UNIVERSITA' DEGLI STUDI DI MILANO-BICOCCA

Scuola di Scienze Matematiche Fisiche e Naturali
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PROBING OPTICAL AND RADIO-LOUD AGN FRACTIONS : A COMPARATIVE ANALYSIS BETWEEN BCGs AND NON-BCGs SAMPLES at z < 0.1

Candidate:
Andrea Maccarinelli

Supervisor:
Prof. Sebastiano Cantalupo

Co-supervisors:
Dott. Andrea Travascio

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Abstract

Brightest cluster galaxies (BCGs) are the most massive and luminous galaxies located near the center of relaxed, virialized, and undisturbed galaxy clusters in the local Universe (Sandage et al. (1976); von der Linden et al. (2010)).

According with several observational studies (Travascio et al. (2020)) these objects experience special formation differing from galaxy evolution in general. Current theoretical models (e.g., De Lucia and Blaizot (2007), Cooke et al. (2019)) predict that the dry mergers are the dominant mechanisms responsible for their mass assembly.

Often, these objects are observed to host a super-massive black hole (SMBH) in their center (Rafferty et al. (2006)). The process of matter accretion into these SMBHs may release a large amount of energy, resulting in Active Galactic Nuclei (AGN). There are two primary modes in which SMBH accretion can occur: the so-called 'radio mode' and the 'quasar mode' The quasar mode consists in a high accretion rate of the SMBH via an optically-thick and geometrically-thin disk, and most of the energy is released in form of radiation. In a radio mode scenario, the SMBH accretion of hotter gas happens with a low rate in a optically-thin and geometrically-thick disk configuration, releasing energy in form of relativistic particles. The latter is typically observed in BCG.

Therefore, in this thesis i present an analysis of Optical and Radio Loud AGN fractions on 2 galaxy samples derived from the combination of the galaxy sample created by the MPA-JHU team in the context of "The Sloan Digital Sky Survey" (SDSS), the C4 BCGs catalogue by Miller et al. (2005), and the Radio Emitters catalogue developed by Best et al. (2005).

As the Optical activity is classified through the BPT diagram diagnostic, the sample without the BCGs has been obtained by overlapping space regions

covered by both the SDSS survey and the Radio Emitters one, to achieve a proper confrontation between the results in the different samples.

These analyses reveal that based on a optical point of view BCGs show a greater AGN activity $\sim 60\%$ when compared to the $\sim 16\%$ obtained on the other sample similar to the ones obtained by Vitale et al. (2012). While At the same time Radio Loud inspections show that the fractions of AGN objects is similar between the BCG sample ($\sim 62\%$) and the other ($\sim 68\%$)

In conclusion, these results strongly support the idea that BCGs are more likely to exhibit radio loudness, as observed in previous studies such Yuan et al. (2016), Oliva-Altamirano et al. (2014). Therefore, any future investigations in this context should prioritize a radio analysis over an optical one.

Contents

Introduction

The first part of the introduction is the abstract of the thesis, which contains an itroductive summary of the whole work, without the actual results. The summary must contain only the main points, leaving to the thesis description all the details of the implementation, of the techniques used, of specific effects. In the introduction, only the main physics motivation and the key elements of the study need to be reported.

The second part of the introduction is the list of chapters presented later on, with one-paragraph description of the content of each of them, such that the reader is aware of what to expect.

A useful introduction on how to use $\LaTeX\,2_\varepsilon$ can be found at this reference Kewley et al. (2006).

Chapter 1

Introduction

1.1 The Main Structure of a Thesis

A thesis may be ideally thought of as divided into three parts. The first chapter contains the description of the environment where the work takes place, both theoretical and experimental. Both of them are instrumental to the work presented in the thesis, and are not meant to replace any notions that the reader would rather acquire from the existing literature. The target audience of this chapter are physicists, who are well aware of the main principle of the modern physics, threfore the is meant only to address the specific knowledge to understand the work presented in the following chapters, in terms of experimental situation and theoretical motivations. This may for example include a brief description of the Large Hadron Collider and of the CMS detector, for the benefit of colleagues working on other subjects for what concerns the experimental part; of the generic particle content of the Standard Model, its limitations if needed, and the connection to the aims of the work. Kewley et al. (2006)

