

Analysis of the Observation Evidence of Different Types of AGNs

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Abstract. As a matter of fact, analysis AGNs play a crucial part in cosmology and astrophysics. With this in mind, this study will present the introduction of AGNs, their historical background, and their importance in comprehending the evolution of the universe is the first section of this research study. The next sections of the paper go into great length to describe numerous AGN types, such as quasars, Seyfert galaxies, blazars, radio galaxies, LINERs, narrow-line AGNs, and changing-look AGNs. Furthermore, it explains basic AGN ideas like supermassive black holes and accretion disks. It is stated how investigating AGNs is constrained by factors including distance, size, dust obscuration, and apparatus requirements. The summary concludes by outlining the bright future directions for AGN study, including multi-wavelength surveys, high-resolution imaging, time-domain astronomy, spectroscopic investigations, dedicated space missions, computational astrophysics, and multidisciplinary cooperation. This paper offers a thorough summary of AGNs, their properties, the difficulties in researching them, and the possibilities for future research.

Keywords: AGNs; Active Galaxies; Observation Evidence.

1. Introduction

AGNs which stand for the Active Galaxy Nucleus. All the discoveries of AGNs began in the 20th century, there was an astronomer called Fath who wanted to test his claim, and while he was testing his claim he found a continuous spectrum with stellar absorption lines, suggestive of an unresolved collection of solar-type stars. This type of star refers to the AGNs. It's essential to study AGNs to understand the development of the universe and how it functions, because of its direct connection to the history of cosmic accretion, the cosmological development of the AGN's luminosity function can reveal the creation history of the supermassive black hole [1].

In the research paper published by Fabian in 2012, scientists discovered that radiation pressure, winds, and jets are three ways that an active nucleus communicates with the gas in its host galaxy [2]. The effects can have significant effects on both the black hole and the star component of the galaxy's ultimate mass. The nucleus produces enough energy and momentum to evacuate the host galaxy's interstellar medium. It appears that the radiative or wind mode was most active when the nucleus was a young quasar. At that stage, the galaxy had a large component of cold molecular gas, and the nucleus was probably highly obscured. Obscuration has meant that direct observational evidence is often circumstantial, relying on nearby analogs. Progress has been difficult and slow but is expected to accelerate soon following observations with ALMA, JVLA, and other telescopes [2]. However, because the kinetic mode is now active in adjacent big objects, it is easier to see, even at X-ray and radio wavelengths.

The baryonic portion of the low-redshift Universe has been altered by the energy and momentum production of black holes through AGN feedback, according to increasing amounts of observational data. As Van Dalene said in 2011 This has profound implications for the understanding of galaxy, group, and cluster evolution and has ramifications for precision cosmology using galaxies. It appears that AGN feedback is a significant factor in the complexity of the baryonic Universe.

This study is going to analyze the observation evidence of different types of AGNs. Firstly, it will talk about the basic description of the AGNs also basic concept formulations. After talking about the basic concept formulations, this study will discuss three different AGN types of evidence that have

been observed. Lastly, this study will demonstrate the limitations and future outlook for observing the AGNs.

2. AGN Descriptions

2.1. Different AGNs Types

AGNs, which are fuelled by the accretion of matter onto a supermassive black hole, are very intense and compact areas at the cores of galaxies. Based on their observational characteristics and the direction of their central engines, AGNs may be divided into numerous different categories, there are mainly seven types of AGNs [3]. The most bright AGN are quasars. They produce enormous amounts of electromagnetic energy, ranging from radio waves to gamma rays. Strong and wide emission lines that show the presence of highly ionized plasma surrounding the core black hole are the usual characteristics of quasars. They frequently link together with far-off, young galaxies.

