Deep IFS View of Nuclei of Galaxies (DIVING^{3D}) survey: first results

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Introduction

- Galactic nuclei are very important regions, as they may contain relevant information about the formation and evolution of these objects
- Many galactic nuclei present emission line spectra that cannot be atributed to stars. These are the Active Galactic Nuclei (AGNs)
- The energy released by AGNs comes from the accretion of matter onto a central supermassive black hole (SMBH)
- AGN types: Quasars, Seyfert galaxies, Low Ionization Nuclear Emission-Line Regions (LINERs), etc

Introduction

- Most, if not all, massive galaxies host SMBHs at their centers (Kormendy & Richstone 1995; Richstone et al. 1998)
- There are strong correlations between the SMBH masses and certain properties of the host galaxies (M-σ relation; Ferrarese & Merritt 2000; Gebhardt et al. 2000)
- Such correlations suggest a co-evolution between the central SMBH and the host galaxy

The DIVING^{3D} project

- The purpose of the Deep IFS View of Nuclei of Galaxies (DIVING^{3D}) survey is to observe the nuclear regions of all galaxies in the Southern hemisphere with $B \leq 12.0$ and $|b| > 15°$

- The complete sample has a total of 170 objects

- Most of the galaxies were observed with the Integral Field Unit (IFU) of the Gemini Multi-Object Spectrograph (GMOS) in the Gemini South telescope

The DIVING^{3D} project

- The main goals of the DIVING^{3D} survey are to study the properties of:

  - nuclear emission

  - circumnuclear emission

  - stellar and gas kinematics

  - stellar populations archeology

The PALOMAR survey

- The purpose of the PALOMAR survey (Filippenko & Sargent 1985) was to observe the nuclear regions of all galaxies in the Northern hemisphere with $B \leq 12.5$
- The complete sample had a total of 486 objects
- The observations were taken with Palomar 5 m telescope, using long-slit spectroscopy
- A slit of 2” x 4” was used

Data reduction and data treatment

- The data cubes were reduced in IRAF environment, using the Gemini package. The reduction included:

  - trim
  - bias subtraction
  - cosmic ray removal
  - extraction of the spectra
  - flat-field correction
  - wavelength calibration
  - sky subtraction
  - flux calibration
  - data cube construction

Data reduction and data treatment

- All data cubes were treated with a procedure including the following steps (Menezes et al. 2014,2015 and Menezes et al.2018 submitted):

