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ANALYSING COMPONENTS AND CLASSIFICATION OF ACTIVE GALACTIC NUCLEI (AGN)

NEPAL SINGH DHAKAR
RESEARCH SCHOLAR SUNRISE UNIVERSITY ALWAR

DR. VIVEK YADAV
ASSOCIATE PROFESSOR SUNRISE UNIVERSITY ALWAR

ABSTRACT

The persistent high brightness objects known as active galactic nuclei (AGN) are driven by the accretion of matter onto super massive black holes (SMBHs) at their centres. The fact that they exhibit flux fluctuation makes it possible to effectively map the size of the wide line region (BLR) and the dusty torus that encircles the core SMBH. Although the motions of nearby stars may be used to directly determine the mass of the SMBH (MBH), this technique is only applicable to objects in the low redshift universe (z < 0.1). Reverberation mapping (RM), on the other hand, is a method that may offer MBH estimates across a variety of redshifts. RM is based on the line emitting gas's reaction to changes in the continuum emission from the accretion disk as well as the reprocessed torus emission. RM-based MBH measurements are now available for more than 100 sources. The optical luminosity (L5100Å) at wavelength 5100 is discovered to be associated with the observed BLR sizes (RBLR). Based on observations of AGN that are accessible across a constrained range of brightness, this link has been established. Additionally, the error bars on many of these metrics are greater. As a result, it is crucial to enhance RM measurements with little error on more.

Keywords: -Active Galactic Nuclei (AGN), Black hole, Seyfert, LINERs, BLR.

I. INTRODUCTION

One of the brightest objects in the cosmos, active galactic nuclei (AGN) generate radiation in all visible bands of the electromagnetic spectrum, but mostly in the X-ray, UV, and optical ranges. It is presently thought that the primary cause of this extreme brightness (10^{42}-10^{46} ergs; Fabian, 1999) is the accretion of matter onto super massive black holes (SMBHs; 106 1010 M) found in the cores of galaxies. An optically thick and geometrically narrow accretion disk surrounds the SMBH.

The line emission is produced by the photo-ionization of gas clouds by the UVoptical ionizing continuum from the accretion disk in the broad line region (BLR), which is located on scales of roughly 0.01 pc (typical for the Seyfert category of AGN). The two forms of the AGN (Type 1 and Type 2), when observed at different angles, are attributed to a hypothesized torus that surrounds the BLR area in the unified theory of AGN (Antonucci, 1993; Urry&Padovani, 1995). For a typical UV intensity of 10^{42}–10^{46} ergs[1], the inner radius of the torus may reach 0.01–0.1 pc, or 10–100 light-days.

Due to their close proximity to one another, the various areas in the center of AGN are so compact that all but a few of the most recent imaging tools find it challenging to explore them. Fig. 1.1 displays a schematic illustration of the various parts of an AGN.

