X-ray spectral variability of LINERs selected from the Palomar sample[★]

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ABSTRACT

Context. Variability is a general property of active galactic nuclei (AGN). The way in which these changes occur at X-rays is not yet clearly understood. In the particular case of low-ionization nuclear emission line region (LINER) nuclei, variations on the timescales from months to years have been found for some objects, but the main driver of these changes is still debated.

Aims. The main purpose of this work is to investigate the X-ray variability in LINERs, including the main driver of these variations, and to search for possible differences between type 1 and 2 objects.

Methods. We examined the 18 LINERs in the Palomar sample with data retrieved from the *Chandra* and/or *XMM-Newton* archives that correspond to observations gathered at different epochs. All the spectra for the same object were fitted simultaneously to study long-term variations. The nature of the variability patterns were studied by allowing different parameters to vary during the spectral fit. Whenever possible, short-term variations from the analysis of the light curves and long-term UV variability were studied.

Results. Short-term variations are not reported in X-rays. Three LINERs are classified as non-AGN candidates in X-rays, all of them are Compton-thick candidates; none of them show variations at these frequencies, and two of them vary in the UV. Long-term X-ray variations were analyzed in 12 out of 15 AGN candidates; about half of them showed variability (7 out of the 12). At UV frequencies, most of the AGN candidates with available data are variable (five out of six). Thus, 13 AGN candidates are analyzed at UV and/or X-rays, ten of which are variable at least in one energy band. None of the three objects that do not vary in X-rays have available UV data. This means that variability on long-timescales is very common in LINERs. These X-ray variations are mainly driven by changes in the nuclear power, while changes in absorptions are found only for NGC 1052. We do not find any difference between type 1 and 2 LINERs, neither in the number of variable cases (three out of five type 1 and four out of seven type 2 LINERs), nor in the nature of the variability pattern. We find indications of an anticorrelation between the slope of the power law, Γ , and the Eddington ratio.

Conclusions. LINERs are definitely variable sources irrespective of whether they are classified as optical type 1 or 2. Their BH masses, accretion rates, and variability timescales place them in the same plane as more powerful AGN at X-rays. However, our results suggest that the accretion mechanism in LINERs may be different. UV variations of some type 2 LINERs were found, this could support the hypothesis of a torus that disappears at low luminosities.

Key words. galaxies: active – X-rays: galaxies – ultraviolet: galaxies

1. Introduction

Active galactic nuclei (AGN) are divided into two classes depending on the width of the permitted optical Balmer spectral lines, which can be broad (type 1) or narrow (type 2). From the viewpoint of the unified model (UM) of AGN (Antonucci 1993; Urry & Padovani 1995), the difference between type 1 and 2 objects is due to orientation effects relative to the obscuring medium, where a direct view into the black hole (type 1) or a view through the absorbing material (type 2) gives rise to a variety of subtypes between both classes. For low-ionization nuclear emission line regions (LINER), it is tempting to view them as a scaled-down version of Seyfert galaxies. However, different physical properties (e.g., black hole masses or luminosities) have been inferred (Eracleous et al. 2010a; Masegosa et al. 2011), and the way to introduce them into the UM is still controversial (Ho 2008). Ho et al. (1997) optically classified a

variety of LINERs as 1.9 or 2.0 types, while objects resembling Seyfert 1–1.5 galaxies have not been found.

X-ray data offer the most reliable probe of the high-energy spectrum, providing many AGN signatures (D’Onofrio et al. 2012). AGN are detected as a point-like source at hard X-rays. This method was applied for LINERs in a number of publications (e.g., Satyapal et al. 2004, 2005; Dudik et al. 2005; Ho 2008). The most extensive work was carried out by González-Martín et al. (2009b). They analyzed 82 LINERs with *Chandra* and/or *XMM-Newton* data and found that 60% of the sample show a compact nuclear source in the 4.5–8 keV band; a multiwavelength analysis yielded that about 80% of the nuclei showed evidence of AGN-related properties. Moreover, their result is a lower limit since Compton-thick (CT) objects (i.e., $N_{\text{H}} > 1.5 \times 10^{24} \text{ cm}^{-2}$) were not taken into account.

Variability is one of the main properties of AGN (Peterson 1997). For LINERs, the first clear evidence of variability was reported by Maoz et al. (2005) at UV frequencies. In X-rays, variability can be studied by comparing spectra at different epochs, which can account for long-term variations. This was done for

[★] Appendices are available in electronic form at <http://www.aanda.org>

LINERs by different authors. Pian et al. (2010) and Younes et al. (2011) showed that long-term variability is common in type 1 LINERs. González-Martín et al. (2011a) studied a type 2 LINER that also showed long-term variations. In a previous paper, we studied long-term spectral variability in six type 1 and 2 LINERs, where spectral and flux variations were found on long-timescales in four objects (Hernández-García et al. 2013, hereinafter HG13). These spectral variations may be related to the soft excess, the absorber, and/or the nuclear power.

For a one-epoch observation, when high signal-to-noise data are available, short-timescale variations can be investigated through a power spectral density (PSD) analysis of the light curve (Lawrence et al. 1987; González-Martín & Vaughan 2012). By using this analysis, González-Martín & Vaughan (2012) found 14% of variable LINERs, compared with 79% found for Seyfert galaxies.

On the other hand, the normalized excess variance, σ_{NXS}^2 , is the most straightforward method to search for short-term variations (Nandra et al. 1997; Vaughan et al. 2003). This quantity can be understood as a proxy of the area below the PSD shape, and can be used to search for short-term variations, with the advantage that high-quality data are not required to calculate it. In HG13 we did not find short-term variations in six LINERs.

The aim of this paper is to study the main driver of the X-ray variability in LINERs. We analyzed the X-ray variability in the largest available sample of LINERs. This paper is organized as follows: the sample and the data are presented in Sect. 2. The reduction of the data is explained in Sect. 3. A review of the methodology is provided in Sect. 4, where individual and simultaneous spectral fittings, comparisons of different apertures, flux variability at X-ray and UV frequencies, and short-term variability are explained. The results from this analysis are given in Sect. 5, and are discussed in Sect. 6. Finally, our main results are summarized in Sect. 7.

2. Sample and data

We used the Palomar Sample (Ho et al. 1997), which is the largest sample of nearby galaxies with optical spectra, containing HII nuclei, Seyferts, LINERs, and transition objects. It includes measurements of the spectroscopic parameters for 418 emission-line nuclei. Since we are interested in LINERs, objects classified as L1, L1:, L1::, L2, L2:, L2::, and L/S¹ were taken into account. This sample contains 89 LINERs, 22 of type 1 and 67 of type 2. Note that throughout this paper, we divide the objects into two groups, type 1 (1.9) and type 2 (2.0), in accordance with the classification by Ho et al. (1997).

We made use of all the publicly available *XMM-Newton* and *Chandra* data up to October 2013. Initially, 63 objects had either *Chandra* or *XMM-Newton* observations by the date of the sample selection. LINERs with only one available observation were rejected from the sample (28 objects). Objects affected by a pileup fraction of 10% or more were excluded (four objects, and one observation of another object). The pileup fractions were estimated using the simulation software PIMMS² version 4.6. We used the 0.5–2 keV and 2–10 keV fluxes, the best-fit model, and the redshift to evaluate its importance. Only two objects in the final sample are affected by a pileup fraction of 6% (obsID. 2079 of NGC 4494, and obsID. 5908 of NGC 4374). As shown later

in the results (see Sect. 5.1), this does not have consequences in the variability studies. To guarantee a proper spectral fitting, observations with fewer than 400 number counts were also excluded (12 objects, and 18 observations). ObsID 011119010 of NGC 4636 and 13814 of NGC 5195 met these criteria, but a visual inspection showed low number counts in the hard band and were rejected from the sample. Finally, NGC 4486 was rejected because it is well known that this source is dominated by the jet emission (Harris et al. 2003, 2006, 2009, 2011).

The final sample of LINERs contains 18 objects, eight of type 1 and 10 of type 2. Table 1 shows the general properties of the galaxies. This sample covers the same range in total apparent blue magnitudes as all LINERs in the sample of Ho et al. (1997), with B_T from 8.7 to 12.3, included in Col. 6. The X-ray classification from González-Martín et al. (2009b) divides the objects into AGN candidates (when a point-like source is detected in the 4.5–8.0 keV energy band) and non-AGN candidates (otherwise). Evidence of jet structure at radio frequencies is provided in Col. 10. Table A.1 shows the log of the valid observations, where the observational identification (Col. 3), dates (Col. 4), extraction radius (Col. 5), and the net exposure time (Col. 6) are presented. Number of counts and hardness ratios, defined as $\text{HR} = (H - S)/(H + S)$ ³ are also included in Cols. 7 and 8. Finally, UV luminosities from the optical monitor (OM) and its corresponding filter are given in Cols. 9 and 10.

3. Data reduction

3.1. Chandra data

Chandra observations were obtained with the ACIS instrument (Garmire et al. 2003). The data reduction and analysis were carried out in a systematic, uniform way using CXC *Chandra* Interactive Analysis of Observations (CIAO⁴), version 4.3. Level 2 event data were extracted with the task ACIS-PROCESS-EVENTS. We first cleaned the data from background flares (i.e., periods of high background) using the task LC_CLEAN.SL⁵, which removes periods of anomalously low (or high) count rates from light curves from source-free background regions of the CCD. This routine calculates a mean rate from which it deduces a minimum and maximum valid count rate, and creates a file with the periods that are considered to be good by the algorithm.

Nuclear spectra were extracted from a circular region centered on the positions given by the NED⁶. These positions were visually inspected to ensure that the coordinates match the X-ray source position. We chose circular radii, aiming to include all possible photons, while excluding other sources or background effects. The radii are in the range between $r_{\text{Chandra}} = 1.5\text{--}5.0''$ (or 3–10 pixels, see Table A.1). The background selection was made taking circular regions between 5–10'' apertures free of sources in the same chip as the target and close to the source to minimize effects related to the spatial variations of the CCD response. We used the task DMEXTRACT to extract the spectra of the source and the background regions. The response matrix file (RMF) was generated for each source region using the task MKACISRMF and the ancillary reference file (ARF) with the task MKWARF. The spectra were binned to have a minimum of

¹ Quality ratings as described by Ho et al. (1997) are given by “:” and “::” for uncertain and highly uncertain classification, respectively.

² <http://heasarc.gsfc.nasa.gov/docs/software/tools/pimms.html>

³ H is the number of counts in the hard (2–10 keV) band and S is the number of counts in the soft (0.5–2 keV) band

⁴ <http://cxc.harvard.edu/ciao4.4/>

⁵ http://cxc.harvard.edu/ciao/ahelp/lc_clean.html

⁶ <http://ned.ipac.caltech.edu/>

20 counts per spectral bin so that we would be able to use the χ^2 -statistics that were compiled with the task GRPPHA included in FTOOLS.

3.2. XMM–Newton data

All *XMM–Newton* observations were made with the EPIC pn camera (Strüder et al. 2001). The data were reduced in a systematic, uniform way using the Science Analysis Software (SAS⁷), version 11.0.0. Before extracting the spectra, good-time intervals were selected (i.e., flares were excluded). The method we used for this purpose maximizes the signal-to-noise ratio of the net source spectrum by applying a different constant count rate threshold on the single-event light curve with a field-of-view background of $E > 10$ keV. The nuclear positions were taken from the NED and were visually inspected to verify that they match the X-ray nuclear positions. As a sanity check, the task EREGIONANALYSE was used to compare whether our visual selection deviated from this selection. This task was applied to three objects with low number counts in the sample (NGC 1961, NGC 3608, and NGC 5982) and relative differences $< 1\%$ were obtained. The extraction region was determined through circles of $r_{\text{XMM}} = 15\text{--}35''$ (i.e., 300–700 px) radius and the background with an algorithm that selects the best circular region around the source that is free of other sources and as close as possible to the nucleus. This automatic selection was checked manually to ensure the best selection for the backgrounds.

We extracted the source and background regions with the EVSELECT task. RMFs were generated using the task RMFGEN, and the ARFs were generated using the task ARFGEN. We then grouped the spectra to obtain at least 20 counts per spectral bin using the task GRPPHA, as is required to be able to use the χ^2 -statistics.

3.3. Light curves

Light curves in the 0.5–10 keV, 0.5–2.0 keV and 2.0–10.0 keV energy bands of the source and background were extracted using the task DMEXTRACT for *XMM–Newton* and the task EVSELECT for *Chandra* with a 1000 s bin. We studied only light curves with exposure times longer than 30 ks. Light curves with longer exposure times were divided into segments of 40 ks. Thus, in some cases more than one segment was obtained from the same light curve. The light curve from the source was manually screened for high background and flaring activity, i.e., when the background light curve showed flare-like events and/or prominent decreasing/increasing trends. After this process the total useful observation time is usually lower, therefore only light curves with more than a total of 30 ks were used for the analysis. The light curves are shown in Appendix D. Note that the values of the means and standard deviations were not used for the variability analysis, but for a visual inspection of the data.

4. Methodology

The methodology is explained in HG13, but differs in the treatment of the short-term variability (see Sect. 4.4). For clarity, we recall the procedure below.

4.1. Individual spectral analysis

An individual spectral analysis allowed us to select the best-fit model for each data set. We used XSPEC⁸ version 12.7.0 to fit the data with five different models:

- ME: $e^{N_{\text{Gal}}\sigma(E)} \cdot e^{N_{\text{H}}\sigma(E(1+z))} [N_{\text{H}}] \cdot \text{MEKAL}[kT, \text{Norm}]$
- PL: $e^{N_{\text{Gal}}\sigma(E)} \cdot e^{N_{\text{H}}\sigma(E(1+z))} [N_{\text{H}}] \cdot \text{Norm}e^{-\Gamma} [\Gamma, \text{Norm}]$
- 2PL: $e^{N_{\text{Gal}}\sigma(E)} (e^{N_{\text{H}1}\sigma(E(1+z))} [N_{\text{H}1}] \cdot \text{Norm}_1 e^{-\Gamma} [\Gamma, \text{Norm}_1] + e^{N_{\text{H}2}\sigma(E(1+z))} [N_{\text{H}2}] \cdot \text{Norm}_2 e^{-\Gamma} [\Gamma, \text{Norm}_2])$
- MEPL: $e^{N_{\text{Gal}}\sigma(E)} (e^{N_{\text{H}1}\sigma(E(1+z))} [N_{\text{H}1}] \cdot \text{MEKAL}[kT, \text{Norm}_1] + e^{N_{\text{H}2}\sigma(E(1+z))} [N_{\text{H}2}] \cdot \text{Norm}_2 e^{-\Gamma} [\Gamma, \text{Norm}_2])$
- ME2PL: $e^{N_{\text{Gal}}\sigma(E)} (e^{N_{\text{H}1}\sigma(E(1+z))} [N_{\text{H}1}] \cdot \text{Norm}_1 e^{-\Gamma} [\Gamma, \text{Norm}_1] + \text{MEKAL}[kT] + e^{N_{\text{H}2}\sigma(E(1+z))} [N_{\text{H}2}] \cdot \text{Norm}_2 e^{-\Gamma} [\Gamma, \text{Norm}_2])$

Here $\sigma(E)$ is the photo-electric cross-section, z is the redshift, and Norm_i are the normalizations of the power law or the thermal component (i.e., Norm_1 and Norm_2). For each model, the parameters that vary are written in brackets. The Galactic absorption, N_{Gal} , is included in each model and fixed to the predicted value (Col. 5 in Table 1) using the tool NH within FTOOLS (Dickey & Lockman 1990; Kalberla et al. 2005).

The $\chi^2/\text{d.o.f.}$ and F-test were used to select the simplest model that best represents the data.

4.2. Simultaneous spectral analysis

We simultaneously fitted the spectra for each object with the same model. The baseline model was obtained from the individual fittings. For each galaxy, the initial values for the parameters were set to those obtained for the spectrum with the largest number counts.

The simultaneous fit was made in three steps:

0. SMF0 (Simultaneous fit 0): The same model was used with all parameters linked to the same value to fit every spectra of the same object, i.e., the non-variable case.
1. SMF1: using SMF0 as the baseline for this step, we let the parameters $N_{\text{H}1}$, $N_{\text{H}2}$, Γ , Norm_1 , Norm_2 , and kT vary individually. The best fit was selected for the χ^2_{r} closest to unity that improved SMF0 (using the F-test).
2. SMF2: using SMF1 as the baseline for this step (when SMF1 did not fit the data well), we let two parameters vary, the one that varied in SMF1 along with any of the other parameters of the fit. The χ^2_{r} and F-test were again used to confirm an improvement of the fit.

