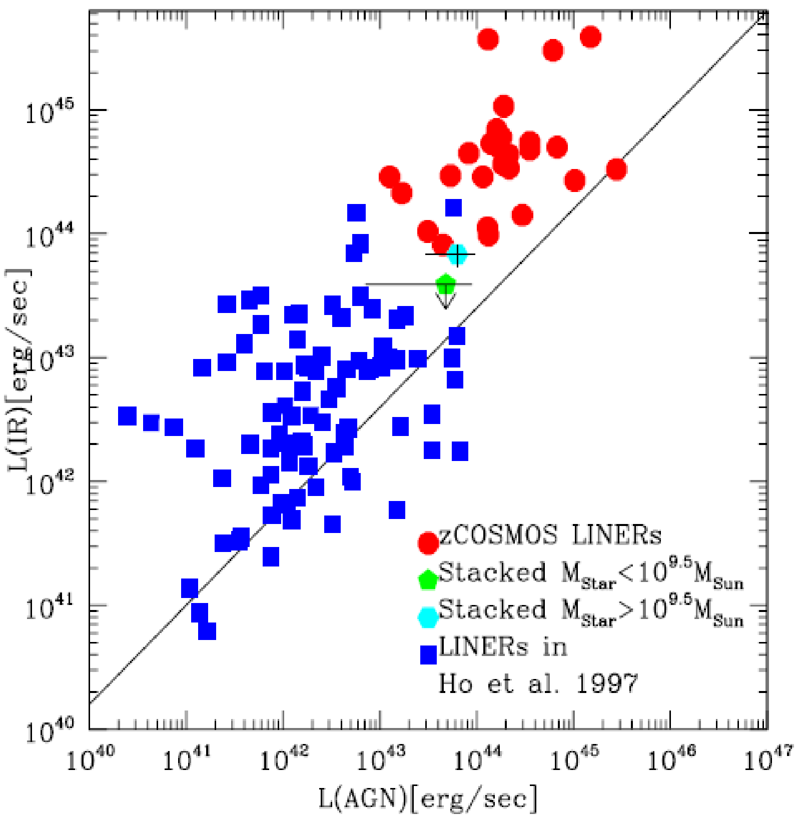
14 with HST/STIS spectroscopy: disagreement when fixing narrow component with [SII] (see Balmaverde et al.)

Very broad Hα in 5 LINERs (N1052, N3718, N3998, N4203, N5077)

(Márquez+, in prep.)

Most luminous LINERs @z=0.04 – 0.11

Tommasin et al. 2012



LINERs from zCOSMOS at

z ~ 0.3 (Herschel-PACS FIR data)

- L(IR) from 10^{44} erg/s

and higher AGN luminosities

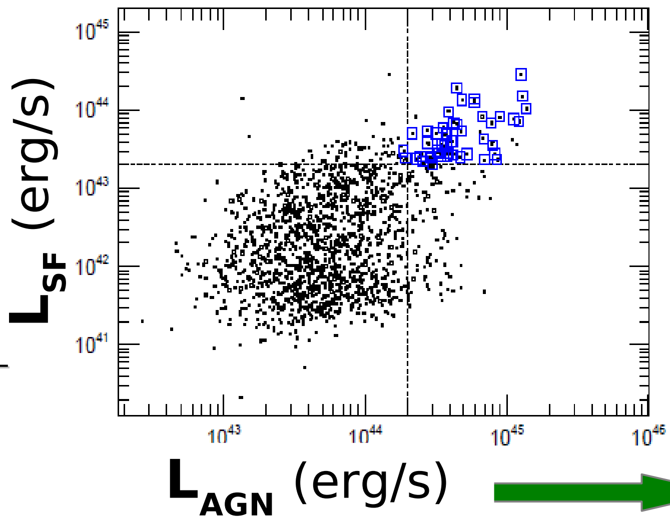
- later morphological types
  (82% of their sample)

- LINERS at z ~ 0.3 have LFIR 2 orders of magnitude higher than those for nearby LINERs

Most luminous LINERs @z=0.04 – 0.11

SAMPLE

- **SDSS/DR4** MPI-JHU catalogue
- classification: **BPT-NII and BPT-OI** diagrams
- redshift selection: **0.04 < z < 0.11**
- **EW(Hα) > 2.5A**



<u>Luminous LINERs (LLINERs) selection, in terms of their AGN luminosity:</u>
- LAGN measured through [OIII] and [OI] (Netzer 2009)
→ ~ 150 LLINERs with **logLAGN > 44.3** (erg/sec)

<u>The most luminous LINERs (MLLINERs) selection, in terms of their AGN and SF luminosity:</u>
- SFR measured with *Dn4000* method → LSF
→ selected <u>**47 sources**</u> with **logLSF > 43.3** (erg/sec)