1.2 The Register in the Text

A thesis is a scientfic document, addressing experts in the field. Its main aim is the description of the results attained during the work, hence the clarity exposition is an essential feature of the text. Sentences will be short, so that the reader will not have to focus on the period structure rather than on the scientific content presented. The thesis will describe the result to a competent audience, not explain it to a learning one. Therefore, graphical artifacts such as bold or italic text will be used for syntactic purposes only: for example, when words are used form a different language with respect to the one of the text. Each concept specific to the work (for example an algorithm or a procedure, or their outcome) needs to be defined before being used, and then the same name shall be used consistently across the entire document when referring to that concept. As a rule of thumb, any expressions that would not result immediately understandable in a particle physics textbook shall be defined. Jargon expressions shall be avoided (for example, electrons and muons are charged leptons, as opposed to neutrinos which also are leptons, and the quantum of the Higgs field is a Higgs boson, not a Higgs, as well as the mediators of the weak force are the W boson and the Z boson, not the W and the Z). Any definitions should happen only once in the text, regardless of whether there is a change in chapter: repetitions shall be avoided. When a concept is specific and yet too long to be described, a citation to a paper where this description is reported shall be added to the text. The fact that the English grammar seems simpler than the Italian one does not mean that the former can be neglected when writing the thesis.

1.3 Consistency

The thesis will be written with a consistent style, that should be maintanined across the whole document.

- the writer may choose whether to used the first-person singular, the fist-person plural, or an impersonal form in the text, and then will stick to the choice
- relevant concepts, objects, tools, algorithms shall always have the same name, in order not to confuse the reader, even if this generates syntactic repetitions
- when used, acronyms shall be at the first occurence in the text, for

example “Large Hadron Collider (LHC)” and then always used in the acronym form

1.4 Completeness of Information

The information in the thesis shall be complete, giving the reader all the technical details necessary for the understanding of each reported result. References to the thesis itself, like ”as written before” or such, shall be avoided, since it’s understood that the reader already read what preceeds each sentence, or is able to browse the table of contents to identify the needed piece of information.
At the same time, this does not imply that the thesis is a narration of the thesis work: the focus is on the results, not on the history of their achievement. For example, failed attempts shall not be reported if they do not constitute a relevant scientific piece of information.

1.5 Images and Tables

The writer may use tables and figures in the writing, remembering that each of them should be always mentioned explicitly in the main text with its numbering, and that each of them should have a caption long and clear enough to allow the reader to understand what is presented without the need of searching for the reference in the main text.

Chapter 2

Title of the Second Chapter

The second part in which a thesis is divided into contains the specific introduction to the work performed. The specific physics context shall be described, for example in terms of what process has been studied, what are its characteristics, peculiarities and main challenges in its study. From the experimental point of view, a description will be presented for the data taking conditions, the particle reconstruction, or the events simulation. Concerning the extraction of the results, the tools utilised will be presented, for example when used to isolate signal over background, or to fit distributions to extract the final result, or to develop the best reconstruction for a given quantity of interest.

Chapter 3

Title of the Third Chapter

The third part of the thesis is the place where the actual work gets described. Here, the reader shall be guided to the final result obtained, which shall have the main relevance of the text. By no means the content exposed here should be weighed by the effort spent in producing each intermediate result, not in terms of the number of plots, nor in terms of several failed attempts (but if the failure is relevant for the final result). The description of the work shall be complete, to guide the reader in the understanding of all the elements necessary to grasp the final result obtained.

As a matter of fact, in the thesis writing one should best start by compiling the index of the work, in terms of chapters and subchapters, with a single sentence, for each subchapter, describing what is expected to be containted in that section. To decide what is relevant to be put in the text, one possible approach is to start from the final result description and proceed conceptually backward, adding in each section what is needed there to understand the result, or the content present in the part following it. The aim of this procedure is to avoid adding unnecessary information to the thesis, while not forgetting relevant bits of it.

One final section of the third chapter may contain the implications of the results, the next steps to be undertaken, and future prospects of the study, from the point of view of the writer.

Conclusions

The final chapter of the thesis is a summary of the work done. Therefore, in its first part it resembles much the introduction, adding to it the actual result of the work, its future evolution and prospects, in the view of the writer.

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