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Long-Term Optical Monitoring of Broad-Line AGNs (LoTerm AGN): Case Study of NGC 3516

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Abstract: Properties of the broad line region (BLR) in active galactic nuclei (AGNs) are commonly used to estimate the mass of the supermassive black hole (SMBH) that powers an AGN. However, the understanding of the physics behind the BLR remains incomplete. The AGNs exhibit strong optical variability, observed in the change of the profiles and fluxes of broad emission lines. Utilizing this variability provides an opportunity to constrain the physics of the BLR, and understand the interplay of the BLR with SMBH and surrounding regions. Here, we present the long-term monitoring campaign of a sample of the known broad-line AGNs (identified as LoTerm AGN). The aim of this study is to show the importance of sustained and dedicated campaigns that continually collect spectroscopic data of the known AGNs over extended timescales, providing unique insight into the origin and structure of the BLR. LoTerm AGN is a collaborative network of seven moderate-size telescopes equipped for spectroscopy. We focus on the recent spectral data of the known changing-look AGN, NGC 3516. Specifically, we examine the broad hydrogen Balmer Hα line observed in the period 2020–2023, demonstrating that this AGN remains active with the BLR signatures observed in the spectra. No significant change in the broad line profile of Hα line is observed during this recent period.

Keywords: galaxies; active galactic nuclei; emission lines; NGC 3516

1. Introduction

Active galactic nuclei (AGNs) are powerful galactic centers, where emissions are driven by the activity of supermassive black holes (SMBH) fueled through the accretion disk [1]. The unified model (e.g., [2]) suggests that the optical broad emission lines originate from the broad line region (BLR) surrounding the SMBH. These lines become visible in the optical spectra when the AGN is oriented such that the obscuring regions are not blocking the observer's line of sight [3]. AGNs falling into this category are referred to as broad-line AGNs or type 1 AGNs [4].

Some AGNs, called changing-look (CL) AGNs, exhibit dramatic variations in their luminosity and spectral properties over relatively short timescales that are detected in different spectral bands (see, e.g., [5–12]). They transition from an active to a quiescent phase, or vice versa, challenging existing unified models of AGN structure and behavior [2,13]. Thus, studies of CL AGNs have gained significant attention, as they offer a window into the complex interplay between SMBH, the emitting line regions around it, and the host galaxy (for a review, see [14]). There are several proposed scenarios to explain this extreme transition, such as obscuration, an intrinsic change in accretion disk, the presence of binary SMBH, a tidal disruption event, supernova explosions, or most likely a combination of all listed (e.g., [15–23]). Understanding the underlying mechanisms driving these transitions will help to characterize the activity process in AGNs [14].

Recent advancements in observational techniques and large-scale sky surveys, along with machine learning algorithms, have significantly expanded the catalogs of CL AGNs (e.g., [24–31]). This trend is expected to increase even further with new time-domain missions like Vera C. Rubin Legacy Survey in Space and Time (LSST) [32] and its spectroscopic follow-ups. These will certainly help with solving the mystery of CL AGN phenomena. Nevertheless, smaller but dedicated monitoring campaigns of the known type 1 AGNs are continuously providing valuable findings; see, e.g., [33–41].

Here, we outline the strategy and advantages of the long-term optical monitoring of the AGN (LoTerm AGN) campaign, initiated in the 1990s by Alla I. Shapovalova. Initially, the campaign aimed to study the size and structure of the BLR in type 1 AGNs and estimate the parameters of the SMBHs, leading to the publication of a number of papers (see [42] and references therein). The focus of the current campaign is to continue the spectroscopic and photometric long-term monitoring of a sample of the most studied type 1 AGNs. The main objective is to identify and characterize long-term trends and extreme variability in broad lines.

LoTerm AGN project is a collaborative network of several international research teams. The project aims to understand the structure of the BLR in AGN, in which properties (i.e., BLR size and gas velocity) are commonly used to estimate the mass of SMBHs; see, e.g., [43–45]. Specifically, LoTerm AGN seeks to investigate possible long-term trends and changes in selected objects (e.g., capturing changing-look events as successfully demonstrated for NGC 3516 [42]), contributing to a deeper understanding of the BLR structure of AGNs. Furthermore, LoTerm AGN data could be merged through careful intercalibration with other campaigns, which could be beneficial for reverberation mapping studies, i.e., the estimation of the time delay between the optical continuum and emission line flux, which, in turn, provides the size of the BLR [46,47]. The reverberation mapping is an highly useful technique to map the inner structure of the emitting regions in AGN (see [48] for review), and, in particular, the broad-line monitoring is especially useful for constraining the BLR physics and kinematics (e.g., [49]). Finally, the LoTerm AGN campaign will continue to build a legacy database of the type 1 AGN. This initiative has been running for about the last 30 years (see [42] and references therein), collecting data from various medium-size optical telescopes worldwide. A dozen of different sub-types within type 1 AGN, using both spectral and photometric observations, have been analyzed in great detail.