Whenever possible, this method was separately applied to the data from the two instruments. When data from *Chandra* and *XMM–Newton* were used together, an additional analysis was performed to make sure the sources included in the larger aperture did not produce the observed variability. A spectrum of an annular region was then extracted from *Chandra* data, with $r_{\text{ext}} = r_{\text{XMM}}$ and $r_{\text{int}} = r_{\text{Chandra}}$. We recall that the PSF of *Chandra* is energy dependent and therefore the annular region might be affected by contamination from the source photons at high energies. We have estimated this contribution by simulating the PSF of the sources in our sample using ChaRT⁹ and MARX¹⁰. A monochromatic energy of 8 keV was used and the ray density was obtained individually for each observation. We find that

⁸ <http://heasarc.nasa.gov/xanadu/xspec/>

⁹ <http://cxc.harvard.edu/chart/>

¹⁰ <http://space.mit.edu/ASC/MARX/>

⁷ <http://xmm.esa.int/sas/>

Table 1. General properties of the sample galaxies.

Name	RA	Dec	Dist. ¹	N_{Gal}	m_B	Morph.	Optical	X-ray	Jet	Ref. ²
(1)	(J2000)	(J2000)	(Mpc)	(10^{20} cm^{-2})	(6)	type	class.	class.	(10)	(11)
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
NGC 315	00 57 48.88	+00 21 08.8	59.60	5.88	12.20	E	L1.9	AGN	Y	(1)
NGC 1052	02 41 04.80	+08 15 20.8	19.48	3.07	11.44	E	L1.9	AGN	Y	(2)
NGC 1961	05 42 04.6	+69 22 42	56.20	8.28	11.01	SAB(rs)c	L2	AGN	Y	(3)
NGC 2681	08 53 32.73	+51 18 49.3	15.25	2.45	11.15	S0-a(s)	L1.9	AGN*	N	(1)
NGC 2787	09 19 18.56	+69 12 12.0	10.24	4.32	11.60	S0-a(sr)	L1.9	AGN	N	(1)
NGC 2841	09 22 02.63	+50 58 35.5	16.62	1.45	10.06	Sb(r)	L2	AGN	N	(1)
NGC 3226 ³	10 23 27.01	+19 53 54.7	29.84	2.14	12.34	E	L1.9	AGN	N	(1)
NGC 3608	11 16 58.96	+18 08 54.9	24.27	1.49	11.57	E	L2/S2:	Non-AGN*	N	(1)
NGC 3718	11 32 34.8	+53 04 05	17.00	1.08	11.19	SB(s)a	L1.9	AGN	Y	(1)
NGC 4261	12 19 23.22	+05 49 30.8	31.32	1.55	11.35	E	L2	AGN	Y	(4)
NGC 4278	12 20 06.83	+29 16 50.7	15.83	1.77	11.04	E	L1.9	AGN	Y	(5)
NGC 4374	12 25 03.74	+12 53 13.1	17.18	2.60	10.11	E	L2	AGN*	Y	(6)
NGC 4494	12 31 24.03	+25 46 29.9	13.84	1.52	10.68	E	L2::	AGN	N	(1)
NGC 4636	12 42 49.87	+02 41 16.0	16.24	1.81	10.43	E	L1.9	Non-AGN*	Y	(7)
NGC 4736	12 50 53.06	+41 07 13.6	5.02	1.44	8.71	Sab(r)	L2	AGN	N	(1)
NGC 5195	13 29 59.6	+47 15 58	7.91	1.56	10.38	IA	L2:	AGN	N	(8)
NGC 5813	15 01 11.26	+01 42 07.1	30.15	4.21	11.48	E	L2:	Non-AGN*	Y	(9)
NGC 5982	15 38 39.8	+59 21 21	41.22	1.82	12.05	E	L2::	AGN	N	(10)

Notes. (Col. 1) Name, (Col. 2) right ascension, (Col. 3) declination, (Col. 4) distance, (Col. 5) galactic absorption, (Col. 6) apparent magnitude in the Johnson filter *B* from Ho et al. (1997), (Col. 7) galaxy morphological type from González-Martín et al. (2009a), (Col. 8) optical classification from Ho et al. (1997), (Col. 9) X-ray classification from González-Martín et al. (2009b), where the * represent Compton-thick candidates from González-Martín et al. (2009a), (Col. 10) evidence of radio jet, and (Col. 11) references for radio data. ⁽¹⁾ All distances are taken from the NED and correspond to the average redshift-independent distance estimates. ⁽²⁾ References: (1) Nagar et al. (2005); (2) Vermeulen et al. (2003); (3) Krips et al. (2007); (4) Birkinshaw & Davies (1985); (5) Giroletti et al. (2005); (6) Xu et al. (2000); (7) Giacintucci et al. (2011); (8) Ho & Ulvestad (2001); (9) Randall et al. (2011); (10) Vrtilik et al. (2013). ⁽³⁾ We rejected the long-term variability analysis (i.e., comparison of spectra at different epochs) of NGC 3226 because *XMM-Newton* data may be contaminated by emission from NGC 3227 (see HG13), while we have maintained the UV and short-term analyses (i.e., light curves).

the highest contribution from the source photons at 8 keV is 7%. Note that this contribution is at high energies (i.e., the contribution is lower at lower energies) and does not affect our results (see Sect. 5.1). The data used for comparisons are marked with *c* in Table A.1. When the contamination by the annular region to the *Chandra* data with the r_{XMM} aperture emission was higher than 50% in the 0.5–10.0 keV energy band, we did not consider the joint analysis since the accuracy of the derived parameters could be seriously affected. For lower contamination levels, we considered that *Chandra* data can be used to estimate the contribution of the annular region to the *XMM-Newton* spectrum. The ring from *Chandra* data was fitted with the five models explained above. The resulting model was incorporated (with its parameters frozen) in the fit of the *XMM-Newton* nuclear spectrum, which enabled us to extract the parameters of the nuclear emission. When multiple observations of the same object and instrument were available, we compared the data with similar dates (see Table A.1).

4.3. Flux variability

X-ray luminosities for the individual and simultaneous fits were computed using XSPEC for the soft and hard bands. Distances were taken from NED and correspond to the average redshift-independent distance estimate for each object when available (or to the redshift-estimated distance otherwise) and are listed in Table 1.

UV luminosities were obtained (when available) from the optical monitor (OM) onboard *XMM-Newton* simultaneously to X-ray data. Whenever possible, measurements from different

filters were retrieved. We recall that *UVW2* is centered at 1894 Å (1805–2454 Å), *UVM2* at 2205 Å (1970–2675 Å), and *UVW1* at 2675 Å (2410–3565 Å). For NGC 4736 we used data from the *U* filter (centered at 3275 Å (3030–3890 Å)) because measures from other filters were not available. We used the OM observation FITS source lists (OBSMLI)¹¹ to obtain the photometry. When OM data were not available, we searched for UV information in the literature. We note that in this case the X-ray and UV data might not be simultaneous (see Appendix B).

We assumed an object to be variable when

$$L_{\text{max}} - L_{\text{min}} > 3 \times \sqrt{(\text{err}L_{\text{max}})^2 + (\text{err}L_{\text{min}})^2} \quad (1)$$

where L_{max} and L_{min} are the highest and lowest luminosities of an object, and $\text{err}L_{\text{max}}$ and $\text{err}L_{\text{min}}$ are the measurement errors. We note that this relation was used to determine whether an object was variable, not as an error estimate.

4.4. Short-term variability

We assumed a constant count rate for the whole observation in the 0.5–10 keV energy band, and we calculated $\chi^2/\text{d.o.f.}$ as a proxy to the variations. We considered the source to be variable if the count rate differed from the average by more than 3σ (or 99.7% probability).

To compare the variability amplitude of the light curves between observations, we calculated the normalized excess variance, σ_{NXS}^2 , for each light curve segment with 30–40 ks. This

¹¹ <ftp://xmm2.esac.esa.int/pub/odf/data/docs/XMM-SOC-GEN-ICD-0024.pdf>

magnitude is related to the area below the PSD shape. We followed the prescriptions given by [Vaughan et al. \(2003\)](#) to estimate σ_{NXS}^2 and its error, $\text{err}(\sigma_{\text{NXS}}^2)$ (see also [González-Martín et al. 2011b](#))

$$\sigma_{\text{NXS}}^2 = \frac{S^2 - \langle \sigma_{\text{err}}^2 \rangle}{\langle x \rangle^2} \quad (2)$$

$$\text{err}(\sigma_{\text{NXS}}^2) = \sqrt{\frac{2}{N} \left(\frac{\langle \sigma_{\text{err}}^2 \rangle}{\langle x \rangle^2} \right)^2 + \frac{\langle \sigma_{\text{err}}^2 \rangle}{N} \frac{4\sigma_{\text{NXS}}^2}{\langle x \rangle^2}}, \quad (3)$$

where x , σ_{err}^2 and N are the count rate, its error, and the number of points in the light curve, respectively, and S^2 is the variance of the light curve,

$$S^2 = \frac{1}{N-1} \sum_{i=1}^N (x_i - \langle x \rangle)^2, \quad (4)$$

when σ_{NXS}^2 was negative or compatible with zero within the errors, we estimated the 90% upper limits using Table 1 in [Vaughan et al. \(2003\)](#). We assumed a PSD slope of -1 , the upper limit from [Vaughan et al. \(2003\)](#), and we added the value of $1.282\text{err}(\sigma_{\text{NXS}}^2)$ to the limit (to take into account the uncertainty due to the experimental Poisson fluctuations). For a number of segments, N , obtained from an individual light curve, an upper limit for the normalized excess variance was calculated as

$$\sigma_{\text{NXS}}^2 = \frac{\sqrt{\sum_{i=1}^N \sigma_{\text{NXS}_i}^2}}{N}, \quad (5)$$

when N segments were obtained for the same light curve and at least one was consistent with being variable, we calculated the normalized weighted mean and its error as the weighted variance.

5. Results

In this section we present the individual results on the variability in LINERs of all the sources (Sect. 5.1) as well as the general results (Sects. 5.2, 5.3, and 5.4). This includes short- and long-term variations in X-rays and long-term variations at UV frequencies. The summary of the results obtained for the variability is given in Table 2. Notes and comparisons with previous works for individual objects are included in Appendix B.

5.1. Individual objects

To be concise, we list the peculiarities of each source. For details on the data and results, we refer to the following tables and figures: the observations used in the analysis (Table A.1), variations of the hardness ratio, HR, only compared for data from the same instrument (Col. 8 in Table A.1), UV luminosities when simultaneous data from the OM monitor were available for more than one date (Col. 9 in Table A.1 and Fig. 2), individual and simultaneous best fit and the parameters that varied in the model (Table A.2 and Fig. 1), X-ray flux variations (Table A.3 and Fig. 3), the analysis of the annular region when data from *Chandra* and *XMM-Newton* were used together (Table A.4), the simultaneous fittings of these observations (Table A.5), and short-term variability from the analysis of the light curves (Table A.6 and Appendix D). When short-term variations were not detected, upper limits of σ_{NXS}^2 were calculated.

- **NGC 315**: from the simultaneous analysis of *Chandra* data, variations are not found in a three-year period (i.e., SMF0). The annular region contributes with 3% in *Chandra* data. When they are compared with *XMM-Newton* data, variations of the parameters do not improve the fit within the five-year period. The analysis of one of the *Chandra* light curves shows variations in the hard band at 1.6σ confidence level.
- **NGC 1052**: SMF2 was used to fit its *XMM-Newton* data, with variations of Norm₂ (49%) and $N_{\text{H}2}$ (31%) over a period of eight years. Flux variations of 20% are obtained for soft and hard energies in the same period. Since the annular region contributes with 10% in *Chandra* data, *Chandra* and *XMM-Newton* data were compared, without changes in a one-year period. Short-term variations are not detected. UV variations from the UVM2 (13%) and UVM1 (21%) are found.
- **NGC 1961**: *XMM-Newton* data do not show variations in a one-month period (i.e., SMF0). UV data are available, but the nucleus of the galaxy is not detected.
- **NGC 2681**: the SMF0 results for *Chandra* data did not improve for varying parameters. Consequently, the object does not vary in a period of four months. Short-term variations are not detected.
- **NGC 2787**: one observation per instrument is available. When they are compared, the emission from the annular region contributes with 53% in *Chandra* data. Therefore we did not perform a simultaneous fit and did not use this object to discuss long-term variations. Short-term variations are not detected.
- **NGC 2841**: one observation per instrument is available. When they are compared, the emission from the annular region contributes with 60% in *Chandra* data. Therefore we did not perform a simultaneous fit and did not use this object to discuss long-term variations. In this case the *Chandra* image reveals at least three X-ray sources within the annular region (see Appendix C).
- **NGC 3226**: long-term X-ray variations from this source are not taken into account because of possible contamination from NGC 3227. We refer to HG13 for details. The analysis from the *Chandra* light curve shows variations in the soft and total bands below the 2σ confidence level. UV variations amount to 11% in the UVM1 filter.
- **NGC 3608**: SMF0 was used to fit the *XMM-Newton* data, with no variations in a 12 year period.
- **NGC 3718**: we jointly fit *Chandra* and *XMM-Newton* data since emission from the annular region is negligible. The best representation of the data need Norm₂ to vary (37%), i.e., SMF1 was used. This implies a change in luminosity of 35% (29%) at soft (hard) energy in a one-year period. The nucleus of the galaxy is not detected in the UV data.
- **NGC 4261**: the simultaneous fit with constant parameters (i.e., SMF0) results in a good fit both in *Chandra* and *XMM-Newton* data over a period of eight and six years, respectively. A simultaneous fit of *Chandra* and *XMM-Newton* (the annular region contributes with 37% in *Chandra* data) did not show changes. Short-term variations are not detected. Considering the UV range, variations amount to 9% in the UVM1 filter and 34% in the UVM2 filter.
- **NGC 4278**: the best fit for *Chandra* data is SMF1, with Norm₂ varying (30%) in a one-year period. An X-ray intrinsic luminosity variation at soft (hard) energy of 26% (29%) is found. The contribution of the annular region in *Chandra* data amounts to 38%. When comparing *XMM-Newton* and *Chandra* data, a variation in the normalization of the

Table 2. Results of the variability analysis.

Name	Type	$\log(L_{\text{soft}})$ (0.5–2 keV)	$\log(L_{\text{hard}})$ (2–10 keV)	$\log(M_{\text{BH}})$	$\log(R_{\text{Edd}})$	Variability			T (Years)	HR
(1)	(2)	(3)	(4)	(5)	(6)	SMF0 (7)	SMF1 (8)	SMF2 (9)	(10)	(11)
NGC 315 (C)	AGN	41.38	41.58	8.65	−3.67	MEPL	–	–	3	
	L1.9	0%	0%							8%
NGC 1052 (X)	AGN	41.04	41.52	8.07	−3.14	ME2PL	Norm ₂ 49%	$N_{\text{H}2}$ 31%	8	33%
	L1.9	20%	20%							
NGC 1961 (X)	AGN	41.20	41.23	8.67	−4.03	ME2PL	–	–	0.08	0%
	L2	0%	0%							
NGC 2681* (C)	AGN	39.02	38.93	7.07	−4.73	MEPL	–	–	0.4	
	L1.9	0%	0%							4%
NGC 3608* (X)	Non-AGN	40.32	40.24	8.06	−4.41	ME2PL	–	–	12	
	L2/S2:	0%	0%							4%
NGC 3718 (C+X)	AGN	40.76	40.99	7.85	−3.60	2PL	Norm ₂ 37%	–	1	14%
	L1.9	35%	29%							
NGC 4261 (X)	AGN	40.98	41.02	8.96	−4.54	ME2PL	–	–	8	0%
	L2	0%	0%							
(C)						ME2PL	–	–	6	
		0%	0%							19%
NGC 4278 (C)	AGN	39.80	39.75	8.46	−5.30	MEPL	Norm ₂ 30%	–	1	4%
	L1.9	26%	29%							
NGC 4374* (C)	AGN	39.64	39.59	8.74	−5.79	MEPL	Norm ₂ 73%	–	5	12%
	L2	64%	71%							
NGC 4494 (X,C)	AGN	39.13	39.37	7.64	−4.84	PL	Norm 33%	–	0.3	
	L2::	31%	35%							
NGC 4636* (X)	Non-AGN	40.86	39.81	8.16	−5.00	MEPL	–	–	0.5	
	L1.9	0%	0%							14%
NGC 4736 (X)	AGN	39.61	39.73	6.98	−3.84	MEPL	–	–	4	
	L2	0%	0%							5%
NGC 5195 (X)	AGN	39.24	39.25	7.59	−4.86	MEPL	Norm ₂ 20%	–	8	3%
	L2:	9%	19%							
(C)		38.56	38.61			MEPL	–	–	0	
		0%	0%							2%
NGC 5813* (X)	Non-AGN	41.33	40.30	8.42	−4.72	MEPL	–	–	4	
	L2:	0%	0%							1%
(C)		39.68	39.07	8.42	−5.95	MEPL	–	–	6	
		0%	0%							5%
NGC 5982 (X)	AGN	40.70	40.49	8.44	−4.71	MEPL	Norm ₂ 50%	–	1	
	L2::	11%	49%							10%

Notes. (Col. 1) Name (the asterisks represent Compton–thick objects), and the instrument (C: *Chandra* and/or X: *XMM-Newton*) in parenthesis, (Col. 2) X-ray and optical types, (Cols. 3 and 4) logarithm of the soft (0.5–2 keV) and hard (2–10 keV) X-ray luminosities, where the mean was calculated for objects with variability, and percentages in flux variations, (Col. 5) black-hole mass in logarithmical scale, determined using the correlation between stellar velocity dispersion (from HyperLeda) and black-hole mass (Tremaine et al. 2002), (Col. 6) Eddington ratio, $L_{\text{bol}}/L_{\text{Edd}}$, calculated from Eracleous et al. (2010a) using $L_{\text{bol}} = 33L_{2-10 \text{ keV}}$, (Col. 7) best fit for SMF0, (Col. 8) parameter varying in SMF1, with the percentage of variation, (Col. 9) parameter varying in SMF2, with the percentage of variation, (Col. 10) the sampling timescale, and (Col. 11) variations in the hardness ratios.

