NGC 4593

Untertitel (falls nötig)

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Abstract

Hier kommt die Zusammenfassung deiner Arbeit.

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Chapter 1

Theoretical Background

1.1 Active Galactic Nuclei

Active Galactic Nuclei (AGN) are among the brightest and most energetic objects in the known universe, with bolometric luminosities ranging from 10^{41} to $10^{48}\,\mathrm{erg\,s^{-1}}$, which surpasses other galaxies by many orders of magnitude. AGN emit radiation across the entire electromagnetic spectrum, from radio waves to gamma rays. In the optical and ultraviolet bands, their spectrum is dominated by the "Big Blue Bump" which is attributed to thermal emission from a hot accretion disc surrounding a central supermassive black hole. AGN spectra also exhibit strong emission lines: broad lines (FWHM up to $25.000\,\mathrm{km\,s^{-1}}$) produced by fast-moving gas in the Broad-Line Region (BLR), and narrower lines from the more distant, slower gas in the Narrow-Line Region (NLR) (Bradley M Peterson 1997).

1.1.1 Structur of an AGN

1.1.2 Unification Model

Figure 1.1 shows the unification model of an AGN. As illustrated an AGN is powered by a supermassive black hole surrounded by several distinct regions. Closest to the black hole is the accretion disc, whose hot, optically thick gas emits the thermal “Big Blue Bump” in the optical/UV bands (Bradley M Peterson 1997). Encircling the disc is the Broad-Line Region (BLR), a compact area of dense clouds orbiting at thousands of kilometers per second, which produces the broad emission lines. Outside the BLR lies the dusty torus, a toroidal structure of cooler gas and dust that can obscure the inner regions when viewed edge-on (Antonucci 1993). Beyond the torus, the more extended Narrow-Line Region (NLR) emits narrower lines from slower gas at distances of hundreds of parsecs. In radio-loud AGN, powerful relativistic jets emerge perpendicular to the disc plane, accelerating particles to near-light speeds and generating strong radio emission (Urry and Padovani 1995).

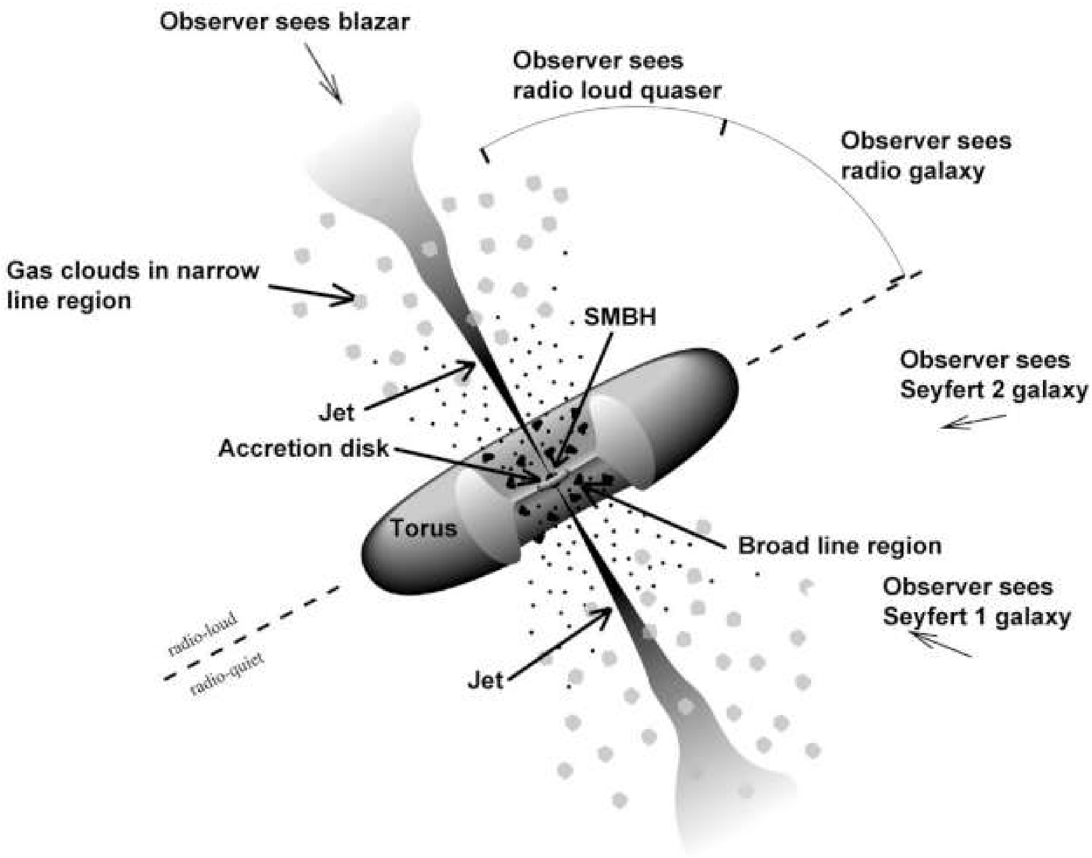

Figure 1.1: Unification model of an AGN (Fermi Gamma-ray Space Telescope 2025).

