*Nuclear Activity in Galaxies Across Cosmic Time*
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# Optical variations in changing-look AGNs selected at X-rays

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**Abstract.** Recent observations of local AGNs have revealed that many of them show a ‘changing look’ behavior at optical and X-rays wavelengths in the sense of transiting between different AGNs families (e.g. from type-1 to type-2 or vice-versa). In order to pinpoint the possible relation of the changes, we performed optical spectroscopic observations (with CAFOS/CAHA) of 15 changing look AGNs selected at X-rays. Highlights from our spectroscopic study are presented.

**Keywords.** galaxies: active, galaxies: kinematics and dynamics, techniques: spectroscopic.

## 1. Introduction

Under the AGN unification scheme (see Padovani *et al.* 2017 for a review) the different optical classifications are explained in terms of orientation effects. The torus, is responsible for obscuring the broad line region (BLR) where broad Balmer lines, as H$\beta\lambda$4861 and H$\alpha\lambda$6563, are originated. This way, type 2 AGNs are those observed throughout the torus (only narrow lines) whereas type 1s have a direct view onto the BLR (broad Balmer lines and narrow forbidden lines). Intermediate classes from 1.2 to 1.9 are those in between, with type 1.2 having the largest contribution of broad lines, and 1.9 having only a broad H$\alpha$. The classification at X-rays is done by measuring the column density ($N_H$): for $N_H$ below $\sim 10^{22}$ cm$^{-2}$ the source is unobscured (i.e. type 1) whereas for larger values the source is obscured (i.e. type 2). For $N_H$ larger than $1.5 \times 10^{24}$ cm$^{-2}$, the sources are classified as Compton-thick (Maiolino *et al.* 1998).

In the last decades some AGNs have been observed to transit (e.g. from Compton-thick to Compton-thin in X-rays, or vice versa) between type 1 and type 2 AGNs (e.g. Matt *et al.* 2003). These objects are called “changing-look” (CL) AGN. At optical wavelengths, sources showing variations in the broad lines have also been observed, changing from one type to another type (e.g. Lamassa *et al.* 2015).

The physical mechanism of the changes is still under debate and two main different scenarios have been proposed to explain the CL behavior. On the one hand, the variation can be caused by a dramatic change of the obscuration along the line of sight which results in a variation of the column density inferred both from X-rays and optical data (e.g. Risaliti *et al.* 2005). On the other hand, the variations of the accretion onto the super-massive black hole may result in a disappearance of the BLR as below a certain accretion rate no type-1 AGN should be observed (e.g. Nicastro *et al.* 2000).

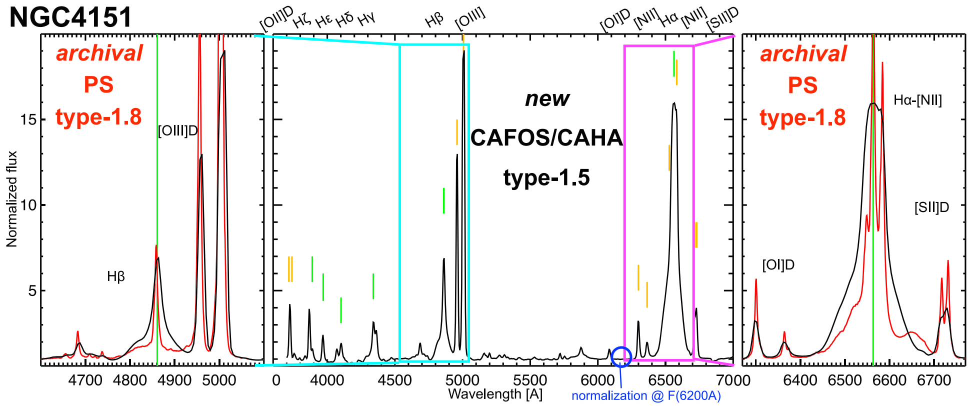


**Figure 1.** Example of the CL-behavior for NGC4151: comparison between new CAFOS/CAHA (Dic 2018, black) and archival Palomar Survey (PS, red, Ho *et al.* 1995).

