Universidad de Cantabria
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Una visión multifrecuencia de Núcleos de Galaxias Activas

Memoria presentada por el Licenciado

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para optar al título de Doctor en Ciencia y Tecnología

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Declaración de Autoría

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y

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CERTIFICAN que la presente memoria

Una visión multifrecuencia de Núcleos de Galaxias Activas

ha sido realizada por **Ignacio Ordovás Pascual** bajo nuestra dirección.
Consideramos que esta memoria contiene aportaciones suficientes para construir la tesis Doctoral del interesado.

En Santander, a 11 de Julio de 2018

Silvia Mateos Ibáñez   Francisco Jesús Carrera Troyano

La dedicatoria apropiada....

Agradecimientos

Agradecimientos

Resumen de la tesis en castellano

Objetivos de la Investigación

Relleno.

Planteamiento y metodología

Relleno.

Aportaciones originales

Relleno.

Conclusiones

Relleno.

Futuras líneas de investigación

Relleno.

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A multifrequency view of Active Galactic Nuclei

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor in Science and Technology

by

Ignacio Ordovás Pascual

“I am your father.”

Lord Voldemort
(John Ronald Reuel Tolkien, Game of Thrones)

*“The problem with quotes found on internet
is that they are often not true.”*

Abraham Lincoln

s

Summary

Summary in english.

Contents

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Chapter 1

Introduction

Begin with observational evidence of AGN. They are extragalactic sources whose main power is not from the stellar nuclear reactions. After that we prove that given the luminosity, time variability and density of energy, the origin is a Supermassive black hole.

After that mention that the AGN are long lived objects, that given its visibility we can detect them at high redshifts, and then are a useful tool to study the evolution of the universe.

AGN are very important to understand the evolution of the galaxies, as there is a coevolution of SMBH and host galaxies via feedback.

After that we may mention the X-ray background, compound by AGNs. In the soft energies the background is explained, but at hard energies is not. The obscured AGN still are something not completely understood. That is why we must study the extinction in AGNs. Extinction plays a major role in AGN subdivision in types that is not following unified models for part of the population.

1.1 Active galactic nuclei

Describe the emission mechanisms of the AGN in each wavelength. This is:

Radio: introducing two types that contributes differently to the bolometric luminosity, but later on we will explain more. IR: Emission from the heated dust, forming a IR bump. Optical/UV: THe Big Blue Bump, that also have broad and narrow emission lines. THere are pseudo continuum contribution that are blends of lines and not a real continuum emission: X-ray: power law emission. Maybe in this part introduce as well all the physical origins of X-ray emission Gamma-ray: for the non-thermal continuum, of Blazards

We may put as a subsection the extinction?

1.2 Unified Model of AGN

List all the regions of the unified model and where the emission mechanisms are originated.

-Disk: infalling material that emits in the optical/UV -Corona: inverse compton scattered emission that is triggered by the accretion disk -BLR: ionized gas region outside the disk. -NLR:less ionized material outside de BLR -Torus:Dusty region surrounding the BLR,disk,corona -Jets: polar radio emission.

1.3 Classification of AGN

Here we describe the classification and subclassification of AGN.

-We first explain the orientation effects in the observed spectra and SED with a figure where it is seen the type depending on the orientation.

-After that we put a table and explain other classifications where there is dependency on other factors as the luminosity (QSO) or FE emission/FWHM (NLS1)

-We introduce as well the subclassification within type-1 linking it with different levels of extinction

If not mentioned before, we focus on classification of type-1 and 2 based on X-ray and optical data.

1.4 Absorption and obscuration

In this section we begin to introduce some aspects of importance in the thesis that are the differences between X-ray and optical extinction of AGN. We explain the effects of absorption in the X-rays and the effects of optical obscuration in UV/optical/IR.

-Gas absorption in the X-rays

-Extinction by dust in the UV/optical/IR

We point out that this is not followed by a significant fraction of sources.