Spiral galaxies with reasonably bright and compact nuclei are known as Seyfert galaxies. They may be identified by the thin emission lines that are present in their spectra. The two kinds of Seyfert galaxies are Seyfert Type 1, which has both wide and thin emission lines, and Seyfert Type 2, which only has narrow emission lines. It is thought that the direction of the obscuring material surrounding the core black hole is the cause of the variation in their spectra. AGNs that have a jet of high-energy particles aimed straight towards Earth are known as blazars. They seem extraordinarily bright and vary throughout the electromagnetic spectrum, from radio to gamma-ray wavelengths, due to their orientation. Supermassive black holes that are actively accreting matter are frequently connected to blazars. AGNs that release a considerable quantity of radio waves are known as radio galaxies. They frequently create synchrotron radiation in the radio wavelength region by strong jets of charged particles. Based on the morphology of their radio emission, radio galaxies are divided into two major categories: Fanaroff-Riley Type I (FR I) and Fanaroff-Riley Type II (FR II). LINERs are weak nuclear emission-line galaxies that typically exhibit lower gas ionization states than Seyfert galaxies. They frequently go hand in hand with supermassive black holes that are less energetic or have little accretion. These AGNs do not cleanly fit into the Seyfert or LINER classifications because of the thin emission lines in their spectra. They stand for a wide range of things whose nuclei could be active at various intensities. Some AGNs experience spectral property changes over time. They can change from one class of AGN to another, for as from a Seyfert-like spectrum to a quasar-like spectrum or the opposite. These AGNs with shifting appearances shed important light on the diversity and development of AGNs.

2.2. Basic Concept Formulations

It is essential to take into account the underlying ideas and physical mechanisms that underlie the behavior of Active Galactic Nuclei (AGNs) to comprehend them on a fundamental level. Supermassive Black Hole(SMBH), Accretion Disk, Radiative Processes, Emission Lines, Quasar Phenomenon, Relativistic Jets, Dust Torus, Variability, Host Galaxy, and Black Hole Feedback are some basic concept formulations for the AGNs, although they offer a condensed perspective of a highly complicated astrophysical event, these fundamental ideas aid in describing the essential elements and processes involved in AGNs. the knowledge of AGNs is constantly being improved through observations and theoretical modeling since they are still a topic of ongoing research.

3. Quasars

Quasars refer to a very bright and active astronomical object. Quasars are thought to be a form of active galactic nucleus (AGN), which are among the most distant and potent things in the cosmos. When sufficiently fueled, massive black holes would exhibit quasar-like activity; for the sake of simplicity, this study will refer to such objects as 'quasars'. Quasars are essential objects for comprehending the early cosmos and how matter and energy behave under extreme circumstances.

Since their first discovery in the 1960s, astronomers and astrophysicists have been examining them in detail. Their presence and characteristics shed light on how galaxies originate and evolve, how supermassive black holes expand, and what the cosmos is like at cosmologically important distances and durations. Seen from Fig. 1, four alternative aperture radii were used to calculate the values for rounded models, and the results are displayed as follows: two pixels (triangles), four pixels (crosses), eight pixels (squares), and twenty pixels (circles). Solid triangles represent systems with an attenuated (v 0.5) aperture of two pixels. When smaller than the size of the symbols, error bars are not displayed. The data points in the two graphs on the bottom row were subjected to an arbitrary vertical offset.