  - correction of the differential atmospheric refraction

  - combination of the data cubes, in the form of a median

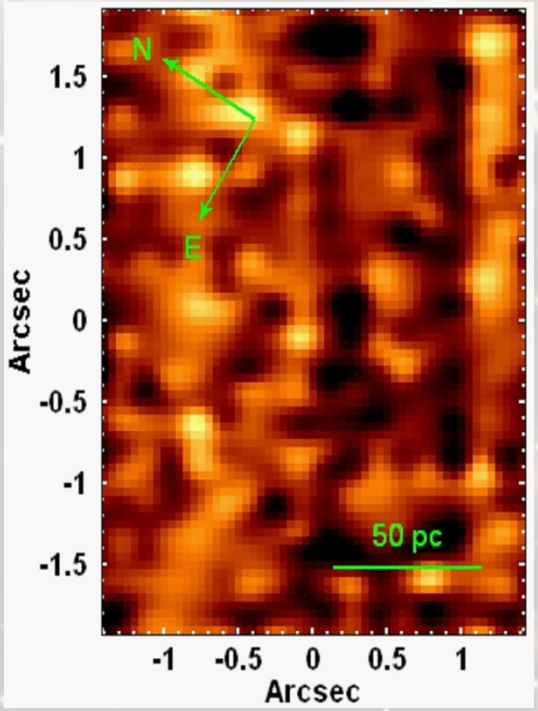
  - Butterworth spatial filtering

  - Richardson-Lucy deconvolution

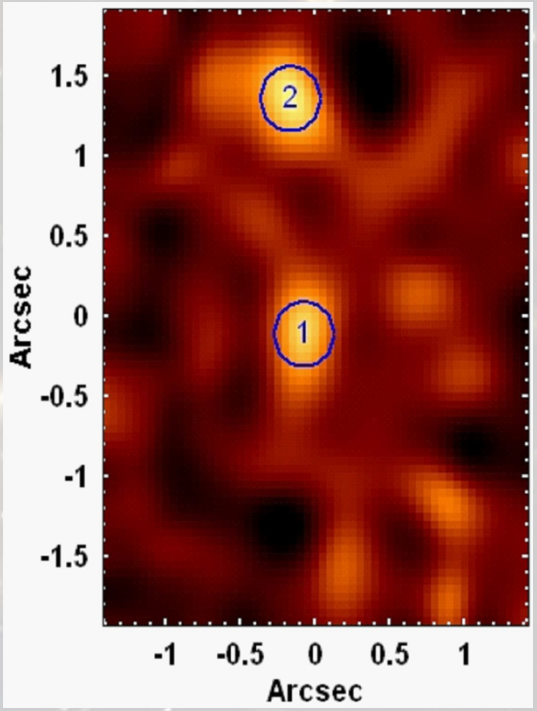
Data reduction and data treatment

[N II] λ6584 images of NGC 2835

Non-treated



Treated



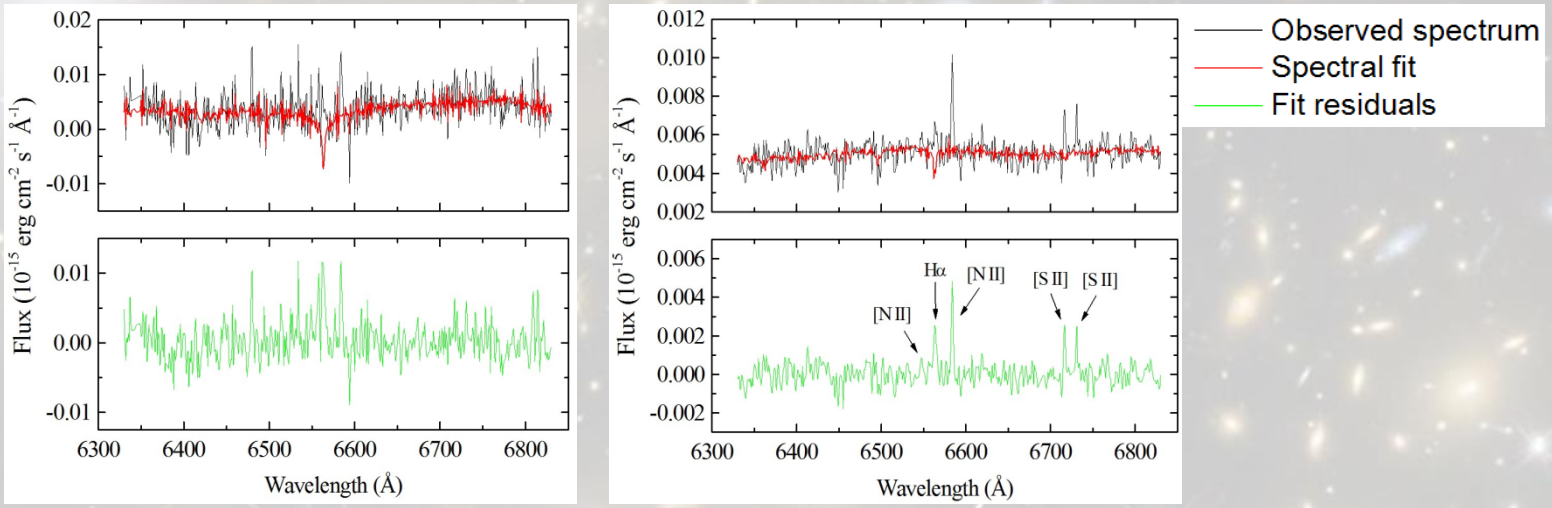
Data reduction and data treatment

Spectra of regions 1 and 2 of NGC 2835