Among the objects in the LoTerm AGN sample is a bright (with the visual magnitude of V$\sim$12.5) nearby (of the redshift z = 0.0088) type 1 AGN NGC 3516, which was one of the first AGN to show a dramatic change in its broad emission lines [50]. Being that bright and strongly variable, this AGN has been intensively observed and studied both optically and by X-ray [38,42,51–59]. Within LoTerm AGN monitoring, NGC 3516 has been followed during several decades (1996–2018) [42] when it was discovered that in 2014 optical broad emission lines significantly decreased, i.e., the hydrogen Balmer Hβ broad line completely disappeared), and later quite a weak broad Hβ component appeared in 2017. This confirmed the classification of this object as CL AGN. The phase of the arising BLR and increase in weak broad lines continued after 2017; see [38,60]. Peculiar spectral features have been observed in this object, such as the variability and increase in coronal lines [60], and the strong asymmetry in broad line profiles [59]. The object was monitored in the X-ray during this awaking phase, also revealing strong variability [38,57]. Despite intensive observations, it was not possible to well distinguish between the previously proposed two scenarios for this object: (i) changes in line-of-sight obscuration due to dust presence [38], or (ii) intrinsic change in the accretion disk physics [57,59]. This was our motivation to continue to follow this object. Therefore, continuous monitoring of this and other similar objects with dedicated campaigns (such as LoTerm AGN) is crucial in capturing transition events, not only during the rising phase of the activity, but also in the dimming phase, which is more challenging to detect.

This paper is structured as follows. Section 2 provides an overview of the observation facilities, collected data, and data reduction. Section 3 presents the broad line profile analysis and highlights the main findings. Section 4 discusses the results outlines the conclusions and future activities.

2. Observations, Data Reduction and Analysis

LoTerm AGN observations are organized and facilitated in collaboration with the following telescopes located worldwide (Table 1): (1) A 1 m Zeiss telescope of the Special Astrophysical Observatory (SAO) of the Russian Academy of Sciences, equipped with MAGIC focal reducer used in a long-slit spectroscopic mode [61,62]; (2) a 6 m BTA telescope (Big Telescope Alt-azimuth) of SAO, equipped with multi-mode focal reducers, SCORPIO-1 [63] and SCORPIO-2 [64], which are used in the long-slit spectroscopic mode, the latter used occasionally through target of opportunity (ToO) programs in case objects are noticed to show a peculiar variability; (3) a 2.1 m telescope of the Instituto Nacional de Astrofisica, Optica y Electronica (INAOE) at the Guillermo Haro Observatory (GHO) at Cananea, Sonora (Mexico), equipped with a *Boller & Chivens* spectrograph, within the guaranteed time; (4) a 1.8 m Copernico telescope of the Italian National Institute for Astrophysics (INAF) Astronomical Observatory of Padova (OAPd) atop Mount Ekar (Italy), equipped with Asiago Faint Object Spectrograph and Camera (AFOSC); (5) a 1.2 m Galileo telescope (OAPd) recently refurbished [65], equipped with the *Boller & Chivens* spectrograph, and within a guaranteed time; (6) a 1.4 m Milanković telescope of the Astronomical Station Vidojevica (ASV) within the Astronomical Observatory Belgrade (Serbia), for which the installation of stellar spectrograph [66] is currently under consideration; and (7) a 1.5 m T150 telescope of the Observatory Sierra Nevada (OSN), Granada (Spain), for which a spectrograph installation is currently under consideration. Table 1 lists the instruments and gratings currently used on the telescope involved in the LoTerm AGN campaign.

The LoTerm AGN observing strategy is to observe in the spectral mode all objects in the sample preferably once per month, in order to capture significant changes in the broad line profile. To note is that, given the often irregular nature of AGNs, particularly when an object is in a highly active state with significant variability (either intrinsically or possibly due to the presence of jets), the low observing cadence increases the risk of overlooking certain details. The selected objects are all bright AGNs, i.e., these AGNs do not require long exposures with available instruments; thus, they could be potentially suggested to fill the observation gaps within other observing programs. The observing strategy is the same at all sites, with the standard star observed separately. The list of current LoTerm AGN targets are: Mrk 6, OI 371, NGC 3516, NGC 4151, NGC 5548, Mrk 817, ARP 102B, E1821 + 643, 3C390.3, Ark 564, NGC 7469, and NGC 7603. This sample has been carefully selected to have a bright type 1 AGN with peculiar and variable broad line profiles.

Table 1. Telescopes and instruments used within the LoTerm AGN campaign. Here, VPH/G stands for a volume phase holographic grating, GR stands for a grism and @ indicates the central wavelength. See text for more details.

Telescope	Instrument	Gratings	Status *
1 m Zeiss (SAO)	MAGIC	VPHG600@500	Operational
6 m BTA (SAO)	SCORPIO-1, SCORPIO-2	VPHG550G, VPHG1200@540	On demand
2.1 m Telescope (GHO)	*Boller & Chivens*	150 l/mm	Operational
1.8 m Copernico (Cop)	AFOSC	GR04, GR07, VPH7	Operational
1.2 m Galileo (OAPd)	*Boller & Chivens*	150/300/600/1200 l/mm	Operational
1.4 m Milanković (ASV)	-	-	In plan
1.5 m T150 (OSN)	-	-	In plan

* Describes the level of service provided by listed telescope: "Operational"—regularly used through long-term proposal or guaranteed time; "On demand"—applied for additional time within special or other observing programs; "In plan"—spectrograph yet to be installed, currently in use for photometry.

The CL AGN NGC 3516 has been monitored for almost three decades, from 1996 [42] to 2021 [59]. Details on the instruments, observations, data reduction, spectral calibration, and unification, are extensively described earlier in [42] (see also references therein). In the recent publication [59] by LoTerm AGN on NGC 3516, the analysis of the Hβ line profile evolution during the long period of 1996–2021 was studied; however, only data from GHO have been included in the analysis. Within this paper, as a case study of LoTerm AGN, we present the latest observations from 2020 to 2023, taken with the instrument configurations described in Table 1, rows 1 to 4.