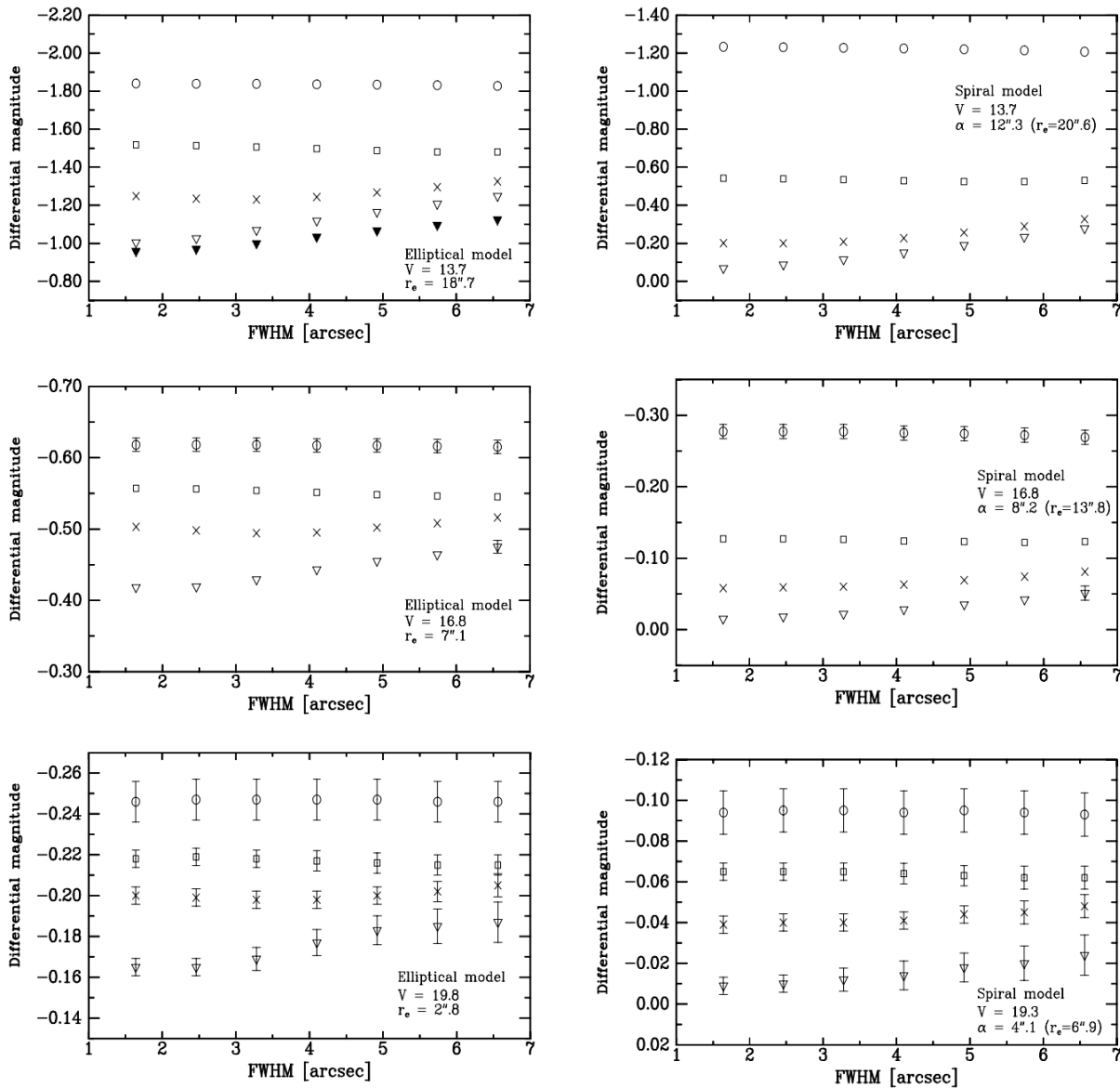


Fig. 1 Various simulated host galaxies' differential magnitudes (AGN minus comparison star) as a function of PSF FWHM.

The Fig. 2 provide observational proof that bright host galaxies can impart erroneous variances into quasar microvariability measurements. In each scenario, an AGN of V 16 mag was considered. The aperture values are coded in the same manner as in Fig. 1. The target, the brilliant elliptical galaxy-embedded BL Lac object PKS 2316[423], had a differential light curve that was like another neighboring galaxy inside the same CCD frame, precisely matching the same FWHM temporal nuctuations during the observing nights. The effects of seeing on a bright host were still present despite differential light curves between comparison and control stars showing no significant can't variations, indicating that all effects caused by variable extinction and/or transparency were eliminated by the differential photometry technique. With various simulated viewing circumstances,

astronomical pictures of AGNs in hosts with a wide range of magnitudes were produced. They were used to demonstrate how host magnitude correlates with the amplitude of the erroneous fluctuations in differential magnitude brought on by observing nuctuations, and that the amplitude is stronger for smaller photometric apertures.

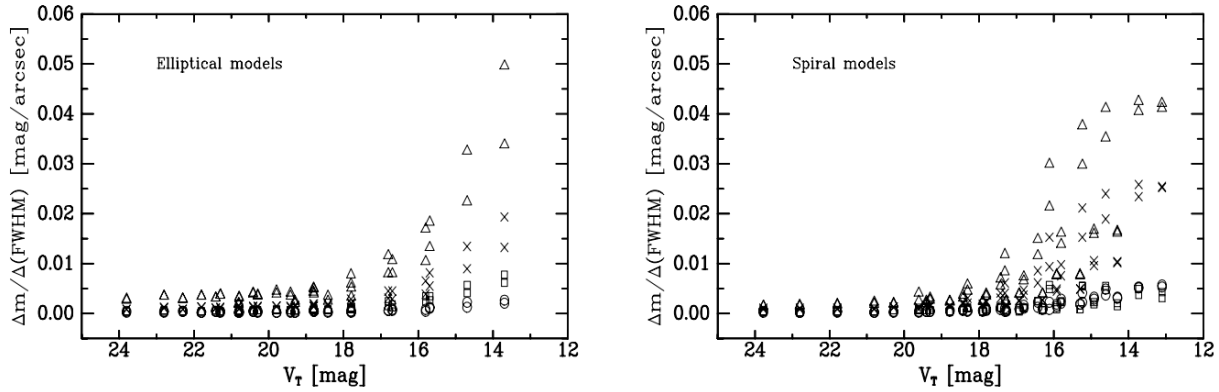


Fig. 2 The amplitude of the variation in simulated AGNs' differential magnitude (Δm), averaged to 1A variation in seeing FWHM as a function of the host galaxy's integrated magnitude (V_r), for (left) elliptical models and (right) disk models.