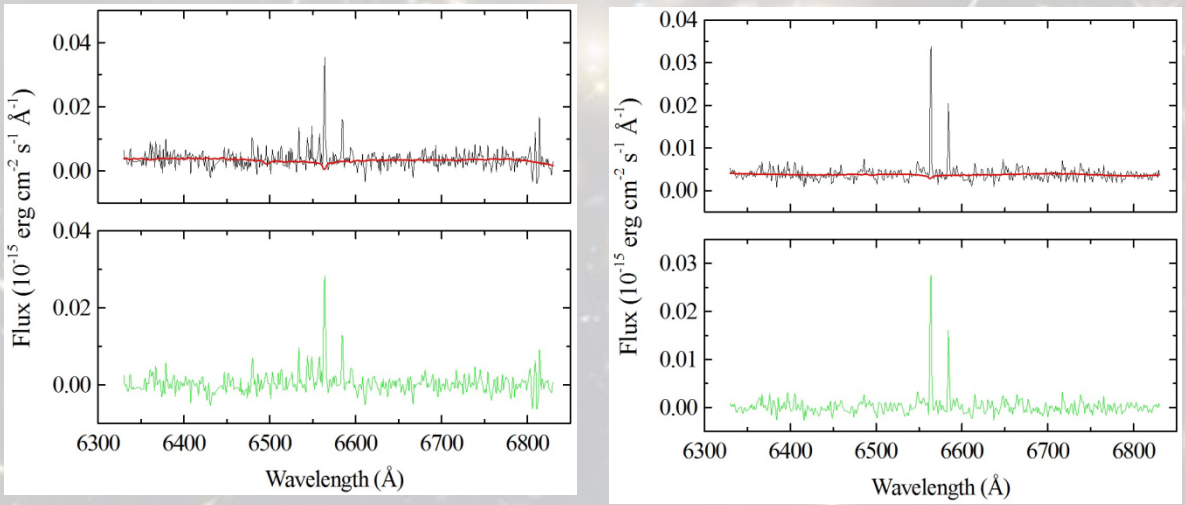
Non-treated

Treated

Region 1



Region 2



Data reduction and data treatment

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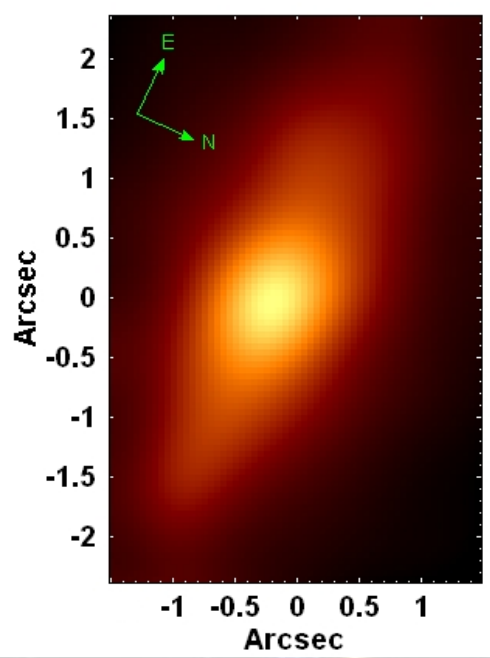

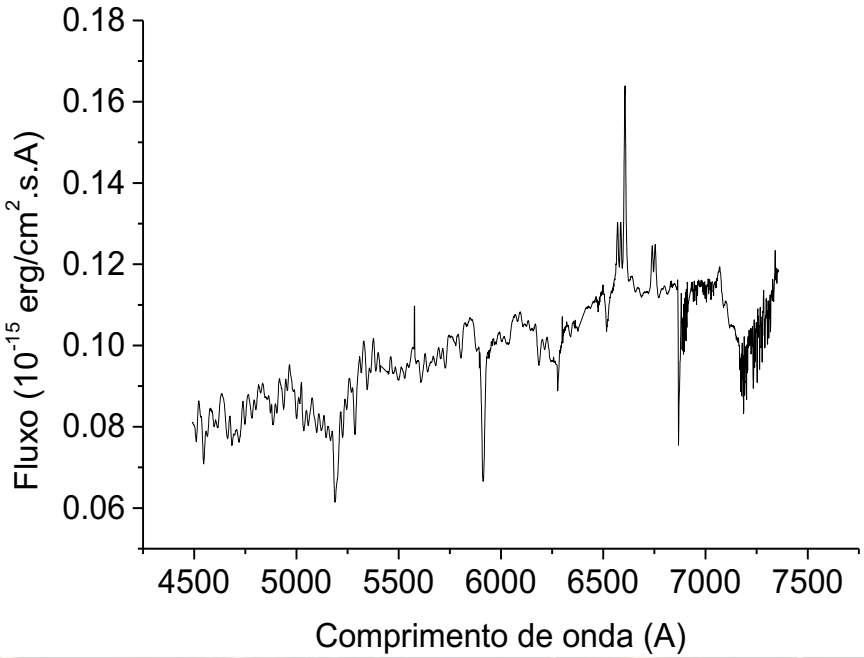

Analysis of the nuclear emission-line spectra

- We analyzed the nuclear emission-line spectra of one sub-sample of the DIVING^{3D} sample, which includes all galaxies (a total of 57 objects) with B < 11.2: the mini-DIVING^{3D}