- PL (15%) during two years is found. Short-term variations are not detected.
- **NGC 4374:** SMF1 was used for the simultaneous fit with *Chandra* data, with variations of Norm₂ (73%) in a period of five years. Flux variation of 64% (71%) in the soft (hard) band during the same period are found. Data from different instruments were not compared because the annular region contributes 84% in *Chandra* data. Short-term variations in the soft and total bands are found from one *Chandra* observation below 2σ confidence level.
 - **NGC 4494:** the simultaneous fit was jointly performed for *Chandra* and *XMM-Newton* data (the contribution of the annular region is 21% in *Chandra* data) up to 4.5 keV, because *Chandra* data show a low count-rate at harder energies. We used SMF1 and obtained the best representation of the data set when Norm varied (33%). Flux variation of 31%

- (35%) is obtained for the soft (hard) energy in a four-month period.
- **NGC 4636:** SMF0 was used to fit *XMM-Newton* data, i.e., variations were not found over a six-month period. Note that $\chi^2_{\text{r}} \sim 2$. Unfortunately, none of the proposed models are good enough to improve the final fit. From the analysis of the light curves, short-term variations in the hard band are obtained from one *XMM-Newton* observation at 1.4σ confidence level. Variations of 28% are obtained from the UVW1 filter in the UV.
 - **NGC 4736:** variations are not found from *XMM-Newton* data, i.e., SMF0 was used in a period of four years. *Chandra* and *XMM-Newton* data were not compared since the emission from the annular region contributes with 84% in *Chandra* data. From the analysis of the light curves, variations in the soft, hard, and total bands are obtained below 2σ

Fig. 1. For each object and instrument we plot (top): a simultaneous fit of X-ray spectra; (from second row on): the residuals. The legends contain the date (in the format yyymmdd), and the obsID. Details are given in Table A.1.

Fig. 1. continued.

confidence level in all cases. At UV frequencies, a variation of 66% is obtained from the *U* filter.

- **NGC 5195:** SMF1 was used for *XMM-Newton* data, where the best representation was achieved for Norm₂ varying (20%). A flux variation of 9% (19%) in the soft (hard) energy band was found in a period of eight years. For *Chandra* data, no variations are found from the simultaneous fit (i.e., SMF0) in a three-day period. The annular region contributes with 74% in *Chandra* data, so the data from the two instruments were not compared. The analysis of one *Chandra* light curve reveals short-term variations in the soft and total bands below 2σ confidence level. At UV frequencies, variation of 16% are found with the *UVW1* filter.
- **NGC 5813:** for *Chandra* data we made the simultaneous analysis up to 4 keV because of the low count rate at harder energies. For both *Chandra* and *XMM-Newton* data SMF0 was used, with no improvement of the fit when we varied the parameters in a period of six and four years, respectively. Note that $\chi^2_r \sim 2$ in *XMM-Newton* data. Unfortunately, none of the proposed models are good enough to improve the final fit. The data from the two instruments were not compared since the annular region contributes with 100% in *Chandra* data. Short-term variations are not detected. In the UV, OM observations with the *UVW1* filter were used, which show variations of 8% in a period of four years.
- **NGC 5982:** SMF1 was used to fit *XMM-Newton* data, with the best representation achieved by varying Norm₂ (50%). Flux variations of 11% (49%) in the soft (hard) band were obtained in a period of one year. UV variations are not found.

5.2. Long-term X-ray spectral variability

A first approximation to the spectral variations can be made from the hardness ratios (HR). Following the results in HG13, an object can be considered to be variable when HR varies by more than 20%. One out of the 14 objects in our sample is variable according to this criterion, using the HR measurements with the same instrument (NGC 1052). Since we mainly doubled the sample number, we conclude that the result obtained in HG13 is a consequence of low number statistics. However, no clear relation can be invoked between variable objects and a minimum in HR variations (see Table 2).

Chandra and *XMM-Newton* data are available together for the same object in 12 cases. We recall that we only compared the data from the two instruments when the emission from the annular region with $r_{\text{ext}} = r_{\text{XMM}}$ and $r_{\text{int}} = r_{\text{Chandra}}$ contributed less than 50% in *Chandra* data with the r_{XMM} aperture. For NGC 3718 there is no extranuclear contamination, therefore we performed the simultaneous analysis without any prior analysis of the extended emission. In six cases we made no simultaneous fit with data from the two instruments. In five objects (NGC 315, NGC 1052, NGC 4261, NGC 4278, and NGC 4494) the extranuclear contamination was taken into account for the simultaneous fit following the methodology described in Sect. 4.2.

None of the three non-AGN candidates show variations (one type 1 and two type 2). Seven out of the 12 AGN candidates (three out of five type 1, and four out of seven type 2) show spectral variations. We find no variations in the spectral index, Γ , in any of the objects in the sample. In all cases Norm₂ is responsible for these variations (between 20–73%). In one case (NGC 1052, type 1) variation in $N_{\text{H}2}$ (31%) is required along

Fig. 2. UV luminosities obtained from the data with the OM camera onboard *XMM-Newton*, when available. Different filters have been used; *UVW1* (red triangles), *UVW2* (green circles), *UVM2* (blue squares), *U* (black pentagons).

with variations in Norm₂. These variations were found irrespective of the LINER type (see Table 2).

5.3. UV and X-ray long-term flux variability

Since variations in Norm₂ naturally imply changes in the flux, all the objects that show spectral variations at X-ray frequencies also show flux variability (see Sect. 5.2). This means that none of the non-AGN candidates show flux variations, while seven out of the 12 AGN candidates do. Variations from 9 to 64% (19 to 71%) are obtained in the soft (hard) band (see Table 2). Soft and hard X-ray luminosities are listed in Table A.3 and are presented in Fig. 3 for objects with flux variations.

In eight out of the 18 cases, data at UV frequencies are provided by the OM onboard *XMM-Newton* at different epochs (simultaneously with X-ray data). Two of them are non-AGN candidates (the type 1 NGC 4636 and the type 2 NGC 5813). Both show variations in the *UVW1* filter, while NGC 4636 does not vary in the *UVW2* filter. Five out of the six AGN candidates show UV variability in at least one filter (except for NGC 5982, type 2). Two variable objects are type 1 (NGC 1052 varies about 20% in the *UVM2* and *UVW2* filters, and NGC 3226¹² shows 11% variation in the *UVW1* filter), and three are type 2

(NGC 4261 shows 10% (33%) variations in the *UVW1* (*UVM2*) filter, NGC 4736 varies 66% in the *U* filter, and NGC 5195 varies 51% in the *UVW1* filter). In summary, three out of four type 1 and the two type 2 AGN candidates are variable objects at UV frequencies. Their UV luminosities are presented in Table A.1 and Fig. 2.

A comparison of X-ray and UV flux variations shows two non-AGN candidates have UV variations but no X-ray variations (one type 1 and one type 2). Of the AGN candidates, three show X-ray and UV flux variations (two type 1 and one type 2), and three type 2 LINERs show variations only in one of the frequencies (two in the UV, one in X-rays).

Taking into account UV and/or X-ray variations, ten out of 13 AGN candidates are variable (four out of six type 1, and six out of seven type 2). We note that the three objects without variations at X-ray frequencies (NGC 315, NGC 2681, and NGC 1961) do not have UV data in more than one epoch.

5.4. Short-term variability

According to the values of σ_{NXS}^2 , four objects show positive values within the errors in the soft and total bands, one type 1 (NGC 3226), and three type 2 (NGC 4374, NGC 4736, NGC 5195). We obtain σ_{NXS}^2 values above zero for three objects in the hard band, two type 1 (NGC 315, and NGC 4636), and one

¹² We recall that NGC 3226 varies at UV frequencies, but long-term variations in X-rays were rejected for the analysis.

Fig. 3. Intrinsic luminosities calculated for the soft (0.5–2.0 keV, green triangles) and hard (2.0–10.0 keV, red circles) energies in the simultaneous fitting, only for the variable objects.

type 2 (NGC 4736). However, all the measurements are consistent with zero at 2σ level. For the remaining light curves we estimate upper limits for the normalized excess variance. Therefore, we cannot confirm short-term variability in our sample. The light curves are presented in Appendix D, their statistics in Table A.6.

6. Discussion

6.1. Long-term variations

We analyzed three non-AGN candidates (one type 1 and two type 2), but none of them showed X-ray spectral or flux variations. An additional source, NGC 5846 (type 2), was studied in HG13, but did not show variations either. All of them were classified as CT candidates by González-Martín et al. (2009a). In these objects, the nuclear obscuration is such that X-ray emission cannot be observed directly, i.e., the view of their nuclear emission is suppressed below ~ 10 keV (Maiolino et al. 1998). If this is the case, spectral variations might not be detected, in accordance with our results. Indications for classifying objects as an AGN candidate can be found at other frequencies, for example, with radio data. At these frequencies, a compact, flat-spectrum nuclear source can be considered as an AGN signature (Nagar et al. 2002, 2005). González-Martín et al. (2009b) collected multiwavelength properties of 82 LINERs. In their sample, 18 objects are classified in X-rays as non-AGN

candidates and have detected nuclear radio cores. From these, 14 are classified as CT candidates. Thus, it might be possible that the AGN in CT objects are not seen at X-ray frequencies (and therefore their X-ray classification is non-AGN), whereas at radio frequencies the AGN can be detected. Of the four non-AGN candidates studied in HG13 and this work, radio cores are detected in three objects and, in fact, evidence of jet structures are reported in the literature (NGC 4636, Giacintucci et al. 2011; NGC 5813, Randall et al. 2011; NGC 5846, Filho et al. 2004), which suggests that they are AGN. Moreover, in this work UV variability is found for NGC 4636 and NGC 5813, while UV data are not available to study long-term variations in the other two cases. A nuclear counterpart was not detected for NGC 3608 with VLA by Nagar et al. (2005). Therefore, an X-ray variable nature of CT objects cannot be excluded, but variability analyses at higher energies need to be performed.

Of the 12 AGN candidates in our sample, two objects are proposed to be CT candidates (NGC 2681 and NGC 4374, González-Martín et al. 2009a). In these objects a point-like source at hard energies is detected, which might indicate that part of the AGN continuum is still contributing below 10 keV. Hence, variations in the nuclear continuum may be observed, as is the case of NGC 4374. An example of a confirmed CT type 2 Seyfert that shows spectral variations with *XMM-Newton* data is Mrk 3 (Guainazzi et al. 2012).

Only in one case (NGC 1052) were variations in $N_{\text{H}2}$ needed along with those in Norm_2 (see below). Variations in the column density have been extensively observed in type 1 Seyferts (e.g., NGC 1365, Risaliti et al. 2007; NGC 4151, Puccetti et al. 2007; Mrk 766, Risaliti et al. 2011; Swift J2127.4+5654, Sanfrutos et al. 2013). Brenneman et al. (2009) studied a 101 ks observation of NGC 1052 from *Suzaku* data and did not find short-term variations. NGC 1052 also shows variations at UV frequencies, as shown by Maoz et al. (2005), and we confirm this here. However, the LINER nature of this source has been discussed in the literature; Pogge et al. (2000) studied 14 LINERs with *HST* data and only NGC 1052 shows clear evidence for an ionization cone, analogously to those seen in Seyferts. From a study that used artificial neural networks (ANN) to classify X-ray spectra, NGC 1052 seems to be associated to type 1 Seyfert galaxies in X-rays (Gonzalez-Martín et al. 2014). The fact that the observed variations in NGC 1052 are similar to those seen in type 1 Seyfert galaxies agrees well with the observation that this galaxy resembles Seyferts at X-ray frequencies.

Spectral variations do not necessarily imply flux variations. For example, if variations in the column density, N_{H} , alone were found, flux variations would not be present. However, all the results reported in the literature for LINERs show spectral variations that are related to flux variability. Variations in the normalization of the power law, that is, in Norm_2 , are found in all the variable sources in our sample. Variations of other components, such as the soft emission (NGC 4102, González-Martín et al. 2011a; NGC 4552, HG13) or the slope of the power law (NGC 7213, Emmanoulopoulos et al. 2012) are reported in the literature. The variations in Γ found by Emmanoulopoulos et al. (2012) are small and were obtained on average every two days from 2006 to 2009. In contrast, the observations we used here were obtained with separations of months, and therefore it might be that if these variations occurred in LINERs we are unable to detect them. The most natural explanation for the variations in Norm_2 is that the AGN continuum changes with time. The first conclusion derived from this result is that the X-ray emission in these variable LINERs is AGN-like. Moreover, these types of variation are common in other AGN (e.g., Turner et al. 1997). Thus, even if the sample is not large enough to be conclusive, from the point of view of the X-ray variability, LINERs are similar to more powerful AGN. This is confirmed by the characteristic timescales derived from our analysis (see Sect. 6.2).

Our results show that UV and X-ray variations are not simultaneous (see Sect. 5.3). This means that some X-ray variable sources are not UV variable, and vice versa. The most illustrative case is NGC 5195, which changes 39% at UV frequencies but does not vary in X-rays in the same period (see Tables A.1 and A.3, and Figs. 2 and 3). The most widely accepted scenario assumes that the X-ray emission is produced by a disk-corona system, where UV photons from the inner parts of the accretion disk are thermally Comptonized and scattered into the X-rays by a hot corona that surrounds the accretion disk (Haardt & Maraschi 1991). In this case we expect that X-ray and UV emissions reach us at different times, because of the time that light takes to travel from one place to another. These time lags will depend on the sizes of the BH, the disk and the corona, so that the larger the sizes, the longer the time lags we expect. For example, Degenaar et al. (2014) conducted a multiwavelength study of the X-ray binary (XRB) Swift J1910.2-0546 and found time lags between X-ray and UV frequencies of about eight days. They argued that the changes may be related to the accretion morphology, perhaps due to a jet or a hot flow. LINERs have larger sizes

Fig. 4. Observed variability timescale, T_{obs} , against the predicted value, T_{B} , from González-Martín & Vaughan (2012). The solid line represents the 1:1 relationship, the dashed lines the errors. Only variable objects are represented. The big orange rectangle represents the location of AGN, the small blue rectangle the location of XRB as in McHardy et al. (2006).

than XRBs and, therefore, longer time lags are expected. Thus, the mismatch between UV and X-ray variabilities might be due to these time lags. Simultaneous X-ray and UV studies monitoring the sources would be useful for measuring these time lags, and also for calculating the sizes of the variable regions.

6.2. Variability timescales

Short-term variability ($\sim$ few days) is found in the literature. Pian et al. (2010) and Younes et al. (2011) found short-term variations in two objects in their analyses of type 1 LINERs, i.e., four in total. Two objects are in common with our sample (NGC 3226 and NGC 4278). However, in HG13 we did not find short-term variations, neither in these two nor in the other objects in the sample. González-Martín & Vaughan (2012) reported two out of 14 variable LINERs, one of them in common with those reported by Pian et al. (2010). In the present paper, we studied short-term variability from the analysis of the light curves for a total of 12 objects in three energy bands (soft, hard, total). Six objects show $\sigma_{\text{NXS}}^2 > 0$ in at least one of the three bands. However, we note that these variations are below the 2σ confidence level. None of the objects show a value that is higher than zero above 3σ , and therefore we cannot confirm short-term variations.