4. Seyfert Galaxies

A bright and extremely fluctuating nucleus is a characteristic of Seyfert galaxies, a subclass of active galaxies. They bear the name Carl Seyfert after the American astrophysicist who discovered and investigated these objects in the early 1940s. Active Galactic Nuclei (AGNs) that include Seyfert galaxies are distinguished by unique spectral characteristics. Seyfert galaxies offer important new understandings into the characteristics of active galactic nuclei, the mechanics of accretion onto supermassive black holes, and the function of black holes in the development of galaxies. They belong to a significant class of objects in the study of extragalactic astronomy and are a component of the larger area of astrophysics known as active galactic nucleus (AGN) research (seen from Fig. 3).

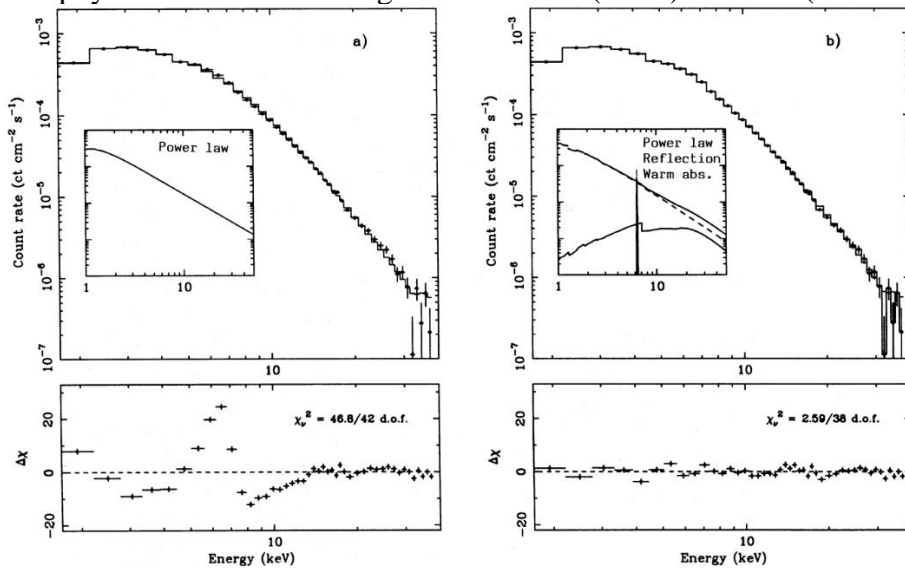


Fig. 3 Count as a function of energy: (a) A straightforward power-law fit to the summed data for all 60 observations of the 27 Seyferts in this sample, input model (insets), count spectrum (top panels), and residuals (bottom panels) and (b) a fit to the more intricate model, which has an iron line, an ionized absorber, and a reflection continuum.

Seen from Fig. 3, it fits much better, without a doubt. When suitable, power-law, reflection, and warm absorber fits have been used to get the intrinsic spectral indices. The corresponding widths

come from fits with the reflection component, while the line energies come from fits with the power law plus lines. As shown in Fig. 3(b) the composite spectrum for all of the data combined, fitted with the updated standard model of a power law, warm absorber, line, and reflection hump, is a final example of the significance of the phenomena mentioned above. High statistical significance requires the use of all features, and the mean spectrum yields parameters that are very comparable to those obtained from the individual fits discussed in this study. Although the composite fit is formally unacceptable, the improvement compared to the power law and the overall goodness of fit are impressive. This is because one has not added any systematic error to account for uncertainties in background subtraction or poor calibration around the instrumental silver line at 20-25 keV.