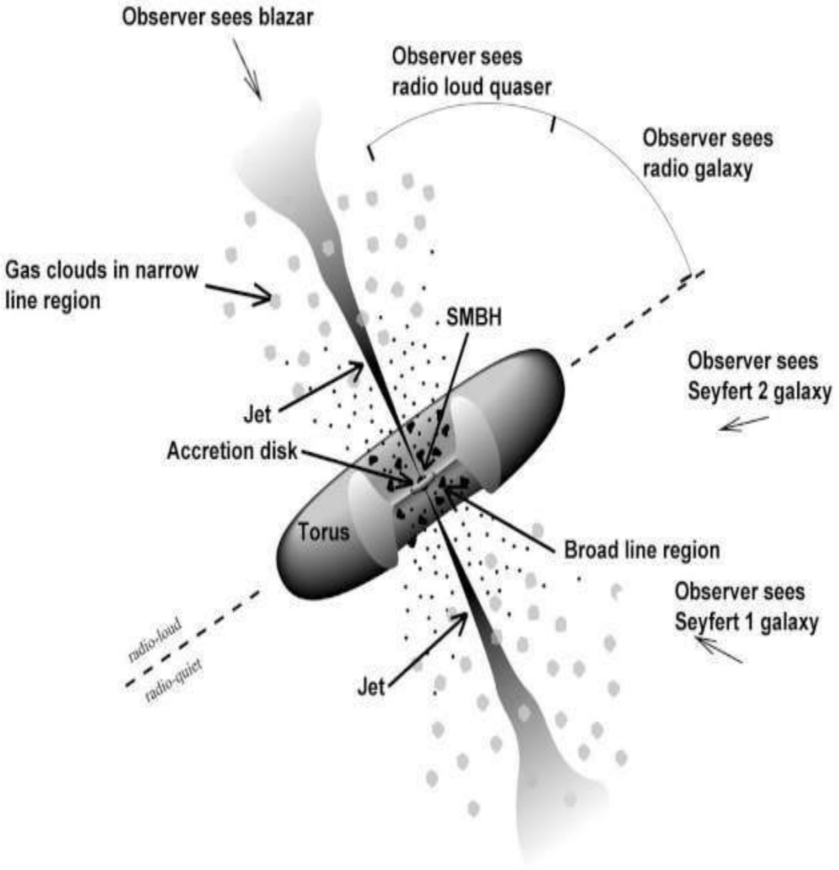

Fig 1. Unification scheme of AGN. Image courtesy: *Fermi* Gamma−ray Space Telescope.

II. ACTIVE GALACTIC NUCLEI

Massive energy sources in the universe, AGN radiate over the whole electromagnetic spectrum. In 1909, E.A. Fath discovered the earliest indication of an AGN's existence Fath. In the optical spectrum of the spiral nebula NGC 1068, he saw strong emission lines that Slipher subsequently verified. These lines were wide, with widths of hundreds of km/s, according to Slipher. Heber Curtis discovered an optical jet coming from the heart of M 87 in 1918. Astronomers conducted more research and discovered that certain spiral nebulae's spectra had nuclear emission lines. According to Hubble, the spectral characteristics of the spiral nebulae NGC 1068, NGC 4051, and NGC 4151's nucleus mimic the spectrum of a planetary nebula and are extragalactic origins. However, Seyfert initiated a comprehensive investigation of galaxies with nuclear optical emission lines. He identified a collection of galaxies (NGC 1068, 1275, 3516, 4051, 4151, and 7469) that belong to a certain type currently referred to as Seyfert galaxies that have high central surface brightness and high-excitation nuclear emission lines. However, this science saw a breakthrough with the introduction of radio astronomy.

AGN have certain distinctive observable characteristics. They exhibit large luminosity (1042−1048 erg s−1 or 109−1015L) from a compact region, continuum emission over a wide range of wavelengths (from radio to gamma rays), high variability on various time scales in various energy bands, strong optical/UV emission lines, and relativistic jet emission in the radio band, among other characteristics.

III. COMPONENTS OF AGN

The core of the system, according to the traditional model of AGN, is a supermassive blackhole encircled by an accretion disc. At a distance of around 10 to 100 Rg1 (10-3 pc), this area of high density (10 -5 cm3) and big column density gas is visually thick and geometrically thin. Its temperature is roughly 105 to 106 K. Through magneto-rotational instabilities, the accretion disc distributes binding energy and transmits angular momentum. Above the deepest regions of an accretion disc (10-5 pc), the instabilities in the disc result in a magnetically active corona. This area of hot plasma (106 K) is optically thin and heated by magnetic fields. Precise geometry is yet unclear, however a number of geometries, including the slab or sandwich geometry, sphere-disc geometry, and patchy corona or pill box model, have been put forward. The occurrence of jets, which are thought to be produced by magneto-hydrodynamic processes in the inner regions of the nucleus, is another remarkable characteristic of AGN. The jets, which may reach lengths of several hundred kiloparsecs or perhaps megaparsecs, are plasma structures that are ejected from the accretion disc and are very energetic and highly collimated. According to andUrry and Padovani, the jet emission may range from being quite faint to being substantial at relativistic speeds. The superluminal mobility of jet components has been seen using VLBI.

The emission line regions, also known as the broadline regions (BLR) and narrow-line regions (NLR), are additional significant elements of AG. According to studies by these locations are probably connected to gas clouds that are photoionized by the emission from the central engine. The broad-line areas are located between 0.01 and 1 pc away from the blackhole . High density (1010 cm3) and significant column density (10^{23} cm2) gas clouds are present in the BLR. These are high-velocity clouds, and their allowed optical emission lines have FWHMs of 1000 km s1.

Atomic Hydrogen, Helium, Carbon (including [CIII] 1909), Nitrogen, Oxygen, Silicon, Magnesium, and Iron are all present in these wide emission lines. At a distance of around 100–1000 pc from the nucleus, the narrow-line areas are connected to low density (104 cm3) clouds with lesser column density ($10^{20–21}$ cm2). They have thin emission lines in their spectra that correspond to a typical gas velocity of 500 km/s1. NLR's spectrum comprises both legal and illegal lines.