McHardy et al. (2006) reported a relation between the bend timescale for variations (i.e., the predicted timescale, T_{B}), black-hole mass, and bolometric luminosity. This T_{B} corresponds to a characteristic frequency, ν_{B} , of the PSD, which occurs when the spectral index of the power law bends from ~ 1 to ~ 2 . González-Martín & Vaughan (2012) updated this relation as

$$\log(T_{\text{B}}) = A \log(M_{\text{BH}}) + B \log(L_{\text{bol}}) + C, \quad (6)$$

where $A = 1.34 \pm 0.36$, $B = -0.24 \pm 0.28$, $C = -1.88 \pm 0.36$, and T_{B} , M_{BH} , and L_{bol} are in units of *days*, $10^6 M_{\odot}$, and 10^{44} erg/s, respectively. By using Eq. (6), we plot the observed timescales of the variability, T_{obs} , against the predicted timescales, T_{B} , for the sources with variations in our sample (Fig. 4). The observed timescales were computed from the shortest periods in which variations were observed, and are represented as upper limits.

It is important to note that the timescales between the observations probably differ from the predicted timescales. This is obvious since the observations were obtained randomly at different epochs. All the variable objects are compatible with the 1:1 relation (represented by a solid line, and dashed lines are the errors), although most of them have longer T_{obs} than predicted. In Fig. 4, we also plot the location of AGN and X-ray binaries (XRB) as reported in McHardy et al. (2006). It can be observed that LINERs are located in the upper part of the relation together with the most massive AGN because of the strong dependence of T_B on the M_{BH} . Note here that while T_B represents the bending frequency of the PSD, T_{obs} is a direct measure of changes in the spectral shape. This implies that the variability timescales are often shorter than the timescales between the observations (except for NGC 4278) for our sample. All the variable objects are then consistent with the relation reported by González-Martín & Vaughan (2012).

On the other hand, five objects in our sample do not show variations (and are not represented in Fig. 4). For these (NGC 315, NGC 1961, NGC 2681, NGC 4261, and NGC 4494), we obtain T_B (T_{obs}) $\sim$ 77 (873), 100 (14), 3 (92), 273 (2830), and 12 (120) days, respectively. In the case of NGC 1961, $T_B > T_{\text{obs}}$, so variations between the observations are not expected. From Eq. (6), we would expect variations from the other sources. It could be possible that we do not detect variations because observations were taken at random. However, it could also be possible that these objects do not follow Eq. (6).

Our results are consistent with the scaling relation found by McHardy et al. (2006) and González-Martín & Vaughan (2012) because, according to the BH mass and accretion rates of LINERs, variations of the intrinsic continuum are expected to be of large scales. This means that LINERs would follow the same relation as other AGN and XRBs (see Fig. 4). We recall that T_B has a strong dependence on M_{BH} , while the dependence with L_{bol} (and with the accretion rate) is much lower (McHardy 2010), and hence it prevents us from obtaining useful information related to accretion physics.

Although LINERs and more powerful AGN are located in the same plane, different authors have pointed out that the accretion mechanism in LINERs could be different from that in more powerful AGN (e.g., Gu & Cao 2009; Younes et al. 2011). When a source accretes at a very low Eddington rate ($R_{\text{Edd}} < 10^{-3}$), the accretion is dominated by radiatively inefficient accretion flows (RIAF, Narayan & Yi 1994; Quataert 2004). Such flows are thought to be present in XRB, since they are closer accreting black holes that can be easily studied. It is well known that XRB show different X-ray emission states that are separated by their spectral properties (e.g., Remillard & McClintock 2006). In comparison with XRB, LINERs should be in the “low/hard” state or, if the Eddington ratio is too low, in the “quiescent” state, while more powerful AGN should be in the “high/soft” state.

An anticorrelation between the slope of the power law, Γ , and the Eddington ratio, R_{Edd} , is expected from RIAF models. Qiao & Liu (2013) theoretically investigated this correlation for XRB and found that advection-dominated accretion flow (ADAF)¹³ models can reproduce it well. In these models the X-ray emission is produced by Comptonization of the synchrotron and bremsstrahlung photons. Later, they studied low-luminosity AGN (LLAGN) in the framework of a disk evaporation model (inner ADAF plus an outer truncated accretion disk) and found that it can also reproduce the anticorrelation (Qiao et al. 2013).

Fig. 5. Spectral index, Γ , versus the Eddington ratio, $R_{\text{Edd}} = \log(L_{\text{bol}}/L_{\text{Edd}})$. Type 1 (blue circles) and type 2 (green squares) LINERs are distinguished. The solid and dashed lines represent the relations given by Younes et al. (2011) and Gu & Cao (2009), respectively, shifted to the same bolometric correction (see text).

Some efforts have been made to observationally investigate that relationship for LLAGN. Gu & Cao (2009) used a sample of 55 LLAGN (including 27 LINERs and 28 Seyferts) and found a regular anticorrelation between Γ and R_{Edd} . However, when LINERs were considered alone, they did not find a strong correlation. Later, Younes et al. (2011) studied a sample of type 1 LINERs and found a statistically significant anticorrelation. In HG13 we found that the seven LINERs studied in the sample fitted the relation given by Younes et al. (2011) well. Here we plot the same relation in Fig. 5, where the values of Γ and $L_{2-10 \text{ keV}}$ were obtained from the simultaneous fittings, since Γ did not vary in any of the objects (see Table 2). For NGC 2787 and NGC 2841 the individual fit from *Chandra* data was used because a simultaneous fit cannot be performed (see Sect. 5.1). R_{Edd} were calculated following the formulation given in Eracleous et al. (2010b), assuming $L_{\text{bol}} = 33L_{2-10 \text{ keV}}$. The solid and dashed lines in Fig. 5 are the relations given by Younes et al. (2011) and Gu & Cao (2009), respectively, corrected to our L_{bol} . The coefficient of the Pearson correlation is $r = -0.66$, with a coefficient of determination of $p = 0.008$. This might suggest that RIAF models apply to LINERs, indicating an inefficient accretion disk, in contrast to the efficient accretion disk found for more powerful AGN. A larger sample of LINERs would be useful to be conclusive.

6.3. Type 1 and type 2 variable AGN candidates

Some studies at X-ray frequencies have shown the variable nature of LINERs. Type 1 LINERs were studied by Pian et al. (2010), Younes et al. (2011), Emmanoulopoulos et al. (2012), and HG13. Pian et al. (2010) studied four sources with *Swift* and found variations in two of them. Younes et al. (2011) detected long-term variations in seven out of the nine sources in their sample from *XMM-Newton* and *Chandra* data. Emmanoulopoulos et al. (2012) studied one object with the Rossi X-ray Timing Explorer (RXTE) and found a “harder when brighter” behavior. In HG13 we analyzed three AGN candidates using *Chandra* and/or *XMM-Newton* data and found variations in all the three.

¹³ The RIAF model is an updated version of the ADAF model.

In the present analysis our sample contains five type 1 AGN candidates, three of them variable. From the sample by [Younes et al. \(2011\)](#), five objects are in common with our sample, four of them with similar results, and differs only for NGC 315 (see Appendix B for notes and comparisons).

Type 2 objects were studied by [González-Martín et al. \(2011a\)](#) and HG13. [González-Martín et al. \(2011a\)](#) used *Suzaku*, *Chandra*, and *Swift* data to study one object and found variations in the thermal component. In HG13 we reported long-term variations in one of the two AGN candidates.

In the present analysis our sample contains seven type 2 AGN candidates, four of them variable.

Taking into account the present analysis and the studies listed above from the literature, 14 out of 22 LINERs are X-ray variable objects (eight out of 13 type 1, and six out of nine type 2). Therefore, there is no significant difference in the proportion of variable objects in X-rays in terms of the classification into optical type 1 or type 2. Given that the observed variations are intrinsic to the sources, similar proportions were expected in view of the UM, in good agreement with our results.

A similar behavior is found at UV frequencies. [Maoz et al. \(2005\)](#) were the first authors to show that UV variability is common in LINERs, and to demonstrate the presence of a non-stellar component at these frequencies. From their sample of 17 LINERs, only three do not show either short-term (<1 yr) or long-term (>1 yr) variability. From these, all the seven type 1 LINERs and seven out of ten type 2 objects show variations.

When data from the OM onboard *XMM-Newton* were available, we searched for UV variability. Taking into account only AGN candidates, five out of six objects show variations (two type 1 and three type 2). This supports the hypothesis of a variable nature of LINERs. In common with our sample, [Maoz et al. \(2005\)](#) already showed the variable nature of NGC 1052 and NGC 4736. Thus, taking into account the present analysis and the study by [Maoz et al. \(2005\)](#), 17 out of 21 LINERs are variable at UV frequencies (eight type 1, and nine out of 13 type 2). As previously noted by [Maoz et al. \(2005\)](#), the fact that type 2 LINERs show variations at UV frequencies suggests that the UM may not always apply to LINERs. It has been suggested that the broad-line region (BLR) and the torus, responsible for obscuring the continuum that is visible in type 1 AGN, disappear at low luminosities ([Elitzur & Shlosman 2006](#); [Elitzur & Ho 2009](#)). The disappearance of the torus could in principle explain why type 2 LINERs do vary in the UV, because the naked AGN is directly seen at these frequencies.

We find that some objects show variations in X-rays but do not vary at UV frequencies, or vice versa. This means that the percentage of variable objects is higher if we take into account different frequencies. From all the 34 LINERs studied at UV and X-ray frequencies in this and other works, 27 LINERs show variations in at least one energy band (13 out of 16 type 1, and 14 out of 18 type 2). Thus, the percentage of type 1 and 2 variable objects is similar. Consequently, variability is very common in LINER nuclei, a property they share with other AGN.

7. Conclusions

Using *Chandra* and *XMM-Newton* public archives, we performed a spectral and flux, short and long-term variability analysis of 18 LINERs in the Palomar sample. The main results of this study can be summarized as follows:

1. Seven out of the 12 AGN candidate LINERs show long-term spectral variability, while the three non-AGN candidates do

not. In two cases the simultaneous fit was not possible because of strong external contamination, and in one case the long-term analysis was rejected because of possible contamination of a companion galaxy.

2. No significant difference in the proportion of X-ray variable nuclei (type 1 or 2) was found.
3. The main driver of the spectral variations is the change in the normalization of the power law, Norm₂; only for NGC 1052 is this accompanied by variations in the column density, $N_{\text{H}2}$.
4. UV variations are found in five out of six AGN candidates. The two non-AGN candidates also show variations.
5. Short-term variations are not found.

From X-ray and UV data, we find that ten out of 13 LINERs in our sample show evidence of long-term variability in at least one energy band. Hence, variability is very common in LINERs.

X-ray variations are caused by changes in the continuum of the AGN. These results agree well with the expected variations according to their BH masses and accretion rates. In this sense, LINERs are in the same plane as more powerful AGN and XRB. However, we found an anticorrelation between the slope of the power law, Γ , and the Eddington ratio, which might suggest that a different accretion mechanism is active in LINERs, that is more similar to the hard state of XRB.

On the other hand, the result that some type 2 LINERs possibly vary at UV frequencies may suggest that a naked AGN can be observed at these wavelengths, which could be explained within the scenario where the torus disappears at low luminosities.

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References

- Antonucci, R. 1993, *ARA&A*, 31, 473
- Birkinshaw, M., & Davies, R. L. 1985, *ApJ*, 291, 32
- Brassington, N. J., Fabbiano, G., Kim, D.-W., et al. 2009, *ApJS*, 181, 605
- Brenneman, L. W., Weaver, K. A., Kadler, M., et al. 2009, *ApJ*, 698, 528
- Brightman, M., & Nandra, K. 2011, *MNRAS*, 413, 1206
- Cappellari, M., Renzini, A., Greggio, L., et al. 1999, *ApJ*, 519, 117
- Cardullo, A., Corsini, E. M., Beifiori, A., Pizzella, A., & Buson, L. M. 2008, in *Formation and Evolution of Galaxy Disks*, eds. J. G. Funes, & E. M. Corsini, ASP Conf. Ser., 396, 53
- Carollo, C. M., Franx, M., Illingworth, G. D., & Forbes, D. A. 1997, *ApJ*, 481, 710
- de Vaucouleurs, G. 1975, *Soc. Stud. Sci.*, 9, 557
- Degenar, N., Maitra, D., Cackett, E. M., et al. 2014, *ApJ*, 784, 122
- Dickey, J. M., & Lockman, F. J. 1990, *ARA&A*, 28, 215
- D’Onofrio, M., Marziani, P., & Sulentic, J. W. 2012, *Fifty Years of Quasars: Current Impressions and Future Perspectives*, eds. M. D’Onofrio, P. Marziani, & J. W. Sulentic, 549
- Dudík, R. P., Satyapal, S., Gliozzi, M., & Sambruna, R. M. 2005, *ApJ*, 620, 113
- Elitzur, M., & Ho, L. C. 2009, *ApJ*, 701, L91
- Elitzur, M., & Shlosman, I. 2006, *ApJ*, 648, L101
- Emmanoulopoulos, D., Papadakis, I. E., McHardy, I. M., et al. 2012, *MNRAS*, 424, 1327