5. Limitations and Future Outlooks

Numerous AGNs are found at great distances from Earth; they can even be billions of light-years distant. This restricts the quantity of information that can be acquired and makes it difficult to obtain thorough observations. When observed from Earth, AGNs are quite modest in angular size. This implies that it can be difficult to resolve the tiny features of AGN structures, such as the inner regions of the accretion disk or the close neighborhood of the supermassive black hole, even with powerful telescopes. Particularly in Type 2 Seyfert galaxies and quasars, dust, and gas in the neighborhood of AGNs might make it difficult to observe the center regions. It is challenging to directly detect the deepest regions of AGNs because of this obscuration. The brightness of AGNs fluctuates quickly and unpredictably throughout a range of wavelengths. Due to this, it may be difficult to collect data at the appropriate moment to examine a particular phenomenon or to compare observations collected at various points in time. On timeframes far longer or shorter than a person's lifespan, some AGN occurrences take place. For instance, it is challenging to investigate these processes thoroughly since they can take thousands or even millions of years to develop an AGN or process relativistic jets. To efficiently research AGNs, sophisticated and specialized equipment is needed. To fully capture AGN activity, observations spanning a variety of wavelengths, from radio to gamma rays, are frequently required. These devices can be expensive, and access to large telescopes is necessary.

It is difficult to analyze certain spectral properties in detail since many distant AGNs have measured spectra that are skewed toward longer wavelengths due to their high redshift. Furthermore, the observable characteristics of far-off AGNs are impacted by the universe's cosmic expansion. AGN observations may be impacted by background noise, cosmic and terrestrial influence, and both. Researchers must take action to reduce these sources of data contamination. While numerous AGNs have been seen in the far reaches of the cosmos, there are not many close AGNs that can be thoroughly explored. Understanding the physical processes taking place in AGNs throughout the entire population is difficult. Despite these constraints, developments in observational methods, technology, and space-based observatories have substantially increased the understanding of AGNs in recent years. To better understand these mysterious objects' characteristics and how they fit into the history of galaxies and the cosmos, researchers are making great strides in their research.

Large-scale, multi-wavelength observatories like the Cherenkov Telescope Array (CTA), Square Kilometer Array (SKA), and James Webb Space Telescope (JWST) will be launched and put into operation, opening up previously unheard-of opportunities to observe AGNs in all parts of the electromagnetic spectrum, from radio waves to gamma rays. Astronomers will be able to examine AGNs in great detail and find new AGN populations thanks to these surveys. Scholars are becoming better at getting high-resolution photos of AGN settings thanks to developments in adaptive optics and interferometry methods. The features and dynamics of the areas surrounding supermassive black holes in AGNs may then be directly seen by astronomers. The variability and transient occurrences of AGNs are increasingly being studied via time-domain surveys and monitoring programs. AGN variability on various timeframes is intended to be detected and tracked by facilities like the Zwicky Transient Facility (ZTF) and the Large Synoptic Survey Telescope (LSST). High-resolution spectra of AGNs will be made available by next-generation spectrographs on ground-based telescopes and

space observatories, enabling in-depth research into their kinematics, gas dynamics, and the characteristics of their center supermassive black holes. Future satellite missions with improved sensitivity and geographical resolution, like NASA's Lynx X-ray Observatory and the European Satellite Agency's Athena X-ray Observatory, will significantly advance X-ray studies of AGNs. Complementing observational efforts with advanced computer simulations and modeling will make it easier to interpret AGN data and comprehend the underlying physical processes.

6. Conclusion

The importance of Active Galactic Nuclei (AGNs) in comprehending the evolution of the cosmos and the history of cosmic accretion is underlined in the introduction. The paper highlights the development of AGN research and the requirement to examine various AGN forms. The section on AGNs has detailed descriptions of all the many types of AGNs, such as quasars, Seyfert galaxies, blazars, radio galaxies, LINERs, narrow-line AGNs, and changing-look AGNs. It also covers key ideas that are crucial for comprehending AGNs, including supermassive black holes, accretion disks, emission lines, and more. The emphasis on these AGN types in astrophysics study is emphasized in the sections on quasars and Seyfert galaxies, which dig into particular features and observational evidence for these AGN types. The limits in viewing AGNs, such as those caused by distance, size, dust obscuration, and equipment restrictions, are also highlighted in this work. Furthermore, it highlights the bright prospects for AGN observations in the future, including multi-wavelength surveys, high-resolution imaging, time-domain astronomy, spectroscopy, dedicated space missions, computational astrophysics, and multidisciplinary cooperation. It is anticipated that these developments will improve the knowledge of AGNs and their place in the cosmos.

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