The spectra have been pre-processed (e.g., corrected for Galactic absorption, cosmological redshift, calibrated to [O III] line fluxes, and shifted) as in Ref. [59]. Since within the current study, the focus is on the evolution of the Hα line profile only, we do not correct for the host galaxy contribution, as its contribution to the Hα line profile is negligible (see, e.g., Figure 3 in Ref. [60]).

Table 2 lists the observation log of NGC 3516 in the period 2020–2023. Figure 1 presents all calibrated spectra (in the rest frame) covering the Hβ and Hα spectral range. Figure 2 shows the zoom-in of the Hα region only. Due to the different spectral resolution of the instruments, as well as different observing conditions in terms of seeing, the contribution of narrow Hα and [N II] satellite lines is sometimes hidden in the broad line profile. This is especially observed in the case of the 2.1 m GHO and 1.8 m Copernico observation, which have the poorest spectral resolution (see Figure 2, which shows the zoom-in of the Hα line only). These effects somewhat influence the extracted broad line profile. However, considering the large width of the Hα profile, one may assume that the effects are not dominant. A similar observation applies for different slit widths, since it is assumed that the broad line profile originates dominantly from the compact parsec-scaled BLR.

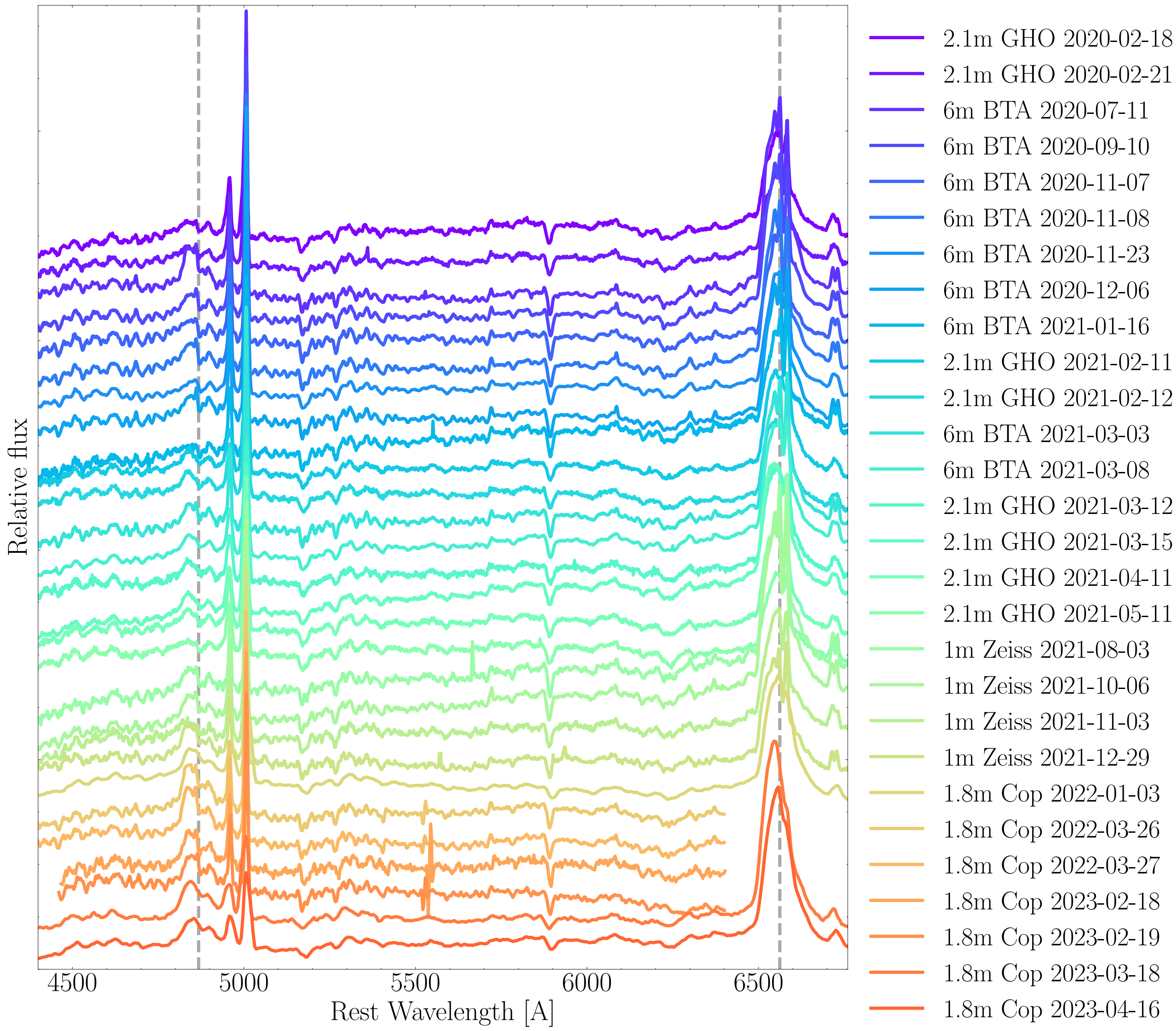

Figure 1. NGC 3516 spectra covering both Hβ λ4868 Å and Hα λ6562 Å (position marked with vertical dashed line) spectral range in the period 2020–2023. Spectra are normalized to the mean for comparison. See text for details.