- The nuclear spectra of the galaxies in the sub-samples were extracted from circular regions, centered on the stellar nuclei

- The radii of such regions were taken as half of the FWHM of the PSF

- The extracted spectra were corrected for the interstellar extinction, due to the Milky Way, using the Av values provided by the NASA Extragalactic Database (NED) and the extinction law of Cardelli et al. (1989)

Analysis of the nuclear emission-line spectra

- The starlight subtraction of the extracted spectra was performed using the Penalized Pixel Fitting (pPXF) procedure
- The interstellar extinction at the observed objects was corrected using the Hα/Hβ ratio and the extinction law of Cardelli et al. (1989)
- In order to obtain a diagnostic diagram, we calculated the [N II]λ6584/Hα and [O III]λ5007/Hβ ratios

Analysis of the nuclear emission-line spectra

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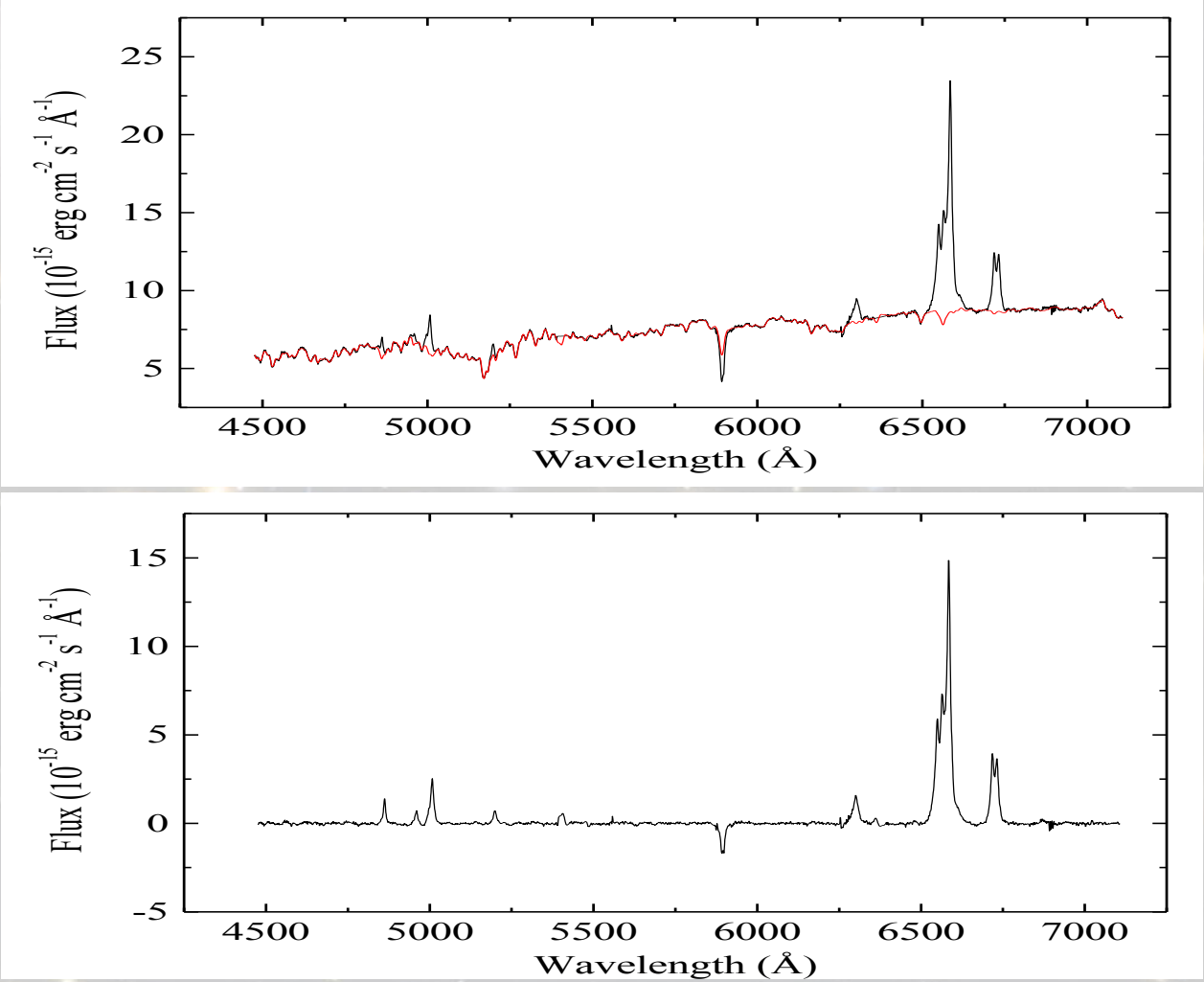
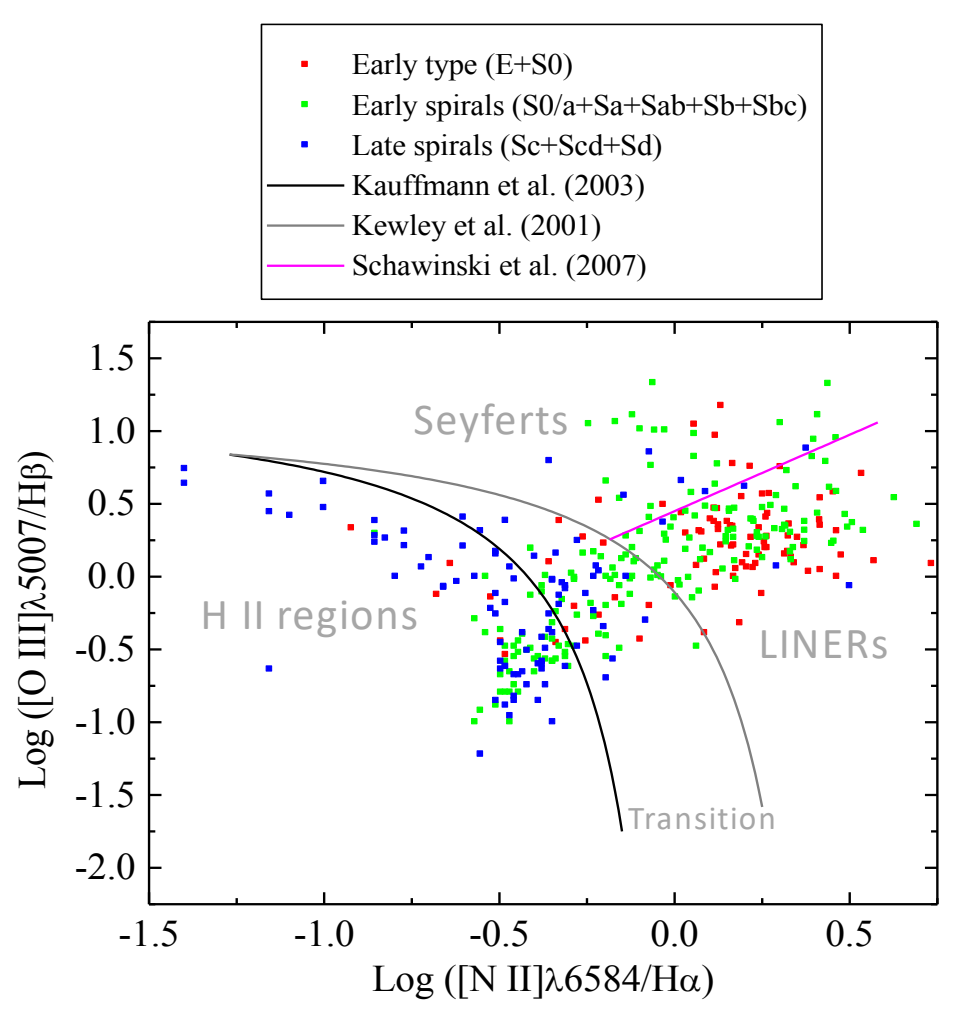