- Eracleous, M., Shields, J. C., Chartas, G., & Moran, E. C. 2002, *ApJ*, 565, 108
- Eracleous, M., Hwang, J. A., & Flohic, H. M. L. G. 2010a, *ApJ*, 711, 796
- Eracleous, M., Hwang, J. A., & Flohic, H. M. L. G. 2010b, *ApJS*, 187, 135
- Ferrarese, L., Ford, H. C., & Jaffe, W. 1996, *ApJ*, 470, 444
- Filho, M. E., Fraternali, F., Markoff, S., et al. 2004, *A&A*, 418, 429
- García, A. M. 1993, *A&AS*, 100, 47
- Garmire, G. P., Bautz, M. W., Ford, P. G., Nousek, J. A., & Ricker, J. G. R. 2003, in *SPIE Conf. Ser.* 4851, eds. J. E. Truemper, & H. D. Tananbaum, 28
- Giacintucci, S., O'Sullivan, E., Vrtilek, J., et al. 2011, *ApJ*, 732, 95
- Giroletti, M., Taylor, G. B., & Giovannini, G. 2005, *ApJ*, 622, 178
- González-Martín, O., & Vaughan, S. 2012, *A&A*, 544, A80
- González-Martín, O., Masegosa, J., Márquez, I., & Guainazzi, M. 2009a, *ApJ*, 704, 1570
- González-Martín, O., Masegosa, J., Márquez, I., Guainazzi, M., & Jiménez-Bailón, E. 2009b, *A&A*, 506, 1107
- González-Martín, O., Papadakis, I., Braitto, V., et al. 2011a, *A&A*, 527, A142
- González-Martín, O., Papadakis, I., Reig, P., & Zezas, A. 2011b, *A&A*, 526, A132
- Gonzalez-Martin, O., Diaz-Gonzalez, D., Acosta-Pulido, J. A., et al. 2014, *A&A*, 567, A92
- Gu, M., & Cao, X. 2009, *MNRAS*, 399, 349
- Guainazzi, M., Oosterbroek, T., Antonelli, L. A., & Matt, G. 2000, *A&A*, 364, L80
- Guainazzi, M., La Parola, V., Miniutti, G., Segreto, A., & Longinotti, A. L. 2012, *A&A*, 547, A31
- Haardt, F., & Maraschi, L. 1991, *ApJ*, 380, L51
- Harris, D. E., Biretta, J. A., Junor, W., et al. 2003, *ApJ*, 586, L41
- Harris, D. E., Cheung, C. C., Biretta, J. A., et al. 2006, *ApJ*, 640, 211
- Harris, D. E., Cheung, C. C., Stawarz, L., Biretta, J. A., & Perlman, E. S. 2009, *ApJ*, 699, 305
- Harris, D. E., Massaro, F., Cheung, C. C., et al. 2011, *ApJ*, 743, 177
- Heckman, T. M. 1980, *A&A*, 87, 152
- Hernández-García, L., González-Martín, O., Márquez, I., & Masegosa, J. 2013, *A&A*, 556, A47
- Ho, L. C. 2008, *ARA&A*, 46, 475
- Ho, L. C., & Ulvestad, J. S. 2001, *ApJS*, 133, 77
- Ho, L. C., Filippenko, A. V., Sargent, W. L. W., & Peng, C. Y. 1997, *ApJS*, 112, 391
- Ishwara-Chandra, C. H., & Saikia, D. J. 1999, *MNRAS*, 309, 100
- Kalberla, P. M. W., Burton, W. B., Hartmann, D., et al. 2005, *A&A*, 440, 775
- Krips, M., Eckart, A., Krichbaum, T. P., et al. 2007, *A&A*, 464, 553
- Lawrence, A., Watson, M. G., Pounds, K. A., & Elvis, M. 1987, *Nature*, 325, 694
- Maiolino, R., Salvati, M., Bassani, L., et al. 1998, *A&A*, 338, 781
- Maoz, D., Nagar, N. M., Falcke, H., & Wilson, A. S. 2005, *ApJ*, 625, 699
- Masegosa, J., Márquez, I., Ramirez, A., & González-Martín, O. 2011, *A&A*, 527, A23
- McHardy, I. 2010, in *Lect. Notes Phys.* 794 (Berlin: Springer Verlag), ed. T. Belloni, 203
- McHardy, I. M., Koerding, E., Knigge, C., Uttley, P., & Fender, R. P. 2006, *Nature*, 444, 730
- Nagar, N. M., Falcke, H., Wilson, A. S., & Ulvestad, J. S. 2002, *A&A*, 392, 53
- Nagar, N. M., Falcke, H., & Wilson, A. S. 2005, *A&A*, 435, 521
- Nandra, K., George, I. M., Mushotzky, R. F., Turner, T. J., & Yaqoob, T. 1997, *ApJ*, 476, 70
- Narayan, R., & Yi, I. 1994, *ApJ*, 428, L13
- O'Sullivan, E., Vrtilek, J. M., & Kempner, J. C. 2005, *ApJ*, 624, L77
- Pellegrini, S., Fabbiano, G., Fiore, F., Trinchieri, G., & Antonelli, A. 2002, *A&A*, 383, 1
- Pellegrini, S., Wang, J., Fabbiano, G., et al. 2012, *ApJ*, 758, 94
- Peterson, B. M. 1997, *An Introduction to Active Galactic Nuclei*, ed. B. M. Peterson (Cambridge: Cambridge University Press)
- Pian, E., Romano, P., Maoz, D., et al. 2010, *MNRAS*, 401, 677
- Pogge, R. W., Maoz, D., Ho, L. C., & Eracleous, M. 2000, *ApJ*, 532, 323
- Puccetti, S., Fiore, F., Risaliti, G., et al. 2007, *MNRAS*, 377, 607
- Qiao, E., & Liu, B. F. 2013, *ApJ*, 764, 2
- Qiao, E., Liu, B. F., Panessa, F., & Liu, J. Y. 2013, *ApJ*, 777, 102
- Quataert, E. 2004, in *AGN Physics with the Sloan Digital Sky Survey*, eds. G. T. Richards, & P. B. Hall, *ASP Conf Ser.*, 311, 131
- Randall, S. W., Forman, W. R., Giacintucci, S., et al. 2011, *ApJ*, 726, 86
- Remillard, R. A., & McClintock, J. E. 2006, *ARA&A*, 44, 49
- Risaliti, G., Elvis, M., Fabbiano, G., et al. 2007, *ApJ*, 659, L111
- Risaliti, G., Nardini, E., Salvati, M., et al. 2011, *MNRAS*, 410, 1027
- Rubin, V. C., Ford, W. K. J., & Roberts, M. S. 1979, *ApJ*, 230, 35
- Sambruna, R. M., Gliozzi, M., Eracleous, M., Brandt, W. N., & Mushotzky, R. 2003, *ApJ*, 586, L37
- Sanfrutos, M., Miniutti, G., Agís-González, B., et al. 2013, *MNRAS*, 436, 1588
- Satyapal, S., Sambruna, R. M., & Dudik, R. P. 2004, *A&A*, 414, 825
- Satyapal, S., Dudik, R. P., O'Halloran, B., & Gliozzi, M. 2005, *ApJ*, 633, 86
- Strüder, L., Briel, U., Dennerl, K., et al. 2001, *A&A*, 365, L18
- Terashima, Y., & Wilson, A. S. 2003, *ApJ*, 583, 145
- Terashima, Y., & Wilson, A. S. 2004, *ApJ*, 601, 735
- Tremaine, S., Gebhardt, K., Bender, R., et al. 2002, *ApJ*, 574, 740
- Turner, T. J., George, I. M., Nandra, K., & Mushotzky, R. F. 1997, *ApJS*, 113, 23
- Urry, C. M., & Padovani, P. 1995, *PASP*, 107, 803
- Vaughan, S., Edelson, R., Warwick, R. S., & Uttley, P. 2003, *MNRAS*, 345, 1271
- Venturi, T., Giovannini, G., Feretti, L., Comoretto, G., & Wehrle, A. E. 1993, *ApJ*, 408, 81
- Vermeulen, R. C., Ros, E., Kellermann, K. I., et al. 2003, *A&A*, 401, 113
- Vrtilek, J. M., O'Sullivan, E., David, L. P., et al. 2013, in *AAS/High Energy Astrophysics Division*, 13, #116.06
- Xu, C., Baum, S. A., O'Dea, C. P., Wrobel, J. M., & Condon, J. J. 2000, *AJ*, 120, 2950
- Younes, G., Porquet, D., Sabra, B., et al. 2010, *A&A*, 517, A33
- Younes, G., Porquet, D., Sabra, B., & Reeves, J. N. 2011, *A&A*, 530, A149
- Younes, G., Porquet, D., Sabra, B., Reeves, J. N., & Grosso, N. 2012, *A&A*, 539, A104

Appendix A: Tables

Table A.1. Observational details.

Name	Instrument	ObsID	Date	R ($''$)	Net Exptime (ks)	Counts	HR	$\log(L_{UV})$ (erg/s)	Filter
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 315	<i>XMM-Newton</i> ^c	0305290201	2005-07-02	25	14	5799	$-0.55^{+0.01}_{-0.01}$	$41.75^{+0.05}_{-0.05}$	<i>UVM2</i>
	<i>Chandra</i>	855	2000-10-08	3	5	501	$-0.27^{+0.13}_{-0.13}$	–	
	<i>Chandra</i> ^c	4156	2003-02-22	3	55	5550	$-0.23^{+0.05}_{-0.05}$	–	
NGC 1052	<i>XMM-Newton</i> ^c	0093630101	2001-08-15	25	11.2	5818	$0.28^{+0.06}_{-0.06}$	–	
	<i>XMM-Newton</i>	0306230101	2006-01-12	25	44.8	25 565	$0.34^{+0.03}_{-0.03}$	$41.04^{+0.01}_{-0.01}$	<i>UVM2</i>
								$40.94^{+0.03}_{-0.03}$	<i>UVW2</i>
	<i>XMM-Newton</i>	0553300301	2009-01-14	25	42.4	27 367	$0.39^{+0.02}_{-0.02}$	$41.14^{+0.01}_{-0.01}$	<i>UVM2</i>
								$40.95^{+0.03}_{-0.03}$	<i>UVW2</i>
	<i>XMM-Newton</i>	0553300401	2009-08-12	25	46.8	30 643	$0.42^{+0.02}_{-0.02}$	$41.04^{+0.01}_{-0.01}$	<i>UVM2</i>
								$40.89^{+0.03}_{-0.03}$	<i>UVW2</i>
	<i>Chandra</i> ^c	5910	2000-08-29	3	59.2	6549	$0.40^{+0.04}_{-0.04}$	–	
NGC 1961	<i>XMM-Newton</i>	0673170101	2011-08-31	35	17	1934	$-0.54^{+0.02}_{-0.02}$	Not detected	
	<i>XMM-Newton</i>	0673170301	2011-09-14	35	14	1680	$-0.54^{+0.02}_{-0.02}$	Not detected	
NGC 2681	<i>Chandra</i>	2060	2001-01-30	3	81	1126	$-0.76^{+0.01}_{-0.01}$	–	
	<i>Chandra</i>	2061	2001-05-02	3	79	1018	$-0.73^{+0.01}_{-0.01}$	–	
NGC 2787	<i>XMM-Newton</i> ^c	0200250101	2004-10-10	25	25	2557	$-0.37^{+0.04}_{-0.04}$	–	
	<i>Chandra</i> ^c	4689	2004-05-18	3	31	527	$-0.59^{+0.03}_{-0.03}$	–	
NGC 2841	<i>XMM-Newton</i> ^c	0201440101	2004-11-09	30	9	1712	$-0.57^{+0.02}_{-0.02}$	$41.28^{+0.03}_{-0.03}$	<i>UVW2</i>
	<i>Chandra</i> ^c	6096	2004-12-18	5	28	486	$-0.81^{+0.01}_{-0.01}$	–	
NGC 3226	<i>XMM-Newton</i>	0101040301	2000-11-28	–	–	–	–	$41.38^{+0.01}_{-0.01}$	<i>UVW1</i>
	<i>XMM-Newton</i>	0400270101	2006-12-03	–	–	–	–	$41.33^{+0.01}_{-0.01}$	<i>UVW1</i>
	<i>Chandra</i>	860	1999-12-30	3	46.6	476	$0.53^{+0.12}_{-0.12}$	–	
NGC 3608	<i>XMM-Newton</i>	0099030101	2000-11-22	20	12	454	$-0.48^{+0.06}_{-0.06}$	–	
	<i>XMM-Newton</i>	0693300101	2012-05-20	20	23	1749	$-0.46^{+0.03}_{-0.03}$	$41.01^{+0.07}_{-0.07}$	<i>UVM2</i>
NGC 3718	<i>XMM-Newton</i> ^c	0200430501	2004-05-02	25	10	2473	$0.12^{+0.19}_{-0.19}$	Not detected	
	<i>XMM-Newton</i> ^c	0200431301	2004-11-04	25	8	1734	$0.14^{+0.20}_{-0.20}$	Not detected	
	<i>Chandra</i> ^c	3993	2003-02-08	3	5	1143	$0.11^{+0.29}_{-0.29}$	–	
NGC 4261	<i>Chandra</i>	834	2000-05-06	3	34.4	3465	$-0.58^{+0.01}_{-0.01}$	–	
	<i>Chandra</i> ^c	9569	2008-02-12	3	100.9	7757	$-0.47^{+0.01}_{-0.01}$	–	
	<i>XMM-Newton</i>	0056340101	2001-12-16	25	21.3	10 730	$-0.68^{+0.01}_{-0.01}$	$41.43^{+0.02}_{-0.02}$	<i>UVM2</i>
								$42.17^{+0.01}_{-0.01}$	<i>UVW1</i>
	<i>XMM-Newton</i> ^c	0502120101	2007-12-16	25	63.0	32 156	$-0.68^{+0.01}_{-0.01}$	$41.61^{+0.01}_{-0.01}$	<i>UVM2</i>
								$42.21^{+0.01}_{-0.01}$	<i>UVW1</i>
NGC 4278	<i>Chandra</i> ^c	7077	2006-03-16	3	110.3	9182	$-0.66^{+0.01}_{-0.01}$	–	
	<i>Chandra</i>	7081	2007-02-20	3	110.7	7591	$-0.66^{+0.01}_{-0.01}$	–	
	<i>Chandra</i>	7080	2007-04-20	3	55.8	3379	$-0.69^{+0.01}_{-0.01}$	–	
	<i>XMM-Newton</i> ^c	0205010101	2004-05-23	25	20.8	34 516	$-0.60^{+0.01}_{-0.01}$	$40.90^{+0.02}_{-0.02}$	<i>UVW1</i>
NGC 4374	<i>XMM-Newton</i> ^c	0673310101	2011-06-01	25	25	19 788	$-0.87^{+0.01}_{-0.01}$	$41.48^{+0.01}_{-0.01}$	<i>UVM2</i>
	<i>Chandra</i>	803	2000-05-19	2	28	1010	$-0.67^{+0.02}_{-0.02}$	–	
	<i>Chandra</i>	5908	2005-05-01	2	46	2401	$-0.60^{+0.01}_{-0.01}$	–	
	<i>Chandra</i> ^c	6131	2005-11-07	2	41	812	$-0.68^{+0.02}_{-0.02}$	–	
NGC 4494	<i>XMM-Newton</i> ^c	0071340301	2001-12-04	20	24	2116	$-0.46^{+0.04}_{-0.04}$	$41.99^{+0.01}_{-0.01}$	<i>UVW1</i>
	<i>Chandra</i> ^c	2079	2001-08-05	3	25	580	$-0.57^{+0.03}_{-0.03}$	–	
NGC 4636	<i>XMM-Newton</i>	0111190201	2000-07-13	25	6	9889	$-0.95^{+0.01}_{-0.01}$	$40.62^{+0.06}_{-0.06}$	<i>UVW2</i>
								$41.66^{+0.01}_{-0.01}$	<i>UVW1</i>
	<i>XMM-Newton</i>	0111190701	2001-01-05	25	51	91 789	$-0.97^{+0.01}_{-0.01}$	$40.64^{+0.07}_{-0.07}$	<i>UVW2</i>
								$41.52^{+0.01}_{-0.01}$	<i>UVW1</i>
NGC 4736	<i>XMM-Newton</i> ^c	0094360601	2002-05-23	20	8	11 041	$-0.59^{+0.01}_{-0.01}$	$40.69^{+0.01}_{-0.01}$	<i>U</i>
	<i>XMM-Newton</i>	0094360701	2002-06-26	20	3	3010	$-0.62^{+0.01}_{-0.01}$	$40.76^{+0.01}_{-0.01}$	<i>U</i>
	<i>XMM-Newton</i>	0404980101	2006-11-27	20	33	42 048	$-0.60^{+0.01}_{-0.01}$	$40.29^{+0.01}_{-0.01}$	<i>U</i>
	<i>Chandra</i> ^c	808	2000-05-13	1.5	47	2986	$-0.73^{+0.01}_{-0.01}$	–	

Notes. (Col. 1) name, (Col. 2) instrument, (Col. 3) obsID, (Col. 4) date, (Col. 5) aperture radius for the nuclear extraction, (Col. 6) net exposure time, (Col. 7) number of counts in the 0.5–10 keV band, (Col. 8) hardness ratio, (Cols. 9 and 10) UV luminosity from the optical monitor and filter. The *c* represents data from different instruments that were compared as explained in Sect. 4.2.

Table A.1. continued.

Name	Instrument	ObsID	Date	R ($''$)	Net Exptime (ks)	Counts	HR	$\log(L_{UV})$ (erg/s)	Filter
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 5195	<i>XMM-Newton</i>	0112840201	2003-01-15	20	17	2976	-0.77 ± 0.01	40.98 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i>	0212480801	2005-07-01	20	22	3756	-0.68 ± 0.01	40.80 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i>	0303420101	2006-05-20	20	27	4297	-0.69 ± 0.01	40.89 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i>	0303420201	2006-05-24	20	21	3312	-0.70 ± 0.01	41.11 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i> ^c	0677980701	2011-06-07	20	5	888	-0.79 ± 0.01	–	
	<i>Chandra</i> ^c	13813	2012-09-09	3	179	1340	-0.43 ± 0.04	–	
	<i>Chandra</i>	13812	2012-09-12	3	157	1359	-0.42 ± 0.04	–	
NGC 5813	<i>XMM-Newton</i>	0302460101	2005-07-23	30	20	25 419	-0.96 ± 0.01	42.01 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i>	0554680201	2009-02-11	30	43	58 821	-0.95 ± 0.01	42.04 ± 0.01	<i>UVW1</i>
	<i>XMM-Newton</i> ^c	0554680301	2009-02-17	30	43	58 175	-0.95 ± 0.01	42.04 ± 0.01	<i>UVW1</i>
	<i>Chandra</i>	5907	2005-04-02	3	48	518	-0.92 ± 0.01	–	
	<i>Chandra</i> ^c	9517	2008-06-05	3	99	1181	-0.90 ± 0.01	–	
	<i>Chandra</i>	12951	2011-03-28	3	74	714	-0.95 ± 0.01	–	
	<i>Chandra</i>	12952	2011-04-05	3	143	1451	-0.90 ± 0.01	–	
	<i>Chandra</i>	13253	2011-04-08	3	118	1295	-0.91 ± 0.01	–	
NGC 5982	<i>Chandra</i>	13255	2011-04-10	3	43	465	-0.92 ± 0.01	–	
	<i>XMM-Newton</i>	0673770401	2011-05-18	25	9	1932	-0.78 ± 0.01	41.71 ± 0.05	<i>UVM2</i>
	<i>XMM-Newton</i>	0693300301	2012-08-02	25	21	4235	-0.87 ± 0.01	41.65 ± 0.07	<i>UVM2</i>

Table A.2. Final compilation of the best-fit models for the sample, including the individual best-fit model for each observation, and the simultaneous best-fit model with the varying parameters.