For the extraction of the pure broad line profile, we used an open source code `fantasy` [60,67,68] for the AGN spectra analysis. This code models AGN spectra by simultaneously fitting the underlying broken power-law continuum, emission lines selected from several predefined line lists, and a Fe II model. Recently, in Ref. [68], it was shown that the Fe II emission is also detected redward from the Hα line, contaminating the broad Hα line wings. Therefore, we modeled the observed Hα profile using the narrow Hα and satellite lines ([N II], [S II], [O I]), three broad Gaussians for the broad components, and the Fe II model. For details of the AGN spectral modelling and the application of the `fantasy` code; see [68]. Let us emphasize that the primary goal of the multi-component fittings was not to provide a physical interpretation of the BLR structure, but rather to optimize the extraction of the broad line profile, i.e., subtract the underlying continuum, narrow, and satellite lines. We used three broad Gaussians for reproducing the broad emission line profile, which provided us with the best fitting results based on the minimization of residuals.

Figure 3, left, displays an example of the multi-component fitting of the complex Hα line profile for epoch 2021-03-03 obtained with 6 m BTA. The pure broad line profile can be extracted either by subtracting the continuum, narrow, and satellite lines ([N II], Fe II multiplets, Hα narrow) from the observed spectrum (referred here as the "observed" profile) or by summing the broad Gaussians used to model the broad component of the lines (referred here as the "modelled" profile). Comparing the observed and modelled pure broad lines profile (Figure 4, right), shows that they are of a similar shape; thus, further on, we use the modelled pure broad profiles (as in Ref. [59]).

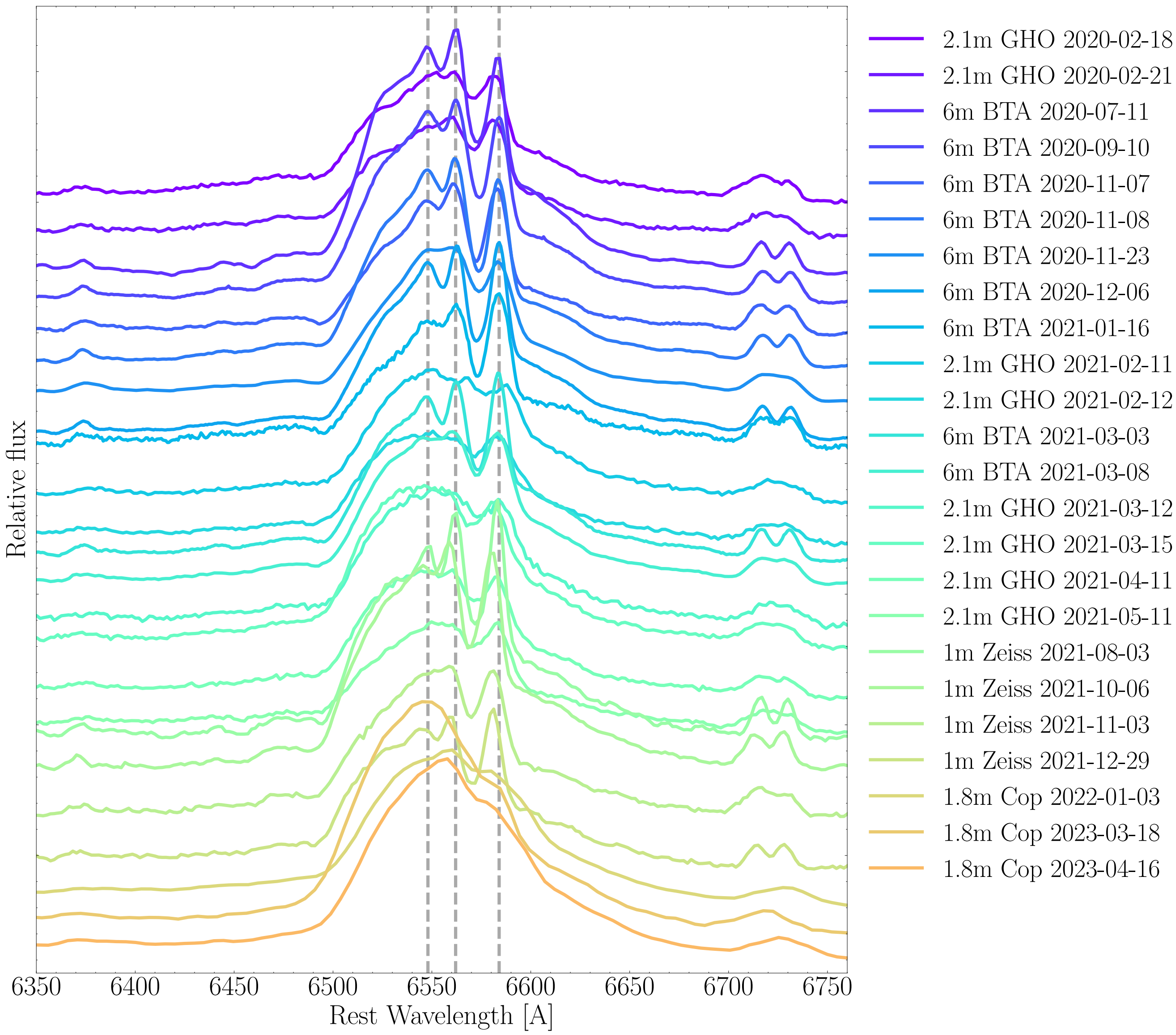

Figure 2. The evolution of Hα line in the period 2020–2023. Vertical dashed line marks the position of narrow Hα and [N II]λλ6548, 6584 doublet. See text for details.