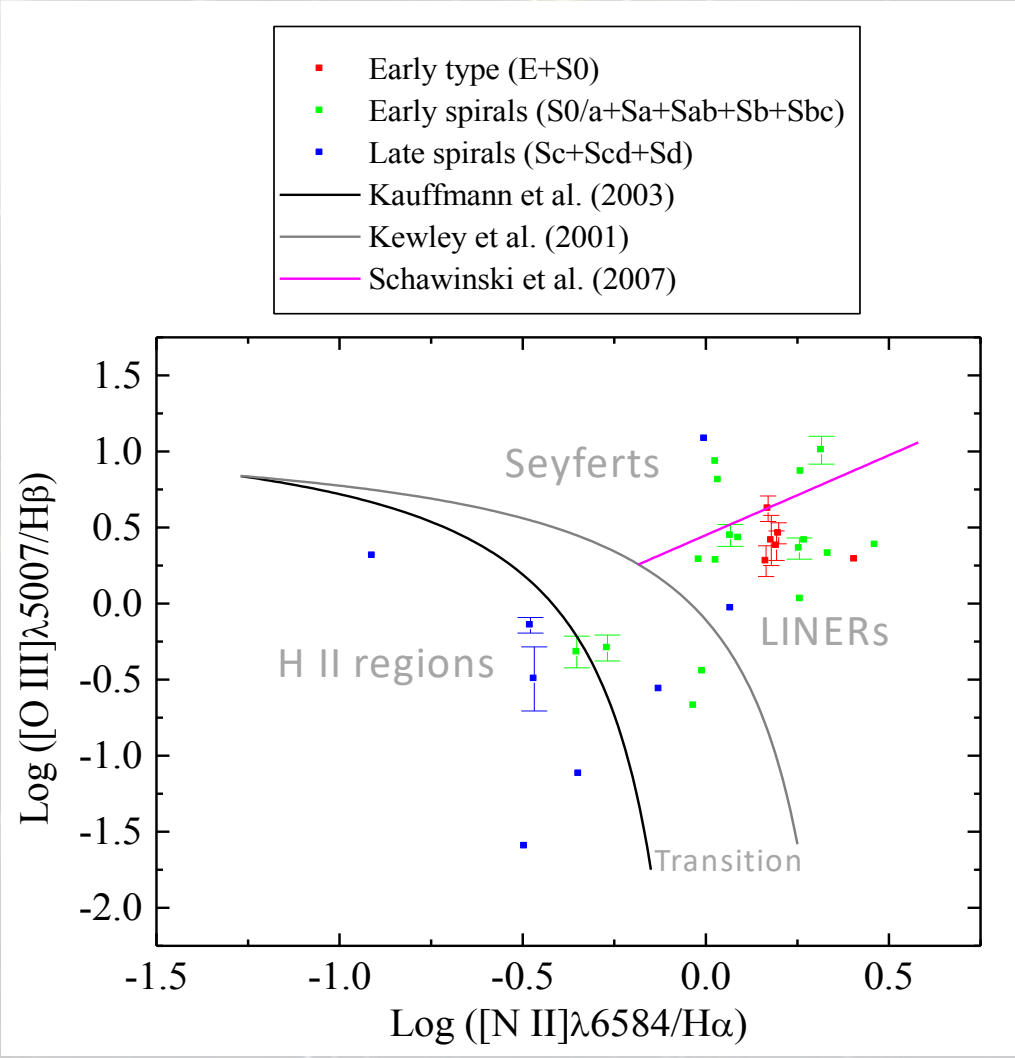
Results

PALOMAR sample



Results

Mini-DIVING^{3D} sample



Results

	Mini-DIVING^{3D}	Palomar
H II regions	14%	30%
Transition objects	7%	17%
Seyfert galaxies	9%	7%
LINERs	32%	31%
Seyferts/LINERs	53%	38%
Objects with emission lines	88%	86%

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Conclusions

- The statistical results obtained with the DIVING^{3D} survey may be able to provide relevant information about the formation and evolution of the galaxies

- The treatment and analysis techniques were essential to obtain most of the results

- So far, a higher number of LINERs and Seyferts was detected with the mini-DIVING^{3D}, in comparison with the PALOMAR survey

- In addition, a lower number of galaxies were classified as transition objects, revealing na apparent dichotomy in the data

Thank you