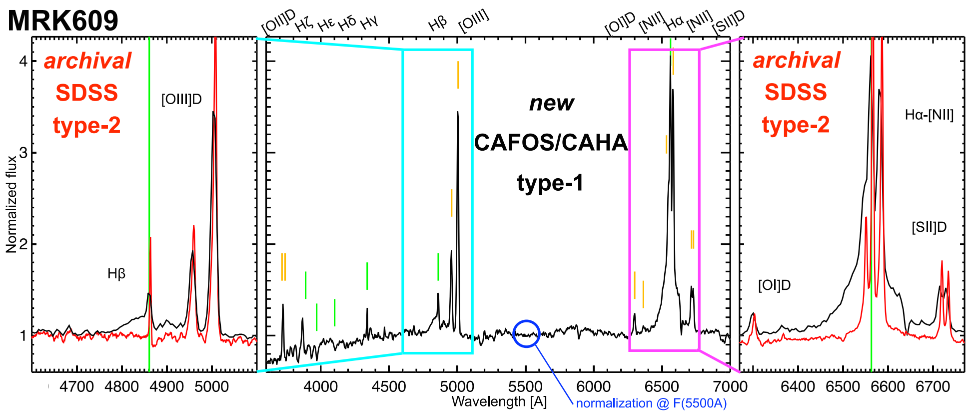


**Figure 2.** Comparison between new CAFOS/CAHA (Nov 2018, black) and archival SDSS-DR7 (data gathered in 2008, Abazajian *et al.* 2009, red) spectra for MRK609.

Many individual and serendipitous discoveries of CL candidates (Ricci *et al.* 2016 and reference therein) can be found in the literature. Surveys of CL-AGNs are rare and have been only lately carried out. For example, in the recent work by Yang *et al.* 2018, their blind search via archival SDSS and LAMOST spectra resulted in a discovery of 21 CL-AGNs.

## 2. Sample and observations

The CL-AGNs in our sample have been selected in X-rays either from previous works by our team (Hernández-García *et al.* 2016, 2017) or from literature, e.g. NGC2617 (Oknyansky *et al.* 2017) and NGC4151 (Puccetti *et al.* 2007). Our total sample is composed by 15 nearby ($z < 0.04$) CL-AGNs. For these AGNs, we obtained broad band (3200-7000 Å) low resolution ($\sim$4 Å/pixel) optical long-slit spectra, in Nov-Dic 2018, with CAFOS mounted at the 2.2m telescope of the Calar Alto Observatory (CAHA). Examples of our new optical spectra and their comparison with archival data are shown in Figures 1, 2 and 3.

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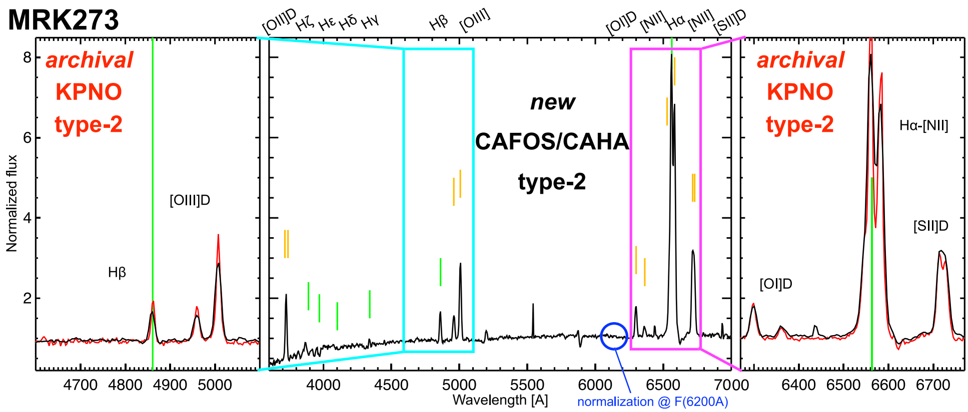


**Figure 3.** New CAFOS/CAHA (black) and archival Kitt Peak National Observatory (KPNO, red, Kim *et al.* 1995) optical spectra of the CL-candidate MRK273 (Hernández-García *et al.* 2016)

## 3. Main results and future works

The main results of our study can be summarized as follows:

• *Detection of CL-AGNs.*

Among the X-rays selected AGNs, the 30 percent (5 out 15) shows the CL-behavior at optical wavelengths. Among these, four known CL-AGNs were caught varying again: two were selected on the basis of $N_H$-variations (e.g. NGC4151, Puccetti *et al.* 2007, Fig. 1) and two from switching from Compton-thin to Compton-thick regime.

• *MRK609, a new CL-AGN.*

This AGN is found to show CL-behavior for the first time in the optical band (Fig. 2). MRK609 has been selected on the basis of the transition from Compton-thin to Compton-thick regime (Hernández-García *et al.* 2017). The AGN-component is absent in the SDSS archival data but visible in our new optical spectra, with FWHM (H$\alpha$) $\sim$ 5150 km/s.

• *CL-AGNs candidates.*

We did not find variations in the optical spectra of 10 (70 percent) AGNs (an example in Fig. 3). $N_H$ variations or changes in the Compton-regime do not guarantee to catch CL-phenomenon in action.

We plan to measure emission lines in both new and archival optical spectra of the selected AGNs fitting both narrow and broad lines, as in Cazzoli *et al.* (2018). The measurements will be compared to those in the literature and to the optical/X-ray properties.

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