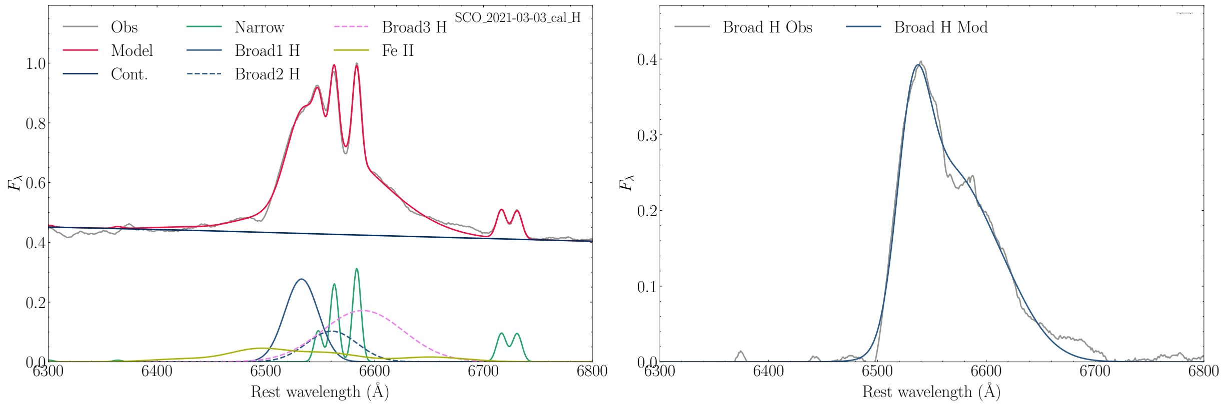

Figure 3. Left: an example of the multi-component fitting with `fantasy` software of the Hα profile for epoch 2021-03-03 obtained with 6 m BTA. Different components (three broad hydrogen (H) components; narrow Hα; [N II]$\lambda\lambda$ 6548, 6584, and [S II]$\lambda\lambda$ 6716, 6730 lines; and Fe II multiples) are shown as indicated. The used multi-component model corresponds to the best empirical fit of the complex broad line profile based on the minimization of residuals. The "Obs" denotes the observed spectrum and "Cont" stands for the underlying continuum. **Right**: comparison of the observed (after the subtraction of continuum, narrow, and satellite lines) and modelled (sum of all Gaussian components, labelled as "Mod") pure broad lines profile. See text for details.

Table 2. Observation log of NGC 3516 in period 2020–2023. Date of observation is given in the format year-month-day. See text for details.

Date	Telescope	Grating	Exposure [s]	Slit Width [arcsec]	Seeing [arcsec]	Weather
2020-02-18	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.2	Good
2020-02-21	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.3	Medium
2020-07-11	6 m BTA	1200@540	4 × 300	1.0	2.0	Medium
2020-09-10	6 m BTA	1200@540	6 × 300	1.0	1.7	Medium
2020-11-07	6 m BTA	1200@540	8 × 300	1.0	4.0	Medium
2020-11-08	6 m BTA	1200@540	8 × 300	2.0	1.3	Excellent
2020-11-23	6 m BTA	550G	5 × 240	1.2	3.4	Medium
2020-12-06	6 m BTA	1200@540	7 × 300	2.0	1.4	Medium
2021-01-16	6 m BTA	1200@540	5 × 240	2.0	4.0	Bad
2021-02-11	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.4	Medium
2021-02-12	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.9	Medium
2021-03-03	6 m BTA	1200@540	3 × 180	2.0	2.5	Medium
2021-03-08	6 m BTA	550 G	6 × 240	1.2	4.5	Good
2021-03-12	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.2	Medium
2021-03-15	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.0	Medium
2021-04-11	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.4	Medium
2021-05-11	2.1 m GHO	150 l/mm	3 × 1800	2.5	2.6	Good
2021-08-03	1 m Zeiss	600@500	5 × 600	2.0	2.0	Bad
2021-10-06	1 m Zeiss	600@500	5 × 600	2.0	2.5	Medium
2021-11-03	1 m Zeiss	600@500	12 × 300	2.0	3.0	Good
2021-12-29	1 m Zeiss	600@500	16 × 300	2.0	1.7	Bad
2022-01-03	1.8 m Cop	GR04	2 × 600	2.5	2.0	Good
2022-03-26	1.8 m Cop	GR07	3 × 540	1.69	2.0	Medium
2022-03-27	1.8 m Cop	GR07	3 × 540	1.69	2.0	Medium
2023-02-18	1.8 m Cop	GR07	2 × 540	1.69	3.0	Medium
2023-02-19	1.8 m Cop	GR07	3 × 540	1.69	2.5	Medium
2023-03-18	1.8 m Cop	VPH7	3 × 540	2.5	2.0	Medium
2023-04-16	1.8 m Cop	VPH7	3 × 540	2.5	3.3	Good