Analysis	ObsID	Model	N_{H1}	N_{H2}	kT keV	Γ	Norm ₁ (10 ⁻⁴)	Norm ₂ (10 ⁻⁴)	$\chi^2/\text{d.o.f.}$ F-test
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 315									
Ind	0305290201	MEPL	—	0.17 ^{0.25} _{0.11}	0.56 ^{0.58} _{0.54}	1.59 ^{1.69} _{1.50}	1.20 ^{1.29} _{1.11}	1.58 ^{1.77} _{1.41}	197.97/198
Ind	855	MEPL	—	0.35 ^{0.87} _{0.00}	0.33 ^{0.55} _{0.17}	1.53 ^{2.01} _{1.10}	0.52 ^{0.87} _{0.25}	1.66 ^{3.27} _{1.01}	15.16/17
Ind (3'')	4156*	MEPL	0.00 ^{0.02} _{0.00}	0.77 ^{0.92} _{0.62}	0.52 ^{0.55} _{0.49}	1.61 ^{1.76} _{1.49}	0.40 ^{0.43} _{0.37}	2.04 ^{2.44} _{1.71}	190.43/172
Ind (25'')	4156	MEPL	—	0.16 ^{0.23} _{0.12}	0.56 ^{0.57} _{0.55}	1.30 ^{1.38} _{1.22}	1.17 ^{1.25} _{1.11}	1.51 ^{1.67} _{1.39}	258.47/206
SMF0	All	MEPL	—	0.75 ^{0.90} _{0.61}	0.52 ^{0.55} _{0.49}	1.62 ^{1.75} _{1.49}	0.40 ^{0.43} _{0.39}	2.02 ^{2.40} _{1.70}	209.89/195
NGC 1052									
Ind	093630101	ME2PL	—	13.77 ^{15.78} _{11.95}	0.63 ^{0.69} _{0.51}	1.24 ^{1.35} _{1.11}	1.05 ^{1.13} _{0.97}	6.09 ^{4.55} _{4.79}	269.16/234
Ind	306230101	ME2PL	—	9.30 ^{9.82} _{8.79}	0.50 ^{0.55} _{0.45}	1.30 ^{1.36} _{1.24}	1.05 ^{1.09} _{1.01}	7.20 ^{8.14} _{6.34}	799.19/822
Ind	553300301	ME2PL	—	8.96 ^{9.39} _{8.54}	0.61 ^{0.64} _{0.57}	1.38 ^{1.43} _{1.32}	1.09 ^{1.14} _{1.06}	10.16 ^{11.31} _{9.10}	923.38/869
Ind	553300401*	ME2PL	—	9.47 ^{9.86} _{9.09}	0.53 ^{0.61} _{0.48}	1.43 ^{1.48} _{1.38}	1.10 ^{1.14} _{1.06}	12.02 ^{13.32} _{10.82}	1006.47/937
Ind (3'')	5910	ME2PL	—	5.33 ^{6.86} _{3.84}	0.64 ^{0.69} _{0.58}	1.21 ^{1.46} _{1.05}	0.37 ^{0.47} _{0.37}	0.57 ^{1.06} _{0.35}	261.04/226
Ind (25'')	5910	ME2PL	—	8.13 ^{11.49} _{5.36}	0.61 ^{0.65} _{0.57}	1.25 ^{1.50} _{1.00}	0.49 ^{0.66} _{0.49}	0.61 ^{1.21} _{0.19}	319.40/269
SMF2	093630101	ME2PL	—	14.14 ^{15.77} _{12.66}	0.59 ^{0.61} _{0.57}	1.36 ^{1.39} _{1.33}	1.09 ^{1.11} _{1.06}	8.06 ^{8.89} _{7.31}	3043.69/2886
	306230101			9.80 ^{10.26} _{9.36}				8.38 ^{8.97} _{7.82}	1.0e-24
	553300301			8.75 ^{9.11} _{8.40}				9.74 ^{10.40} _{9.11}	
	553300401			9.21 ^{9.55} _{8.88}				10.41 ^{11.11} _{9.75}	
NGC 1961									
Ind	0673170101*	ME2PL	0.00 ^{0.08} _{0.00}	20.83 ^{33.49} _{13.41}	0.63 ^{0.67} _{0.58}	2.00 ^{2.50} _{1.89}	0.34 ^{0.52} _{0.34}	1.44 ^{3.96} _{0.84}	69.32/70
Ind	0673170301	ME2PL	0.00 ^{0.05} _{0.00}	9.88 ^{18.23} _{5.67}	0.56 ^{0.61} _{0.49}	1.84 ^{2.27} _{1.60}	0.31 ^{0.41} _{0.31}	0.80 ^{1.43} _{0.35}	85.39/62
SMF0	All	ME2PL	—	15.60 ^{22.74} _{10.82}	0.60 ^{0.63} _{0.56}	1.95 ^{2.08} _{1.81}	0.37 ^{0.40} _{0.34}	1.07 ^{1.55} _{0.71}	165.72/142
NGC 2681									
Ind	2060*	MEPL	0.11 ^{0.26} _{0.00}	—	0.64 ^{0.71} _{0.56}	1.67 ^{1.86} _{1.45}	0.12 ^{0.18} _{0.07}	0.07 ^{0.08} _{0.06}	43.34/36
Ind	2061	MEPL	0.00 ^{0.16} _{0.00}	—	0.63 ^{0.68} _{0.56}	1.61 ^{1.78} _{1.41}	0.06 ^{0.07} _{0.06}	0.07 ^{0.08} _{0.06}	29.71/33
SMF0	All	MEPL	0.07 ^{0.19} _{0.00}	—	0.64 ^{0.69} _{0.58}	1.73 ^{1.89} _{1.55}	0.09 ^{0.12} _{0.06}	0.07 ^{0.08} _{0.06}	81.23/72
NGC 2787									
Ind (25'')	0200250101	PL	—	—	—	1.61 ^{1.66} _{1.55}	—	—	146.28/98
Ind (3'')	4689	PL	0.09 ^{0.18} _{0.03}	—	—	2.21 ^{2.58} _{1.95}	—	—	20.72/21
Ind (25'')	4689	PL	0.01 ^{0.07} _{0.00}	—	—	1.70 ^{1.98} _{1.59}	—	—	42.31/48
NGC 2841									
Ind	0201440101	MEPL	0.82 ^{0.95} _{0.68}	—	0.29 ^{0.34} _{0.25}	1.76 ^{1.97} _{1.60}	3327.57 ^{7082.60} _{368.14}	0.49 ^{0.57} _{0.43}	71.15/50
Ind (5'')	6096	MEPL	0.00 ^{0.68} _{0.00}	—	0.63 ^{0.74} _{0.44}	2.09 ^{2.52} _{1.86}	0.08 ^{0.27} _{0.06}	0.13 ^{0.16} _{0.11}	3.52/13
Ind (30'')	6096	MEPL	0.00 ^{0.45} _{0.00}	—	0.48 ^{0.61} _{0.25}	1.57 ^{1.75} _{1.43}	0.16 ^{0.21} _{0.12}	0.49 ^{0.55} _{0.43}	54.51/57
NGC 3608									
Ind	0099030101	ME2PL	—	9.69 ^{36.25} _{2.76}	0.60 ^{0.80} _{0.36}	2.13 ^{2.56} _{1.79}	0.21 ^{0.33} _{0.21}	0.92 ^{2.90} _{0.23}	6.30/8
Ind	0693300101*	ME2PL	—	13.77 ^{23.33} _{8.17}	0.49 ^{0.59} _{0.28}	2.11 ^{2.32} _{1.79}	0.21 ^{0.26} _{0.21}	0.95 ^{1.60} _{0.32}	89.32/55
SMF0	All	ME2PL	—	10.02 ^{15.64} _{6.26}	0.51 ^{0.60} _{0.35}	2.21 ^{2.38} _{2.03}	0.24 ^{0.26} _{0.22}	0.95 ^{1.40} _{0.62}	88.67/70
NGC 3718									
Ind	0200430501	2PL	1.02 ^{1.35} _{0.91}	0.01 ^{0.22} _{0.00}	—	1.76 ^{1.97} _{1.71}	0.21 ^{0.62} _{0.13}	5.56 ^{6.78} _{4.60}	129.94/104
Ind	0200431301*	2PL	0.08 ^{0.36} _{0.00}	0.96 ^{1.59} _{0.77}	—	1.67 ^{1.93} _{1.49}	0.31 ^{1.46} _{0.12}	4.23 ^{5.67} _{3.25}	56.16/71
Ind	3993	PL	0.95 ^{1.12} _{0.79}	—	—	1.73 ^{1.92} _{1.54}	—	—	51.98/48
Ind		2PL	3.08 ^{5.04} _{0.00}	0.87 ^{1.19} _{0.00}	—	2.15 ^{3.01} _{1.69}	8.74 ^{44.58} _{0.61}	6.77 ^{13.37} _{0.08}	49.04/43

Notes. (Col. 1) kind of analysis performed, where Ind refers to the individual fitting of the observation, SMF0 is the simultaneous fit without varying parameters, SMF1 is the simultaneous fit varying one parameter and SMF2 is the simultaneous fit varying two parameters, (Col. 2) obsID, where the * represents the data that are used as a reference model for the simultaneous fit, (Col. 3) best-fit model, (Cols. 4–9) parameters in the model, where N_{H} are in units of 10²² cm⁻², and (Col. 10) $\chi^2/\text{d.o.f.}$ and in SMFx (where $x = 1, 2$) the result of the F-test is presented in the second line.

Table A.2. continued.

Analysis	ObsID	Model	N_{H1}	N_{H2}	kT keV	Γ	Norm ₁ (10 ⁻⁴)	Norm ₂ (10 ⁻⁴)	$\chi^2/\text{d.o.f.}$ F-test
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 4261									
SMF1	0200431301 0200430501 3993	2PL	0.09 ^{0.22} _{0.00}	1.10 ^{1.32} _{0.97}	—	1.79 ^{1.92} _{1.71}	0.32 ^{0.67} _{0.17}	5.11 ^{6.24} _{4.45} 5.31 ^{6.48} _{4.61} 8.06 ^{9.92} _{7.02}	237.70/224 1.0e-17
Ind	834	ME2PL	0.18 ^{0.47} _{0.06}	11.89 ^{16.01} _{9.31}	0.58 ^{0.60} _{0.56}	2.11 ^{3.07} _{1.52}	0.29 ^{0.55} _{0.19}	4.72 ^{25.76} _{1.60}	110.82/80
Ind (3'')	9569*	ME2PL	0.18 ^{0.47} _{0.08}	8.40 ^{10.20} _{6.90}	0.57 ^{0.58} _{0.56}	1.24 ^{1.51} _{1.07}	0.26 ^{0.37} _{0.20}	2.13 ^{4.57} _{1.18}	198.74/157
Ind (25'')	9569	ME2PL	—	9.03 ^{12.90} _{6.55}	0.61 ^{0.62} _{0.60}	1.16 ^{1.39} _{0.89}	0.35 ^{0.47} _{0.35}	0.64 ^{1.11} _{0.29}	382.42/218
SMF0	All	ME2PL	0.18 ^{0.31} _{0.09}	9.38 ^{10.84} _{7.96}	0.57 ^{0.58} _{0.56}	1.87 ^{2.19} _{1.55}	0.27 ^{0.34} _{0.21}	2.70 ^{4.86} _{1.49}	312.57/247
Ind	0056340101	ME2PL	0.08 ^{0.15} _{0.01}	11.97 ^{14.73} _{9.31}	0.63 ^{0.64} _{0.61}	1.84 ^{2.22} _{1.45}	0.77 ^{0.94} _{0.54}	2.82 ^{6.30} _{1.11}	278.12/255
Ind	0502120101*	ME2PL	0.04 ^{0.07} _{0.00}	9.71 ^{11.14} _{8.30}	0.64 ^{0.65} _{0.64}	1.75 ^{1.97} _{1.54}	0.64 ^{0.74} _{0.55}	2.30 ^{3.65} _{1.40}	563.80/461
SMF0	All	ME2PL	0.04 ^{0.08} _{0.01}	10.28 ^{11.56} _{9.02}	0.64 ^{0.65} _{0.63}	1.76 ^{1.95} _{1.57}	0.67 ^{0.76} _{0.58}	2.36 ^{3.54} _{1.53}	855.28/726
NGC 4278									
Ind (3'')	7077*	MEPL	0.31 ^{0.58} _{0.05}	0.01 ^{0.03} _{0.00}	0.27 ^{0.38} _{0.19}	2.06 ^{2.15} _{1.99}	0.80 ^{6.21} _{0.18}	0.98 ^{1.06} _{0.90}	144.23/158
Ind (25'')	7077	MEPL	0.16 ^{0.45} _{0.01}	—	0.30 ^{0.37} _{0.21}	1.88 ^{1.95} _{1.83}	0.81 ^{3.96} _{0.28}	1.32 ^{1.39} _{1.27}	250.15/210
Ind	7081	MEPL	—	—	0.63 ^{0.68} _{0.57}	2.03 ^{2.10} _{1.99}	0.12 ^{0.14} _{0.09}	0.77 ^{0.82} _{0.75}	155.54/145
Ind	7080	MEPL	0.22 ^{0.71} _{0.00}	—	0.47 ^{0.61} _{0.18}	2.10 ^{2.25} _{2.03}	0.24 ^{13.76} _{0.07}	0.69 ^{0.79} _{0.65}	102.53/96
Ind	0205010101	PL	0.02 ^{0.03} _{0.02}	—	—	2.04 ^{2.08} _{2.01}	—	—	562.25/529
SMF1	7077 7081 7080	MEPL	—	—	0.58 ^{0.62} _{0.48}	2.05 ^{2.11} _{2.03}	0.11 ^{0.12} _{0.10}	0.97 ^{1.02} _{0.82} 0.78 ^{0.82} _{0.77} 0.68 ^{0.72} _{0.65}	414.71/415 6.7e-46
NGC 4374									
Ind	0673310101	ME2PL	0.01 ^{0.02} _{0.00}	269.73 ^{462.21} _{79.23}	0.62 ^{0.63} _{0.61}	2.02 ^{2.08} _{1.93}	1.06 ^{1.23} _{1.06}	20.74 ^{1161.27} _{1.99}	283.99/282
Ind	803	MEPL	0.45 ^{0.79} _{0.00}	0.17 ^{0.28} _{0.10}	0.30 ^{0.60} _{0.18}	2.06 ^{2.42} _{1.79}	0.87 ^{10.78} _{0.06}	0.45 ^{0.61} _{0.34}	35.48/36
Ind	5908*	PL	0.10 ^{0.13} _{0.07}	—	—	2.18 ^{2.32} _{2.13}	—	—	78.73/87
		MEPL	0.00 ^{0.39} _{0.00}	0.10 ^{0.13} _{0.06}	0.54 ^{0.71} _{0.21}	2.07 ^{2.22} _{1.93}	0.06 ^{0.53} _{0.03}	0.83 ^{0.95} _{0.72}	67.73/81
Ind (2'')	6131	MEPL	0.00 ^{0.20} _{0.00}	0.00 ^{0.09} _{0.00}	0.60 ^{0.66} _{0.54}	1.48 ^{1.81} _{1.32}	0.11 ^{0.13} _{0.09}	0.14 ^{0.18} _{0.12}	33.27/28
Ind (25'')	6131	MEPL	—	—	0.55 ^{0.57} _{0.53}	1.95 ^{2.09} _{1.856}	2.07 ^{2.16} _{1.97}	0.90 ^{0.98} _{0.81}	160.27/114
SMF1	5908 803 6131	MEPL	0.02 ^{0.14} _{0.00}	0.09 ^{0.15} _{0.08}	0.59 ^{0.64} _{0.51}	1.98 ^{2.11} _{1.89}	0.10 ^{0.13} _{0.07}	0.80 ^{0.88} _{0.73} 0.39 ^{0.44} _{0.35} 0.22 ^{0.25} _{0.20}	161.08/154 3.02e-55
NGC 4494									
Ind	0071340301*	PL	—	—	—	1.76 ^{1.83} _{1.68}	—	—	115.04/74
Ind (3'')	2079	PL	—	—	—	1.66 ^{1.94} _{1.51}	—	—	19.32/21
Ind (20'')	2079	PL	0.00 ^{0.03} _{0.00}	—	—	1.49 ^{1.68} _{1.38}	—	—	69.38/43
SMF1	0071340301 2079	—	—	—	—	1.81 ^{1.89} _{1.74}	0.36 ^{0.38} _{0.35} 0.24 ^{0.27} _{0.23}	—	117.35/86 6.9e-09
NGC 4636									
Ind	0111190201*	MEPL	—	—	0.53 ^{0.55} _{0.52}	2.47 ^{2.74} _{2.27}	7.93 ^{8.13} _{7.64}	1.01 ^{1.20} _{0.88}	280.73/176
Ind	0111190701	MEPL	—	—	0.55 ^{0.55} _{0.54}	2.58 ^{2.64} _{2.52}	8.07 ^{8.15} _{7.99}	1.01 ^{1.06} _{0.96}	958.65/344
SMF0	All	MEPL	—	—	0.55 ^{0.55} _{0.54}	2.58 ^{2.64} _{2.52}	8.05 ^{8.13} _{7.98}	1.02 ^{1.07} _{0.97}	1260.17/529
NGC 4736									
Ind	0094360601	MEPL	0.00 ^{0.04} _{0.00}	—	0.48 ^{0.51} _{0.45}	1.66 ^{1.70} _{1.64}	1.59 ^{1.73} _{1.47}	4.27 ^{4.43} _{4.10}	337.72/297
Ind	0094360701	MEPL	0.01 ^{0.09} _{0.00}	0.00 ^{0.01} _{0.00}	0.43 ^{0.52} _{0.31}	1.70 ^{1.80} _{1.60}	1.51 ^{1.74} _{10.23}	4.00 ^{4.31} _{3.67}	100.34/100
Ind	0404980101*	MEPL	0.00 ^{0.01} _{0.00}	—	0.55 ^{0.57} _{0.54}	1.66 ^{1.68} _{1.64}	1.61 ^{1.68} _{1.55}	3.87 ^{3.95} _{3.79}	562.21/587
Ind (1.5'')	808	MEPL	0.33 ^{0.49} _{0.27}	0.04 ^{0.09} _{0.02}	0.55 ^{0.61} _{0.47}	2.00 ^{2.25} _{1.88}	0.32 ^{0.80} _{0.23}	0.53 ^{0.67} _{0.51}	66.80/86
Ind (20'')	808	MEPL	—	—	0.51 ^{0.53} _{0.49}	1.57 ^{1.60} _{1.55}	1.28 ^{1.34} _{1.21}	3.07 ^{3.14} _{2.99}	232.63/232
SMF0	All	MEPL	—	—	0.54 ^{0.55} _{0.52}	1.66 ^{1.68} _{1.65}	1.60 ^{1.66} _{1.55}	3.95 ^{4.01} _{3.88}	1051.57/1002

Table A.2. continued.