DATA

CAHA/TWIN & NOT/ALFOSC		**HERSCHEL/PACS**		**IRAS**
- long-slit spectra for 42 sources - spectral sampling 0.8, 1.1-1.2 Å/px	+	- 6 sources - 70 & 10 μm	+	- 13 sources - 12,25,60 & 100 μm

Povic et al. 2016

Most luminous LINERs @z=0.04 – 0.11

Local LINERs are hosted by massive and old early-type galaxies, with low extinctions, massive BHs, old stellar populations, and little or no star-formation

- MLLINERs in this work have:

*** all morphologies**

*** higher extinctions**

*** much higher SFRs**

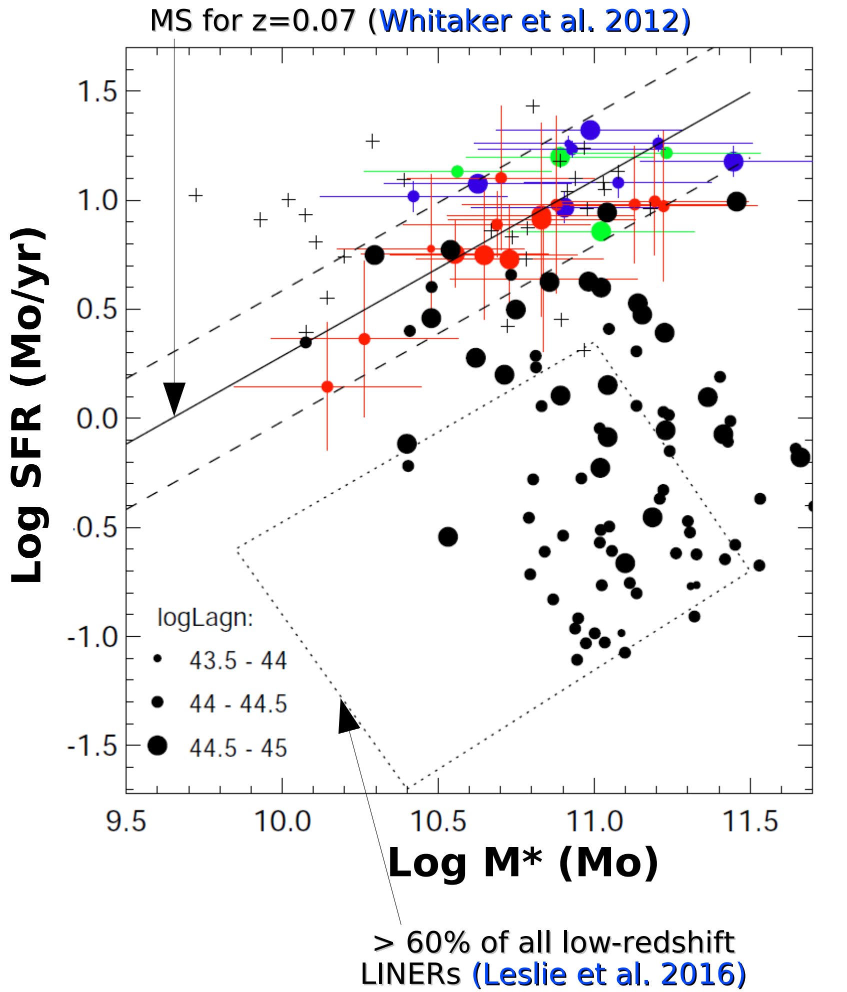
- This kind of LINERs, first detected @ z ~ 0.3, confirmed in the local universe (@z = 0.04 – 0.11) **so evolutionary scenario discarded**

- Same M*, SFRs, and LAGN at both redshifts

- **Along the LAGN = LSF line** (co-evolution?)

- Most of them lie on the MS of SF galaxies, with M* > 10^{10}Mo

- Fraction of LINERs on MS depends on AGN luminosity



Povic et al. 2016

Conclusions

1. AGN LINERs

X-rays: 60%-90% AGN, Compton-thickness, comparison with Sey2 properties and variability

MIR spectroscopy: bright LINERs similar to Sey2, torus contribution negligible $L_{BOL} \sim 10^{41}$ erg/s

HST Hα imaging: outflow/core-halo morphologies

BLR in LINERs 1.9 revisited: 5/22 need very broad Hα

2. Most luminous LINERS @ z=0.04-0.11

- Same M*, SFRs, and LAGN at z=0.3
- Along the LAGN = LSF line
- Most of them lie on the MS of SF galaxies, with M* > 10^{10}Mo
- Fraction of LINERs on MS depending on AGN luminosity