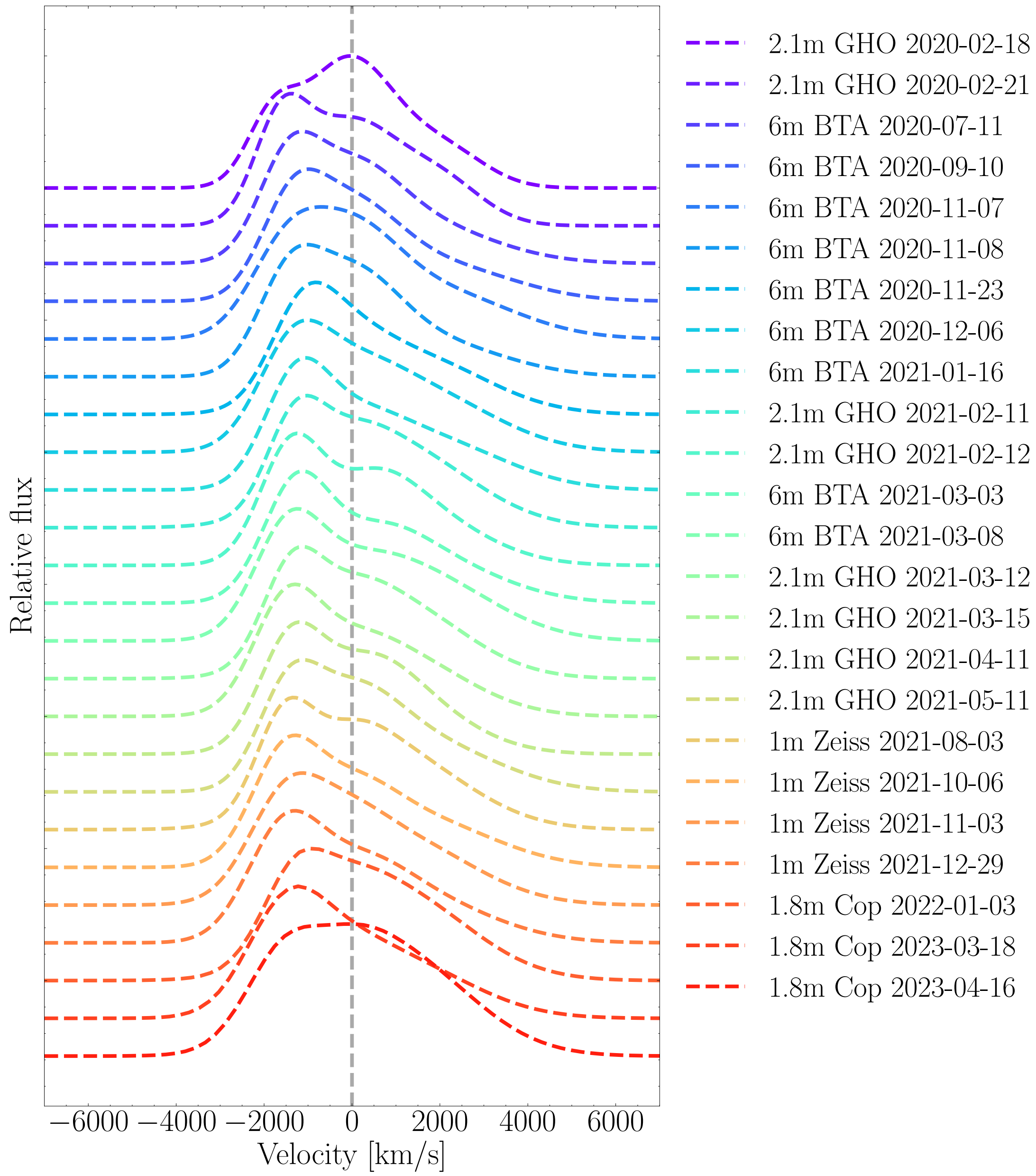

Figure 4. The evolution of the normalized pure broad Hα line profile in the period 2020–2023. Vertical dashed line marks the position of the narrow Hα line at 0 km/s.

3. Results

We study the evolution of the complex broad Hα line profile obtained within the LoTerm AGN in the latest period of 2020–2023, searching for the broad line profile variations. The motivation comes from the fact that the significant variability of the broad line profile can indicate the change in the geometry of the BLR.

Figure 4 shows a pure broad line profile, normalized to its maximal intensity, and a wavelength converted to the velocity scale. In the last three years, the broad Hα profile preserved a similar shape, in contrast to the significant change in the last three decades detected in the Hβ profile on similar time scales of a few years (see Figure 3 in Ref. [59]). The most prominent feature of the broad Hα profile is the strong blue asymmetry (Figure 4). The profile has the prominent blue peak at the velocity of about −(1100–1200) km/s, where the positions seem to be constant. The same complex and asymmetric profile with a prominent blue peak was reported for the Hβ line [38,59]. Note that the limitation in spectral resolution does not allow for precise measurements of the radial shift of the peak.

We further calculate the mean and root mean square (RMS) profiles, which are plotted in Figure 5 and normalized to the peak of the mean profile. Again, both the mean and rms profiles are strongly asymmetric with the blue peak located around -1100 km/s velocity (Figure 5, upper.) The RMS profile demonstrates that some variations are present in the broad line profile, especially around the peak. As expected, the mean profile is slightly narrower with the full-width half-maximum (FWHM) of 4000 km/s, whereas the FWHM of the RMS profile is 4900 km/s (Figure 5, bottom.) This is consistent with the findings from Ref. [59], where the FWHM were measured mostly in the velocity range around 4000–5000 km/s. In the minimum of activity, the FWHM seems to be larger; however, the uncertainties of these measurements are considerably larger. The comparison of the mean and RMS profiles normalized to the unity (Figure 5, bottom) reveals that their profiles are similar, with quite a small radial displacement of the peaks. Let us notice that this might be the effect of different and, in some cases, quite poor spectral resolution.