Analysis	ObsID	Model	N_{H1}	N_{H2}	kT keV	Γ	Norm ₁ (10 ⁻⁴)	Norm ₂ (10 ⁻⁴)	$\chi^2/\text{d.o.f.}$ F-test
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 5195									
Ind	0112840201	MEPL	0.42 ^{0.51} _{0.31}	—	0.29 ^{0.34} _{0.25}	1.58 ^{1.70} _{1.45}	4.74 ^{8.95} _{2.34}	0.37 ^{0.42} _{0.32}	131.59/102
Ind	0212480801*	MEPL	0.03 ^{0.10} _{0.00}	0.00 ^{0.04} _{0.00}	0.58 ^{0.63} _{0.50}	1.49 ^{1.60} _{1.41}	0.57 ^{0.73} _{0.50}	0.53 ^{0.58} _{0.48}	174.79/126
Ind	0303420101	MEPL	0.48 ^{0.53} _{0.37}	—	0.28 ^{0.32} _{0.26}	1.41 ^{1.54} _{1.30}	6.17 ^{8.69} _{3.08}	0.35 ^{0.39} _{0.31}	249.19/143
Ind	0303420201	MEPL	0.39 ^{0.52} _{0.29}	—	0.31 ^{0.38} _{0.26}	1.39 ^{1.53} _{1.26}	3.70 ^{8.21} _{1.93}	0.34 ^{0.39} _{0.29}	177.87/111
Ind	0677980701	MEPL	0.63 ^{0.79} _{0.45}	0.00 ^{0.06} _{0.00}	0.25 ^{0.35} _{0.18}	1.68 ^{2.08} _{1.51}	12.14 ^{57.71} _{3.71}	0.46 ^{0.55} _{0.37}	34.82/30
SMF1	0112840201	MEPL	—	—	0.61 ^{0.63} _{0.60}	1.51 ^{1.57} _{1.46}	0.55 ^{0.61} _{0.53}	0.36 ^{0.39} _{0.33}	639.89/533
	0212480801							0.51 ^{0.55} _{0.48}	6.8e-12
	0303420101							0.38 ^{0.40} _{0.35}	
	0303420201							0.37 ^{0.40} _{0.34}	
	0677980701							0.45 ^{0.51} _{0.40}	
Ind (3'')	13813	MEPL	0.40 ^{0.65} _{0.16}	0.95 ^{2.83} _{0.00}	0.61 ^{0.67} _{0.53}	1.53 ^{2.95} _{1.01}	0.22 ^{0.36} _{0.08}	0.10 ^{0.95} _{0.04}	47.08/50
Ind (20'')	13813	MEPL	0.23 ^{0.31} _{0.14}	0.04 ^{0.17} _{0.00}	0.57 ^{0.60} _{0.52}	1.73 ^{2.09} _{1.47}	0.42 ^{0.57} _{0.31}	0.12 ^{0.17} _{0.09}	129.49/107
Ind	13812	MEPL	0.41 ^{0.63} _{0.00}	0.18 ^{0.73} _{0.08}	0.62 ^{0.83} _{0.48}	1.37 ^{1.79} _{1.19}	0.11 ^{0.25} _{0.03}	0.11 ^{0.21} _{0.08}	59.03/50
SFM0	All	MEPL	0.37 ^{0.49} _{0.19}	0.15 ^{0.69} _{0.06}	0.62 ^{0.67} _{0.57}	1.27 ^{1.61} _{1.11}	0.14 ^{0.21} _{0.08}	0.07 ^{0.12} _{0.06}	134.19/106
NGC 5813									
Ind	5907	MEPL	0.42 ^{0.63} _{0.26}	0.00 ^{2.33} _{0.00}	0.27 ^{0.35} _{0.21}	3.98 ⁰ ₀	0.52 ^{2.26} _{0.11}	0.04 ^{0.19} _{0.01}	19.61/20
Ind (3'')	9517	MEPL	0.00 ^{0.11} _{0.00}	—	0.56 ^{0.60} _{0.48}	2.05 ^{2.32} _{1.72}	0.13 ^{0.20} _{0.12}	0.05 ^{0.07} _{0.04}	50.12/39
Ind (25'')	9517	MEPL	0.09 ^{0.22} _{0.00}	0.00 ^{0.93} _{0.00}	0.54 ^{0.63} _{0.45}	2.04 ^{3.61} _{1.34}	0.10 ^{0.17} _{0.07}	0.03 ^{0.08} _{0.02}	27.74/16
Ind	12951	MEPL	0.08 ^{0.18} _{0.00}	0.00 ^{0.28} _{0.00}	0.64 ^{0.69} _{0.60}	3.92 ⁰ ₀	0.12 ^{0.21} _{0.10}	0.05 ^{0.17} _{0.04}	49.45/24
Ind	12952*	MEPL	0.10 ^{0.19} _{0.00}	—	0.60 ^{0.65} _{0.53}	2.35 ^{2.60} _{2.09}	0.14 ^{0.19} _{0.10}	0.06 ^{0.07} _{0.05}	53.22/48
Ind	13253	MEPL	0.00 ^{0.12} _{0.00}	0.18 ^{0.48} _{0.00}	0.62 ^{0.65} _{0.58}	2.44 ^{3.00} _{1.59}	0.13 ^{0.18} _{0.11}	0.08 ^{0.18} _{0.04}	59.76/43
Ind	13255	MEPL	0.29 ^{0.49} _{0.15}	1.71 ^{4.86} _{0.58}	0.33 ^{0.59} _{0.25}	2.60 ⁰ _{1.10}	0.63 ^{1.78} _{0.13}	0.20 ^{1.10} _{0.09}	21.43/15
SMF0	All	MEPL	0.01 ^{0.07} _{0.00}	0.06 ^{0.17} _{0.00}	0.60 ^{0.62} _{0.57}	2.40 ^{2.87} _{2.01}	0.12 ^{0.13} _{0.11}	0.07 ^{0.09} _{0.05}	260.993/213
Ind	0302460101	MEPL	0.01 ^{0.02} _{0.00}	0 ^{0.03} _{0.00}	0.58 ^{0.59} _{0.57}	2.10 ^{2.33} _{2.00}	7.12 ^{7.30} _{6.77}	0.53 ^{0.65} _{0.48}	436.83/251
Ind	0554680201	MEPL	0.01 ^{0.01} _{0.00}	0.00 ^{0.01} _{0.00}	0.60 ^{0.60} _{0.61}	1.88 ^{2.04} _{1.74}	7.28 ^{7.49} _{7.15}	0.47 ^{0.56} _{0.40}	687.18/329
Ind	0554680301*	MEPL	0.00 ^{0.01} _{0.00}	—	0.59 ^{0.60} _{0.59}	1.66 ^{1.77} _{1.48}	7.19 ^{7.31} _{7.11}	0.44 ^{0.50} _{0.35}	849.57/334
SMF0	All	MEPL	0.01 ^{0.01} _{0.00}	0.01 ^{0.01} _{0.00}	0.59 ^{0.60} _{0.59}	1.95 ^{2.01} _{1.91}	7.17 ^{7.28} _{7.07}	0.51 ^{0.58} _{0.49}	1937.02/918
NGC 5982									
Ind	0673770401	MEPL	—	—	0.53 ^{0.56} _{0.49}	1.28 ^{1.50} _{0.99}	0.81 ^{0.93} _{0.76}	0.23 ^{0.29} _{0.17}	65.24/64
Ind	0693300301*	MEPL	—	—	0.52 ^{0.54} _{0.50}	1.52 ^{1.78} _{1.21}	0.76 ^{0.80} _{0.72}	0.16 ^{0.20} _{0.11}	186.37/117
SMF1	0693300301	MEPL	—	—	0.52 ^{0.54} _{0.50}	1.34 ^{1.52} _{1.15}	0.79 ^{0.82} _{0.75}	0.13 ^{0.16} _{0.10}	260.60/189
	0673770401							0.26 ^{0.31} _{0.21}	3.3e-9

Table A.3. X-ray luminosities.

Name (1)	Satellite (2)	ObsID (3)	Individual		Simultaneous	
			log ($L(0.5-2$ keV)) (4)	log ($L(2-10$ keV)) (5)	log ($L(0.5-2$ keV)) (6)	log ($L(2-10$ keV)) (7)
NGC 315	<i>XMM-Newton</i>	0305290201	41.46 ^{41.47} _{41.44}	41.55 ^{41.57} _{41.52}		
	<i>Chandra</i>	855	41.31 ^{41.43} _{41.15}	41.55 ^{41.63} _{41.47}	41.38 ^{41.40} _{41.37}	41.58 ^{41.61} _{41.55}
	<i>Chandra</i> (3'')	4156	41.38 ^{41.39} _{41.37}	41.58 ^{41.61} _{41.56}	41.38 ^{41.40} _{41.37}	41.58 ^{41.61} _{41.55}
	<i>Chandra</i> (25'')	4156	41.44 ^{41.45} _{41.44}	41.68 ^{41.700} _{41.66}		
NGC 1052	<i>XMM-Newton</i>	093630101	40.96 ^{40.97} _{40.94}	41.46 ^{41.47} _{41.45}	40.99 ^{41.00} _{40.99}	41.47 ^{41.49} _{41.46}
	<i>XMM-Newton</i>	306230101	40.96 ^{40.97} _{40.95}	41.48 ^{41.49} _{41.48}	41.01 ^{41.01} _{41.00}	41.49 ^{41.49} _{41.48}
	<i>XMM-Newton</i>	553300301	41.10 ^{41.11} _{41.10}	41.56 ^{41.56} _{41.55}	41.06 ^{41.07} _{41.06}	41.55 ^{41.55} _{41.54}
	<i>XMM-Newton</i>	553300401	41.12 ^{41.13} _{41.11}	41.55 ^{41.56} _{41.55}	41.09 ^{41.09} _{41.08}	41.57 ^{41.58} _{41.57}
	<i>Chandra</i> (3'')	5910	40.19 ^{40.20} _{40.17}	41.29 ^{41.29} _{41.27}	—	—
	<i>Chandra</i> (25'')	5910	40.29 ^{40.31} _{40.27}	41.34 ^{41.37} _{41.30}	—	—
NGC 1961	<i>XMM-Newton</i>	0673170101	41.20 ^{41.22} _{41.18}	41.27 ^{41.31} _{41.22}	41.20 ^{41.21} _{41.18}	41.23 ^{41.27} _{41.20}
	<i>XMM-Newton</i>	0673170301	41.42 ^{41.44} _{41.40}	41.01 ^{41.06} _{40.97}	41.20 ^{41.21} _{41.18}	41.23 ^{41.27} _{41.20}
NGC 2681	<i>Chandra</i>	2060	39.11 ^{39.13} _{39.08}	38.89 ^{38.97} _{38.80}	39.02 ^{39.04} _{38.99}	38.93 ^{38.99} _{38.87}
	<i>Chandra</i>	2061	38.95 ^{38.97} _{38.92}	38.95 ^{39.02} _{38.86}	39.02 ^{39.04} _{38.99}	38.93 ^{38.99} _{38.87}
NGC 2787	<i>XMM-Newton</i>	0200250101	39.13 ^{39.15} _{39.12}	39.49 ^{39.52} _{39.47}		
	<i>Chandra</i> (3'')	4689	38.95 ^{38.99} _{38.90}	38.86 ^{38.94} _{38.76}		
	<i>Chandra</i> (25'')	4689	39.15 ^{39.18} _{39.11}	39.34 ^{39.41} _{39.26}		
NGC 2841	<i>XMM-Newton</i>	0201440101	39.74 ^{39.76} _{39.72}	39.75 ^{39.79} _{39.71}		
	<i>Chandra</i> (5'')	6096	39.22 ^{39.27} _{39.17}	39.16 ^{39.29} _{39.08}		
	<i>Chandra</i> (30'')	6096	39.71 ^{39.73} _{39.68}	39.86 ^{39.92} _{39.78}		
NGC 3608	<i>XMM-Newton</i>	0099030101	39.65 ^{39.69} _{39.62}	40.37 ^{40.41} _{40.33}	40.32 ^{40.34} _{40.30}	40.24 ^{40.28} _{40.19}
	<i>XMM-Newton</i>	0693300101	40.33 ^{40.35} _{40.31}	40.31 ^{40.35} _{40.26}	40.32 ^{40.34} _{40.30}	40.24 ^{40.28} _{40.19}
NGC 3718	<i>XMM-Newton</i>	0200430501	40.65 ^{40.67} _{40.63}	40.84 ^{40.86} _{40.82}	40.66 ^{40.68} _{40.64}	40.86 ^{40.88} _{40.83}
	<i>XMM-Newton</i>	0200431301	40.42 ^{40.44} _{40.39}	40.85 ^{40.87} _{40.82}	40.64 ^{40.66} _{40.62}	40.84 ^{40.87} _{40.82}
	<i>Chandra</i> (3'')	3993	40.76 ^{40.79} _{40.72}	41.01 ^{41.14} _{40.84}	40.83 ^{40.86} _{40.81}	40.99 ^{41.02} _{40.97}
	<i>Chandra</i> (25'')	3993	40.75 ^{40.78} _{40.72}	41.02 ^{41.15} _{40.24}		
NGC 4261	<i>Chandra</i>	834	41.18 ^{41.20} _{41.16}	41.11 ^{41.27} _{40.86}	40.98 ^{40.98} _{40.97}	41.02 ^{41.06} _{40.97}
	<i>Chandra</i> (3'')	9569	40.92 ^{40.94} _{40.91}	41.00 ^{40.89} _{41.08}	40.98 ^{40.98} _{40.97}	41.02 ^{41.06} _{40.97}
	<i>Chandra</i> (25'')	9569	40.79 ^{40.81} _{40.78}	40.97 ^{40.99} _{40.94}		
	<i>XMM-Newton</i>	0056340101	41.30 ^{41.31} _{41.29}	41.19 ^{41.21} _{41.17}	41.14 ^{41.15} _{41.14}	41.13 ^{41.15} _{41.11}
	<i>XMM-Newton</i>	0502120101	41.22 ^{41.23} _{41.22}	41.15 ^{41.16} _{41.14}	41.14 ^{41.15} _{41.14}	41.13 ^{41.15} _{41.11}
NGC 4278	<i>Chandra</i> (3'')	7077	39.87 ^{39.88} _{39.87}	39.76 ^{39.98} _{39.32}	39.86 ^{39.87} _{39.86}	39.82 ^{39.84} _{39.81}
	<i>Chandra</i> (25'')	7077	40.14 ^{40.17} _{40.10}	40.06 ^{40.08} _{40.04}	—	—
	<i>Chandra</i>	7081	39.31 ^{39.32} _{39.30}	39.27 ^{39.29} _{39.24}	39.78 ^{39.79} _{39.77}	39.73 ^{39.75} _{39.72}
	<i>Chandra</i>	7080	39.78 ^{39.81} _{39.74}	39.62 ^{40.73} _{39.72}	39.73 ^{39.74} _{39.72}	39.67 ^{39.69} _{39.65}
	<i>XMM-Newton</i>	0205010101	40.73 ^{40.74} _{40.73}	40.77 ^{40.78} _{40.76}	—	—
NGC 4374	<i>Chandra</i>	803	39.95 ^{40.02} _{39.86}	39.53 ^{39.60} _{39.44}	39.83 ^{39.85} _{39.82}	39.82 ^{39.86} _{39.78}
	<i>Chandra</i>	5908	39.83 ^{39.86} _{39.80}	39.80 ^{39.84} _{39.75}	39.57 ^{39.59} _{39.55}	39.51 ^{39.55} _{39.47}
	<i>Chandra</i>	6131	39.30 ^{39.35} _{39.24}	39.39 ^{39.46} _{39.30}	39.39 ^{39.42} _{39.36}	39.28 ^{39.32} _{39.23}
	<i>Chandra</i> (25'')	6131	40.39 ^{40.40} _{40.38}	39.98 ^{40.09} _{39.83}		
	<i>XMM-Newton</i>	0673310101	41.30 ^{41.30} _{41.29}	41.31 ^{41.33} _{41.28}		
NGC 4494	<i>XMM-Newton</i>	0071340301	39.29 ^{39.31} _{39.27}	39.50 ^{39.54} _{39.46}	39.26 ^{39.28} _{39.25}	39.48 ^{39.57} _{39.36}
	<i>Chandra</i> (3'')	2079	39.13 ^{39.19} _{39.06}	39.37 ^{39.46} _{39.25}	39.10 ^{39.14} _{39.07}	39.29 ^{39.41} _{39.13}
	<i>Chandra</i> (20'')	2079	39.29 ^{39.34} _{39.23}	39.65 ^{39.73} _{39.54}		
NGC 4636	<i>XMM-Newton</i>	0111190201	40.85 ^{40.86} _{40.84}	39.89 ^{39.94} _{39.85}	40.86 ^{40.86} _{40.86}	39.81 ^{39.83} _{39.80}
	<i>XMM-Newton</i>	0111190701	40.87 ^{40.87} _{40.86}	39.05 ^{39.05} _{39.04}	40.86 ^{40.86} _{40.86}	39.81 ^{39.83} _{39.80}
NGC 4736	<i>XMM-Newton</i>	0094360601	39.63 ^{39.64} _{39.63}	39.75 ^{39.77} _{39.73}	39.61 ^{39.61} _{39.61}	39.73 ^{39.74} _{39.72}
	<i>XMM-Newton</i>	0094360701	39.59 ^{39.61} _{39.58}	39.73 ^{39.76} _{39.69}	39.61 ^{39.61} _{39.61}	39.73 ^{39.74} _{39.72}
	<i>XMM-Newton</i>	0404980101	39.74 ^{39.75} _{39.74}	39.77 ^{39.78} _{39.76}	39.61 ^{39.61} _{39.61}	39.73 ^{39.74} _{39.72}
	<i>Chandra</i>	808	38.80 ^{38.84} _{38.76}	38.60 ^{38.64} _{38.54}		
	<i>Chandra</i> (20'')	808	39.50 ^{39.51} _{39.50}	39.66 ^{39.67} _{39.64}		