1.1.3 Classification

AGNs can be broadly grouped into so called Seyfert galaxies, quasars and radio galaxies. Seyfert galaxies are further subdivided, based on the width of their optical emission lines and radio properties. Seyfert 1 Galaxies show broad emission lines, while Seyfert 2 Galaxies show only narrow emission lines, narrow-line Seyfert 1 galaxies (NLS1), low-ionization nuclear emission-line regions (LINERs), and BL Lac objects or blazars (Antonucci 1993; Urry and Padovani 1995).

1.1.4 Variability

1.2 Reverberation Mapping

1.2.1 Principle

The main focus of this work was to perform a classic reverberation analysis of NGC 4593, with a focus on the broad line region (BLR) and its geometry around the central supermassive black hole (SMBH).

This type of analysis aims to measure the time lag τ between the variable continuum and the emission line response, in order to determine the spatial scale and structure of the BLR. By observing these variations over time and analyzing the delayed response of the broad lines, it is possible to learn more about the geometry and dynamics of the BLR and to estimate the mass of the SMBH.

Reverberation mapping (RM) is based on the strong correlation between a variable continuum emission $C(t)$ and the emission line flux $L(\nu, t)$ (Horne et al. 2021). This correlation originates from the photoionization of gas clouds in the BLR by the central continuum source. As the continuum changes, the emission lines react in a similar way, but with a time delay τ, because of the distance between the central source and the BLR. This delay corresponds to the time it takes for light to travel from the central source to the BLR.

1.2.2 Transferfunction

1.2.3 Cross-Correlation Function

1.2.4 Black-Hole Mass

Chapter 2

Campaign and Analysis

The Analysis of this campaign bases of the observation campaign of NGC4593 in 2016 by Edward M. Cackett (Edward M Cackett et al. 2018). The observations took place between the 12th of July and the 6th of August with 26 successful observations and was performed with the Hubble Space Telescope (HST) using the Space Telescope Imaging Spectrograph (STIS). The following section will cover important properties of NGC4593 and the 2016 campaign.

2.1 NGC4593

NGC4593 is an active galactic nuclei (AGN), classified as an Seyfert 1 Galaxy with a Sb D morphology. It is located at RA = 12:39:39.44, DEC = -05:20:39.03 (2000) and has a of $z = 0.0083 \pm 0.0005$ This correspond to a distance of about 35.6 MPc (SIMBAD 2025)based on the ΛCDM-Model.

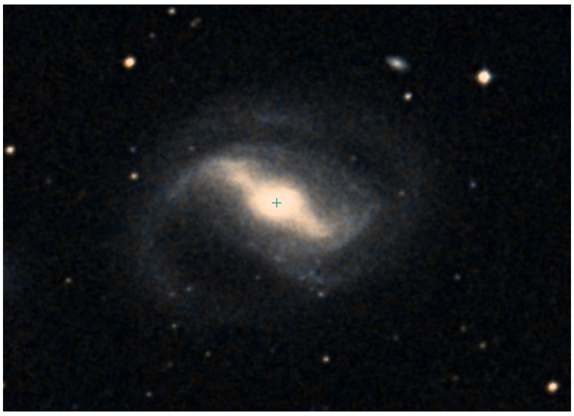

Figure 2.1: A DSS image of NGC4593.

2.2 2016 Campaign by E. M. Cackett

E. M. Cackett's campaign was designed to study wavelength dependent continuum lags. Therefore, the STIS instrument on the Hubble Space Telescope was used with low-resolution gratings to measure a broad range of wavelengths. In each observation, spectra were taken using three different gratings: G140L, G430L, and G750L. These were used together with the $52'' \times 0.2''$ slit.
The characteristics of the STIS gratings used in this analysis are summarized in Table 2.1.

Table 2.1: Overview of STIS Grating Characteristics (Space Telescope Science Institute 2025)

Grating	**Range [Å]**	**Exp. Time [s]**	**Res. Power**	**Dispersion [Å/pixel]**
G140L	1119–1715	1234	~ 1000	0.6
G430L	2888–5697	298	$\sim 500 - 1000$	2.73
G750L	5245–10233	288	$\sim 500 - 1000$	4.92

2.3 Intercalibration

Chapter 3

Reverberation Analysis of NGC4593

3.1 AVG- and RMS-Spectrum

3.2 Lightcurves

3.2.1 Continua

3.2.2 Emission Lines

3.3 Line Profiles

3.4 Cross-Correlation Function

3.5 Time Lag and BH Masses

3.6 Bowen Fluorescence

Chapter 4

Discussion

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