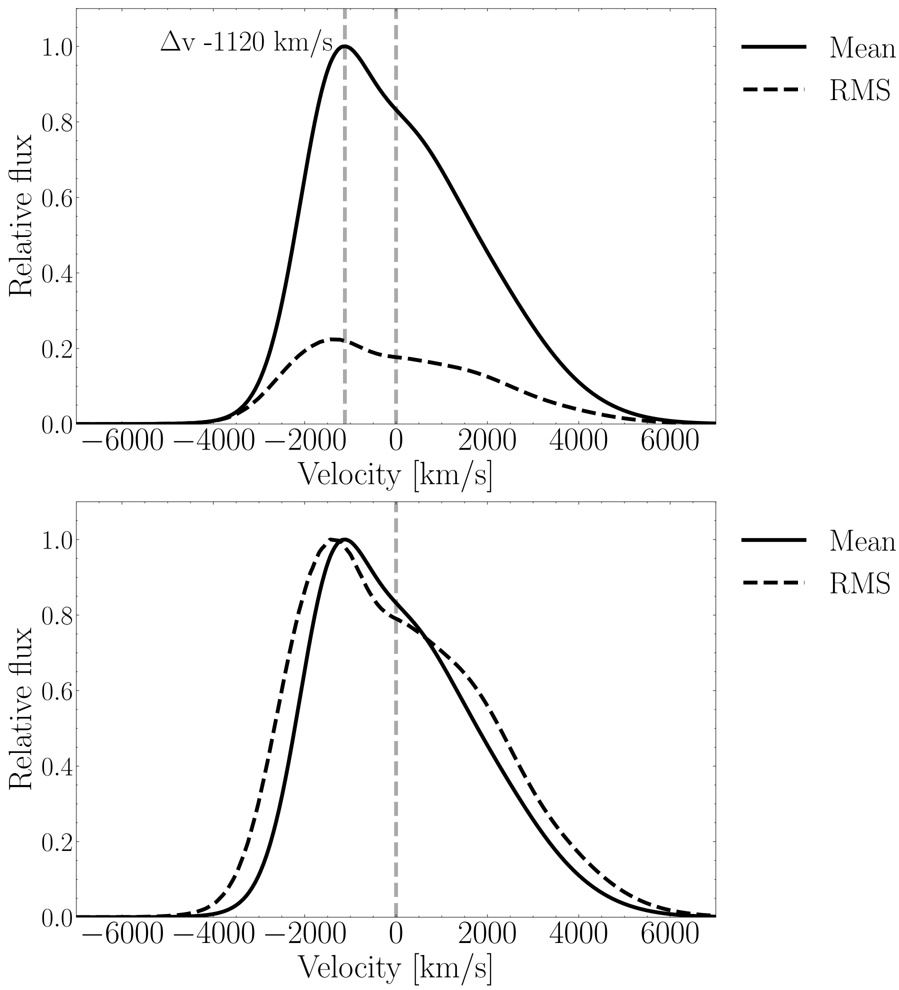

Figure 5. Upper: the mean and root mean square (RMS) profiles of the broad Hα line normalized to the peak of the mean spectrum in the period 2020–2023. Vertical dashed lines denote the position of the peak at -1120 km/s and the position of the line center at 0 km/s. **Bottom**: comparison of the mean and RMS profiles normalized to unity.

In terms of the classification of AGNs to population A or population B (based on broad line width and strength of Fe II emission [69]) objects, and their location on the quasar main sequence (see, e.g., [69] and references therein), in the recent period of 2020–2023, NGC 3516 remains to be the population B object, with the FWHM of broad lines larger than 3000 km/s, and a weak Fe II emission. The mean Eddington ratio, calculated using the continuum flux at 5100 Å and the SMBH mass of $4.7 \times 10^7\ M_\odot$ (Sun mass) [42], is L/L_{Edd} = 0.02. We assumed the bolometric correction of ∼10 [70] and used the Planck cosmology to calculate the luminosity distance [71].

4. Discussion and Conclusions

In this paper, we present the study of the LoTerm AGN project that is a long-term monitoring campaign of a sample of intensively studied broad-line AGNs. LoTerm AGN is a network of medium-size (1 m–6 m) observing facilities conveniently located across the world. The primary goal of the campaign is the ongoing spectroscopic follow-up of type 1 AGN with peculiar broad line profiles. This campaign is essential for the understanding of the physics of the BLR and its connection with the accretion disk and surrounding emitting and dusty regions. As an important case study, we present the recent optical spectral data of the CL AGN and NGC 3516. In this study, we focus on the broad Hα line from the period of 2020–2023.

In Ref. [42] it is noted that during the long-term (1996–2018, with the gap in 2008–2011) monitoring of NGC 3516, the dramatic transition has been captured in 2014, confirming that this AGN is a CL AGN. The follow-up study [59] that was focused on the Hβ line only, showed that the Hβ line was quite intensive at the beginning of the campaign (epoch 1996–1999), followed by the period of variable broad line intensity in 1999–2001, after which (epoch 2002–2003) the Hβ was weak. From 2004 to 2007, Hβ became, again, more intensive. The broad Hβ completely disappeared in period after 2014, i.e., AGN changed its type to almost a type 2 AGN with only a weak broad Hα visible. This quite faint state in 2014 was also reported in the optical (B-band) and X-ray monitoring campaign in Ref. [55]. Later, in 2017, quite a weak broad line component started to appear (also indicated in Refs. [38,60]), thus another CL event happened in NGC 3516. In 2020–2021, Ref. [59] has commented that the broad Hβ becomes stronger, with prominent change in the line profile implying that the BLR geometry is changing after 2020, when the BLR starts again to appear. In Ref. [38], a similar behaviour of Hβ was recognized in the same period. Similarly, In Ref. [38] it is indicated that during the strengthening of the line, the blue part started to dominate the Balmer lines, giving an asymmetric profile with a blue-shifted peak. After this strong phase, in Ref. [59] it was pointed out that the broad line Hβ profile remains almost constant.