-We explain the fraction of discordant sources and possible origin in the literature. Different dust to gas ratio, different absorption regions, ... and variability.

1.5 Aims of this thesis

Describe the aims of the papers in this thesis.

Summarizing, along this work we will tackle the following issues:

1. One
2. Two
3. Three

Chapter 2

Chapter 2

Data

AGN are found in surveys in X and then we look for counterparts in the optical.

2.1 XMM-Newton

Information about the XMM-newton cameras and how the X-ray data are processed from the incoming radiation to the files (the post processing of the extraction of the sources and modeling of the spectra is not in this section)

2.2 Optical telescopes

For the optical observations of the sources. In order to identify all the X-ray sources, optical observations are made. Some of the optical counterparts comes from the SDSS public archive. Others are made using follow up observations.

2.2.1 UV-to-NIR spectrum from VLT/XSHOOTER

Description about the XSHOOTER instrument, how the uv-to-nir radiation is divided and mention the echelle grating. Mention as well the ADC in this section. From the pipeline and reduction is in the following chapter. Maybe this section should be included in the optical telescopes

2.2.2 Long Slit spectra from optical telescopes

Describe each telescope and where is located. After that describe the instrument, wavelength coverage.

2.2.3 Public data from SDSS survey

Description about the SDSS project, and the SDSS and BOSS instruments. We use until the SDSS-DR14 version.

Chapter 3

Methods

- SEDs

3.1 The BUXS sample

In this section we explain how the BUXS sample is selected and the final selection, optical completeness.

3.2 Subsample used in this thesis

Here we give details of the data used in this thesis. This is, a table with the XMM Obs. IDs of each source, total exposure times, etc. In adition we include a table with the optical spectra used for each source and all the useful information related (SDSS/TNG/..., slit width, exposure time, SNR, etc.).

3.3 X-ray extraction and modeling

In this section we explain how the X-ray data were treated. We explain that we combine all the available observations. After that sources were extracted, so we explain how and talk about background subtraction as well. Apart from that we explain the spectral modeling. This is how we select the best model, how we calculate the parameters as the luminosity and nh and how compute errors.

3.4 Optical spectral continuum modeling

In this section we explain the reduction of an optical spectrum. We may distinguish between echelle of xshooter and long slit spectra from other telescopes, as one was analyzed with STARLIGHT and power laws, and the other with SHERPA and combinations of templates.

Apart from that we explain the ways of fitting the optical spectra. We talk about STARLIGHT for the xshooter, and sherpa for the BUXS sample.

The general model is AGN plus SMC extinction and additive host galaxy model. For some objects where we have data in the high order f the Balmer lines and higher, it is necessary to introduce FeII and Balmer Continuum emission, so we describe all the components here.

3.5 Optical emision lines fits

Here we describe the H_α, H_β and MgII line fit models. The NLR uses the same width in velocity. We use the FWHM and flux as free parameters.

3.6 SED fits

Here we describe the SED fits in order to obtain the host galaxy contribution. We explain that we fit the SED using disk, torus and host galaxy model.

Chapter 4

Analysis of XSHOOTER

This chapter is about the two discordant AGN observed with XSHOOTER. We re-format the article to show the results and possible origin of the discordance.

4.1 Subsample of two objects

We describe here the two objects selected with XSHOOTER

4.2 X-ray properties

Here we explain the X-ray spectral fitting of the two sources.

4.3 UV-to NIR observations

In this section we describe the observations from the VLT.

4.4 Analysis

4.4.1 AGN and host galaxy continuum decomposition

With STARLIGHT we decompose the extracted spectrum and divide it into host galaxy and AGN emission, with the STARLIGHT software.

4.4.2 Narrow and broad line Balmer decrements

After removing the host galaxy contamination, we fit the emission lines.

4.4.3 SMBH masses

Using the broad H_α line, we obtain the SMBH masses of each AGN.