IV. AGN CLASSIFICATION

AGN may be divided into many categories according on the observable features. Some of these include Blazars, Low-ionization Nuclear Emission-Line Regions (LINERs), Seyferts, Radio Galaxies, Fanaroff-Riley Class I & Class 2 (FR1 & FR2) Objects, Quasars, and Quasi-Stellar Objects (QSOs), among others. The nature of these classes is briefly described below.

The most luminous AGN observed at high redshifts are quasars, according to studies by Will Author. They resemble stars and were first discovered in the radio frequency. Broad emission lines in the optical spectra help identify quasars. There are sources that have optical spectra like quasars' but little radio emission. These things are categorized as QSOs.

Carl Seyfert discovered Seyfert galaxies, spiral galaxies with very brilliant nucleus. When compared to quasars, these sources have lower luminosities, and their optical spectra show the presence of robust, high-excitation nuclear emission lines. Seyferts are classified as either Type 1 or Type 2 depending on whether or not wide emission lines are present. In the optical band, Type 1 Seyferts exhibit both narrow (FWHM ~500 km s1) and wide (FWHM > 2000 km s1) emission lines. On the other hand, Type 2 Seyferts' optical spectra are distinguished solely by their thin emission lines. Seyferts may be further split into intermediate types: Seyfert 1.2, 1.5, 1.8, and 1.9 based on the relative width of the H component. The Hβ line is less wide in Seyfert 1.2 galaxies than the Balmer lines, but the intensities of the broad and narrow components of the H line are similar in Seyfert 1.5 objects. In Seyfert 1.8, the H and H components are wide but faint, whereas in Seyfert 1.9, the broad component is only discernible for H emission. Narrow-Line Seyfert 1 galaxy (NLS1) is another unique Seyfert 1 subclass.

AGN with significant radio emission are often found in radio galaxies, which are typically linked to bright elliptical galaxies. The radio galaxies often have a compact core, extensive lobe structures, hotspots—regions of heightened emission—on either side of the central source, and jets. Radio galaxies are divided into the FR-I and FR-II object groupings based on how the extended radio emission appears.

The radio lobes dominate the structure of FR-II objects, which are high-luminosity galaxies where most of the emission originates from the far end of the extended areas. FR-I galaxies are low-luminosity sources with relatively compact emission that originates from near to the core. Radio galaxies may be further separated into Broad-Line Radio Galaxies (BLRG) and Narrow-Line Radio Galaxies (NLRG) based on their optical/UV emission lines. While NLRGs have spectra like Seyfert 2 galaxies, BLRGs have continuum and emission lines akin to those of Seyfert 1 galaxies.

They exhibit polarization at radio and optical wavelengths and are core-dominated radio-loud sources. The radiation that blazars generate ranges in frequency from radio to x-rays and is very changeable. Blazars are further broken down into BL Lacertae (BL-Lac) objects, flat-spectrum radio quasars (FSRQs), optically violent variables (OVVs), and Highly Polarized Quasars (HPQs). FSRQs have greater wide emission lines than BL-Lac objects, which have weak or no emission lines in their optical spectra.

The least luminous AGN with modest activity are LINERS, such as those found by Author. It has emission lines in its spectra that are caused by weakly ionized gas, and their line widths (200–400 km s1) are comparable to those of the Seyfert 2 galaxies.

The centres of around one-third of the neighbouring galaxies have LINERs. The non-stellar emission from the majority of LINERS is insignificant in comparison to the stellar emission since LINERs are often rich in star formation activity.

V. CONCLUSION

The orientation-based unified schemes are highly successful at explaining some aspects of AGN classification, in particular, the relationship between broad and narrow line AGN. Over the last 20 years they have withstood most major statistical tests. However, it is clear that they represent a generalisation, an attempt to simplify, perhaps over-simplify, a complex situation. There is much that they cannot explain (e.g. the relationship between radio-loud and radio-quiet AGN). Their main use lies in the fact that they allow us to eliminate certain variables in our quest to understand the fundamental physics, triggering and evolution of AGN. At the same time, the development of the unified schemes has yielded key information about distribution and evolution of the ISM in circum-nuclear regions. As a result, we are beginning to understand AGN as dynamic, evolving systems that have a major impact on their surroundings.

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