In this paper, we present spectra of NGC 3516 obtained during 2020–2023 with the LoTerm AGN, focusing on the behaviour of Hα. During this recent period, the broad Hα line remained almost constant after the increase in 2020–2021 mentioned in Ref. [38]. The Hα line is showing a complex profile, which remained strongly asymmetric with the prominent blue peak. The first and last profiles in Figure 4 do not show the prominent blue-shifted peak. This is most likely due to poor quality of the spectra and less successful subtraction of narrow lines with the automated procedure described in Section 2. The observed almost constant line profile during three years is not typical for strongly variable type 1 AGN such as NGC 3516, especially considering the dramatic changes in the line profile in the period just before the one reported in Ref. [38] or in the past [59]. The asymmetric broad line profiles as well as blue-shifted peaks are not common, but are observed in a fraction of AGNs, typically in population B objects [69]. This type of complex profiles suggest the presence of outflowing gas, and they are good candidates for mapping the BLR kinematics (e.g., [72]). The mean and RMS profiles of Hα in this period are similar, with the latter being a slightly wider, indicating that the geometry of the BLR remains the same. This may be in favor of the scenario of the intrinsic change in the accretion disk physics being responsible for the BLR transitions, which is a scenario outlined for NGC 3516 in Ref. [59] and suggested for other CL AGN (e.g., for IRAS 23226-3843 [39]); however, other possibilities cannot be ruled out.

One way to probe the state of the accretion disk and the degree of obscuration is through the X-ray monitoring. In Ref. [55], following a one-year intensive campaign, it was suggested that a hot accretion flow and a truncated disk are a preferred scenario over the standard "lampost" corona with a standard disk model. This campaign was conducted during quite a faint state of activity in NGC 3516; however, issues with the X-ray reprocessing model were noted during higher state in 1998 (see [73]). The recent multi-wavelength campaign, including the Swift data [38], revealed that the dramatic change in broad line profiles was actually proceeded with the strong outburst in X-rays in 2020, which showed the increase in a few orders of magnitude. A comparable increase in the X-ray flux has been observed in other CL AGNs, such as NGC 1566 [74] or HE 1136-2304 [75]. As a conclusion, Ref. [38] states that the variability in optical broad line profiles and the X-ray are likely to be the results of temporary obscuration by Compton-thick clumps. However, in Ref. [57] a preference is given to the point that the variability is induced by the change in the ionizing spectral energy distribution, which influences the ionization of the warm-absorber outflows, who later mimic the presence of new obscuring gas. Therefore, there is still debate on which of the scenarios is more relevant for NGC 3516; further monitoring is required to solve the issue for this and other highly variable AGNs.

In summary, the LoTerm AGN project is a coordinated network of observational facilities located across three continents, dedicated to the observations of type 1 AGN and operated by diverse research teams. Currently, LoTerm AGN comprises seven facilities, with five equipped with spectrographs and two awaiting the installation of spectral instruments. The LoTerm AGN consortium is opened for inclusion of new facilities and research teams. The sample of type 1 AGN within LoTerm AGN is optimally selected to contain both bright and peculiar AGNs, to ensure their continuous observations (preferably once per month) mainly in the spectral mode (but also in the photometric mode), with the main objective of capturing long-term and significant changes in their broad line profile. The sample consists of extensively studied type 1 AGN that have been observed for many decades. Their continued monitoring is essential for investigating the formation and structure of the BLR in AGNs. One of the main advantages of LoTerm AGN is its low cadence observing strategy, avoiding the challenging requirement for frequent (high cadence) observations as in reverberation mapping campaigns. Moreover, despite potential differences in observational setups among different facilities, (such as significantly different spectral resolution), the changes in the broad line profile will stil be captured. This is demonstrated in this case study of NGC 3516, where the broad line profiles measured from high and low-resolution spectra are compared. Finally, the LoTerm AGN campaign will continue to build a legacy database of the most known type 1 AGN, a project that has been ongoing for the last three decades, with the future goal of making all observed spectra and data products publicly available.

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Abbreviations

The following abbreviations are used in this manuscript:

AGNs	Active galactic nuclei
ASV	Astronomical Station Vidojevic
BTA	Big Telescope Alt-azimuth
BLR	Broad line region
CL AGN	Changing-look AGN
Cop	Copernicus
FWHM	Full-width half-maximum
GHO	Guillermo Haro Observatory
GR	Grism
INAF	Italian National Institute for Astrophysics
LoTerm AGN	Long-term monitoring of AGN
LSST	Legacy Survey in Space and Time
OAPd	Astronomical Observatory of Padova
OSN	Observatory Sierra Nevada
SAO	Special Astrophysical Observatory
SMBH	Super massive black hole
SRM	root mean square
VPH/G	volume phase holographic grating

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