4.4.4 Host galaxy masses

4.4.4.1 Stellar masses

We obtain the host galaxy stellar mass from the STARLIGHT software

4.4.4.2 Dynamical masses

From the NaID, we estimate the host galaxy dynamical masses, and compare it with the stellar masses.

4.5 Discussion and results

Here we describe the possible causes of the discordance between the optical and X-ray classifications.

4.5.1 Compton-thick or Compton-thin obscuration

Using line flux ratios, we determine that the sources are not Compton-thick AGN.

4.5.2 Host-SMBH relations

We compare the SMBH and the host galaxy masses to check if the host galaxy is more massive than expected through the SMBH and the host galaxy relations.

4.5.3 Dust-to-gas ratio ot the obscuring medium

We check if the obscuring medium is more dusty than the Galactic dust-to-gas relation.

4.5.4 Intrinsically weak BLR region

To check if the broad lines are underluminous and that is why they are hard to detect.

4.5.5 Variability

We explain the possible impact of variability in the sources.

4.5.6 Possible origin of the discordance

We point out that one source have higher dust-to-gas ratio than the Galactic, and other is hosted by a massive galaxy.

Chapter 5

Analysis of BUXS sample

We study the obscuration of type-1 AGN by comparing the optical extinction and the X-ray absorption.

5.1 Subsample the type-1 AGN

We describe here that we select all objects that show at least one broad line in their optical spectrum, that is ranging from type-1.0 to type-1.8/9, often grouped with type-2 AGN. We use only the redshift range of z=0.05-1 to measure in a robust way the X-ray obscuration.

5.2 X-ray and optical

5.2.1 X-ray properties

Here we explain the X-ray spectral fitting of the type-1 sources. In this section we also examine the percentage of X-ray absorbed sources and compare it with other samples. We test the evolution of the X-ray luminosity with the fraction of absorbed sources.

5.2.2 Optical spectrum fits

We describe the model used to fit the optical spectrum. This allows us to measure the optical extinction of the sources in terms of Av. We can compare here the Av range of other selections and the fraction of sources not optically obscured.

5.2.2.1 SED Av vs spectrum Av

We compare this estimations with the ones from the SED analysis.

5.2.2.2 Balmer decrement Av vs spectrum Av

We compare this estimations with the ones where H_α and H_β are available. We test if there is an intrinsic H_α/H_β ratio, or it depends on the conditions on the BLR.

5.3 Subdivision in Seyfert subclases

We study the change in parameters such as Av, NH, etc with the Seyfert subclass. We also check with different redshifts if there is an evolution or not.

5.4 Optical extinction versus X-ray absorption

We plot the Av vs NH, and we compute the fraction of sources that follows the Galactic dust-to-gas relation, the ones that are more dusty and the ones that have more gas.

5.5 Dust-to-gas ratio

Plotting the dust-to-gas ratio versus the luminosity or redshift to test if there is any dependence in between those quantities.

5.6 Bolometric luminosity and Bolometric correction

Here we test if the relations between the Bolometric luminosity based on the optical spectrum and the luminosity of the X-rays is compatible with the ones reported in other studies.

5.7 Conclusions of the statistical study

We summarize the main differences that this complete sample of type-1 AGN have with other optical or X-ray selected samples. We explain this differences with context with the unified model of AGN and with the latest explanations in the literature of optical extinction and X-ray absorption.

Chapter 6

Conclusions and future work

6.1 Conclusions of this thesis

6.1.1 Detailed analysis of two X-ray unabsorbed type-2 objects

We determined that the discordant optical and X-ray sources are not a physical family, as the origin of the discordance can be very different.

6.1.2 Optical extinction and X-ray absorption of a complete type-1 sample

The preliminar results obtained is that using a complete sample of X-ray selected type-1 AGN at hard energies we can detect objects with high levels of obscuration in the optical and in the X-rays. The majority of the sources follow the Galactic relation, but there are a significant fraction of discordant sources.

6.2 Future work

Here we explain possible studies that can be derived from this work, that could not be studied in this thesis.

Appendix A

Tables

Along this appendix a table is presented

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