Notes. (Cols. 4 and 5) soft and hard intrinsic luminosities for individual fits, and (Cols. 6 and 7) soft and hard intrinsic luminosities for simultaneous fitting. Blanks mean observations that are not used for the simultaneous fittings.

Table A.3. continued.

Name (1)	Satellite (2)	ObsID (3)	Individual		Simultaneous	
			$\log(L(0.5-2\text{ keV}))$ (4)	$\log(L(2-10\text{ keV}))$ (5)	$\log(L(0.5-2\text{ keV}))$ (6)	$\log(L(2-10\text{ keV}))$ (7)
NGC 5195	<i>XMM-Newton</i>	0112840201	39.86 ^{39.88} _{39.85}	39.17 ^{39.21} _{39.12}	39.22 ^{39.24} _{39.20}	39.19 ^{39.22} _{39.15}
	<i>XMM-Newton</i>	0212480801	39.29 ^{39.31} _{39.28}	39.39 ^{39.42} _{39.35}	39.28 ^{39.30} _{39.26}	39.34 ^{39.37} _{39.31}
	<i>XMM-Newton</i>	0303420101	39.44 ^{39.45} _{39.43}	39.39 ^{39.43} _{39.35}	39.23 ^{39.24} _{39.21}	39.20 ^{39.23} _{39.17}
	<i>XMM-Newton</i>	0303420201	39.76 ^{39.77} _{39.74}	39.23 ^{39.26} _{39.18}	39.22 ^{39.24} _{39.20}	39.20 ^{39.23} _{39.16}
	<i>XMM-Newton</i>	0677980701	40.19 ^{40.23} _{40.15}	39.19 ^{39.26} _{39.10}	39.26 ^{39.28} _{39.23}	39.28 ^{39.33} _{39.23}
	<i>Chandra</i> (3'')	13813	38.77 ^{38.83} _{38.71}	38.59 ^{38.66} _{38.49}	38.59 ^{38.61} _{38.56}	38.61 ^{38.64} _{38.57}
	<i>Chandra</i> (20'')	13813	39.00 ^{39.03} _{38.97}	38.55 ^{38.65} _{38.44}		
	<i>Chandra</i>	13812	38.60 ^{38.66} _{38.52}	38.66 ^{38.72} _{38.57}	38.59 ^{38.61} _{38.56}	38.61 ^{38.64} _{38.57}
NGC 5813	<i>Chandra</i>	5907	40.09 ^{40.25} _{39.83}	39.32 ^{39.58} _{38.65}	39.68 ^{39.72} _{39.63}	39.07 ^{39.15} _{38.95}
	<i>Chandra</i> (3'')	9517	39.69 ^{39.72} _{39.66}	39.15 ^{39.24} _{39.02}	39.68 ^{39.72} _{39.63}	39.07 ^{39.16} _{38.95}
	<i>Chandra</i> (30'')	9517	39.53 ^{39.56} _{39.49}	39.03 ^{39.16} _{38.83}		
	<i>Chandra</i>	12951	39.67 ^{39.80} _{39.48}	39.02 ^{39.16} _{38.78}	39.68 ^{39.72} _{39.63}	39.07 ^{39.16} _{38.95}
	<i>Chandra</i>	12952	39.73 ^{39.76} _{39.69}	39.00 ^{39.10} _{38.88}	39.68 ^{39.72} _{39.63}	39.07 ^{39.16} _{38.95}
	<i>Chandra</i>	13253	39.74 ^{39.81} _{39.66}	39.09 ^{39.22} _{38.91}	39.68 ^{39.72} _{39.63}	39.07 ^{39.16} _{38.95}
	<i>Chandra</i>	13255	39.36 ^{39.43} _{39.29}	39.30 ^{39.42} _{39.14}	39.68 ^{39.72} _{39.63}	39.07 ^{39.16} _{38.95}
	<i>XMM-Newton</i>	0302460101	41.32 ^{41.33} _{41.32}	40.23 ^{40.26} _{40.19}	41.33 ^{41.33} _{41.32}	40.30 ^{40.32} _{40.28}
	<i>XMM-Newton</i>	0554680201	41.52 ^{41.52} _{41.51}	40.84 ^{40.87} _{40.82}	41.33 ^{41.33} _{41.32}	40.30 ^{40.32} _{40.28}
	<i>XMM-Newton</i>	0554680301	41.32 ^{41.33} _{41.32}	40.38 ^{40.40} _{40.35}	41.33 ^{41.33} _{41.32}	40.30 ^{40.32} _{40.28}
NGC 5892	<i>XMM-Newton</i>	0673770401	40.73 ^{40.75} _{40.71}	40.68 ^{40.73} _{40.61}	40.72 ^{40.73} _{40.70}	40.61 ^{40.66} _{40.54}
	<i>XMM-Newton</i>	0693300301	40.67 ^{40.68} _{40.66}	40.11 ^{40.17} _{40.05}	40.67 ^{40.68} _{40.65}	40.32 ^{40.37} _{40.27}

Table A.4. Results for the best fit of the annular region (ring) in *Chandra* data, and the best fit obtained for the nucleus of *XMM-Newton* data when the contribution from the annular region was removed.

Name (obsID)	Region	Model	N_{H1} (10^{22} cm^{-2})	N_{H2} (10^{22} cm^{-2})	kT (keV)	Γ	χ^2_r	$\log(L_{\text{soft}})$ (0.5–2 keV)	$\log(L_{\text{hard}})$ (2–10 keV)	Cont. %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
NGC 315 (4156)	Ring*	MEPL	–	–	$0.59^{0.61}_{0.57}$	$1.47^{1.63}_{1.31}$	1.49	41.13	40.88	3
NGC 315 (0305290201)	Nucleus**	MEPL	–	$0.77^{1.08}_{0.47}$	$0.53^{0.59}_{0.45}$	$1.96^{2.20}_{1.74}$	0.97	41.41	41.43	–
NGC 1052 (5910)	Ring*	ME2PL	–	$26.10^{38.14}_{16.93}$	$0.31^{0.39}_{0.28}$	$1.98^{2.23}_{1.71}$	1.47	40.185	40.563	10
NGC 1052 (093630101)	Nucleus**	ME2PL	–	$7.54^{9.98}_{5.20}$	$0.78^{0.89}_{0.68}$	$1.69^{1.86}_{1.50}$	1.13	39.875	41.235	–
NGC 2787 (4689)	Ring*	PL	$0.00^{0.05}_{0.00}$	–	–	$1.59^{1.92}_{1.43}$	1.05	38.82	39.23	53
NGC 2787 (0200250101)	Nucleus**	PL	–	–	–	$1.65^{1.77}_{1.54}$	1.49	39.12	39.47	–
NGC 2841 (6096)	Ring*	PL	$0.02^{0.11}_{0.00}$	–	–	$1.96^{2.45}_{1.72}$	1.09	39.54	39.60	60
NGC 2841 (0201440101)	Nucleus**	MEPL	$0.43^{0.51}_{0.00}$	–	$0.31^{0.60}_{0.19}$	$2.19^{2.34}_{1.93}$	1.41	39.73	39.77	–
NGC 4261 (9569)	Ring*	MEPL	$0.06^{0.11}_{0.03}$	$0.00^{0.04}_{0.00}$	$0.61^{0.62}_{0.59}$	$1.87^{2.07}_{1.70}$	2.07	40.663	40.252	37
NGC 4261 (0502120101)	Nucleus**	ME2PL	–	$8.29^{9.89}_{7.28}$	$0.67^{0.68}_{0.65}$	$1.56^{1.72}_{1.41}$	1.21	40.857	41.051	–
NGC 4278 (7077)	Ring*	MEPL	–	–	$0.29^{0.36}_{0.19}$	$1.61^{1.71}_{1.51}$	1.12	39.551	39.707	38
NGC 4278 (0205010101)	Nucleus**	PL	$0.02^{0.03}_{0.02}$	–	–	$2.05^{2.10}_{2.03}$	1.05	40.681	40.736	–
NGC 4374 (6131)	Ring*	MEPL	–	–	$0.54^{0.56}_{0.52}$	$2.11^{2.23}_{1.98}$	1.41	40.36	39.78	84
NGC 4374 (0673310101)	Nucleus**	MEPL	–	–	$0.71^{0.74}_{0.68}$	$1.57^{1.80}_{1.33}$	1.06	40.00	39.76	–
NGC 4494 (2079)	Ring*	ME	–	–	$4.00^{3.34}_{3.34}$	–	3.23	38.76	38.88	21
NGC 4494 (0071340301)	Nucleus**	PL	–	–	–	$1.76^{1.83}_{1.68}$	1.54	39.25	39.54	–
NGC 4736 (808)	Ring*	MEPL	–	–	$0.52^{0.54}_{0.49}$	$1.50^{1.54}_{1.47}$	1.12	39.41	39.60	84
NGC 4736 (0404980101)	Nucleus**	MEPL	–	–	$0.62^{0.65}_{0.59}$	$2.03^{2.10}_{1.97}$	0.93	39.15	39.04	–
NGC 5195 (13813)	Ring*	ME	$0.32^{0.37}_{0.27}$	–	$0.54^{0.58}_{0.50}$	–	1.35	39.00	37.18	74
NGC 5195 (0677980701)	Nucleus**	MEPL	$0.66^{0.90}_{0.41}$	–	$0.23^{0.36}_{0.14}$	$1.71^{1.95}_{1.46}$	1.11	39.17	39.14	–
NGC 5813 (9517)	Ring*	MEPL	–	–	$0.59^{0.60}_{0.58}$	$2.29^{2.47}_{2.10}$	1.55	41.08	40.22	100
NGC 5813 (0554680301)	Nucleus**	MEPL	–	–	$0.71^{0.72}_{0.70}$	$0.54^{2.15}_{0.00}$	1.78	40.85	40.05	–

Notes. (Col. 1) name and obsID in parenthesis, (Col. 2) extracted region, (Col. 3) best-fit model, (Cols. 4–8) parameters of the best-fit model, (Cols. 9 and 10) soft and hard intrinsic luminosities, and (Col. 11) the percentage of the contribution from the ring to the r_{ext} aperture *Chandra* data in the 0.5–10.0 keV band. (*) Spectral parameters of the annular region in *Chandra* data. (**) Spectral parameters of the nuclear region in *XMM-Newton* data when the spectral parameters of the ring from *Chandra* data are included in the fit.

Table A.5. Simultaneous fittings taking into account the contribution from the annular region given in Table A.4.

ObsID	N_{H1} (10^{22} cm^{-2})	N_{H2} (10^{22} cm^{-2})	kT (keV)	Γ	Norm ₁ (10^{-4})	Norm ₂ (10^{-4})	$\chi^2/\text{d.o.f.}$	$\log(L_{\text{soft}})$ (0.5–2 keV)	$\log(L_{\text{hard}})$ (2–10 keV)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NGC 315									
0305290201 4156	–	$0.86^{1.00}_{0.73}$	$0.52^{0.55}_{0.50}$	$1.85^{1.96}_{1.74}$	$0.42^{0.44}_{0.39}$	$2.38^{2.77}_{2.05}$	467.58/379	$41.44^{41.55}_{41.43}$ $41.44^{41.55}_{41.43}$	$41.54^{41.56}_{41.52}$ $41.51^{41.53}_{41.49}$
NGC 1052									
0093630101 5910	–	$6.11^{7.18}_{5.07}$	$0.68^{0.73}_{0.63}$	$1.58^{1.70}_{1.47}$	$0.48^{0.53}_{0.44}$	$1.28^{1.69}_{0.95}$	577.98/477	$40.35^{40.36}_{40.34}$ $40.35^{40.36}_{40.34}$	$41.33^{41.35}_{41.32}$ $41.27^{41.28}_{41.26}$
NGC 4261									
0502120101 9569	$0.03^{0.08}_{0.00}$	$7.64^{8.74}_{6.58}$	$0.60^{0.61}_{0.59}$	$1.55^{1.75}_{1.36}$	$0.22^{0.26}_{0.19}$	$1.53^{2.25}_{1.04}$	972.83/627	$40.84^{40.84}_{40.84}$ $40.84^{40.85}_{40.83}$	$41.03^{41.05}_{41.01}$ $40.99^{41.01}_{40.97}$
NGC 4278									
0205010101 7077	$0.03^{0.03}_{0.02}$	–	–	$2.11^{2.14}_{2.08}$	$7.74^{7.95}_{7.54}$ $1.15^{1.18}_{1.11}$	–	844.93/690	$40.71^{40.72}_{40.71}$ $39.89^{39.89}_{39.88}$	$40.71^{40.72}_{40.70}$ $39.86^{39.87}_{39.84}$
NGC 4494									
0071340301 2079	$0.00^{0.01}_{0.00}$	–	–	$1.81^{1.89}_{1.74}$	$0.36^{0.38}_{0.35}$ $0.24^{0.27}_{0.23}$	–	$117.35/86$ $39.10^{39.14}_{39.07}$	$39.26^{39.28}_{39.25}$ $41.85^{42.08}_{41.28}$	$41.85^{42.08}_{41.29}$

Notes. (Col. 1) name and obsID in parenthesis, (Col. 2–7) parameters of the best-fit model, (Col. 8) $\chi^2/\text{d.o.f.}$, and (Cols. 9 and 10) soft and hard intrinsic luminosities.

Table A.6. Statistics of the light curves.

Name (1)	ObsID (2)	Energy (3)	$\chi^2/\text{d.o.f.}$ (4)	Prob.(%) (5)	σ_{NXS}^2 (6)	$\langle\sigma_{\text{NXS}}^2\rangle$ (7)
NGC 315	4156	0.5–10	50.2/55	34	<0.0046	
		0.5–2			<0.0086	
		2–10			0.0096 ± 0.0059	
NGC 1052	0306230101	0.5–10	57.1/49	80	<0.0012	
		0.5–2			<0.0039	
		2–10			<0.0018	
	0553300301	0.5–10	49.5/46	66	<0.0012	
		0.5–2			<0.0037	
		2–10			<0.0016	
	0553300401	0.5–10	39.3/49	16	<0.0011	
		0.5–2			<0.0037	
		2–10			<0.0016	
	5910	0.5–10	48.6/59	17	<0.0046	
		0.5–2			<0.0160	
		2–10			<0.0070	
NGC 2681	2060	0.5–10 (1)	109.8/80	98	<0.0450	<0.0302
		0.5–10 (2)			<0.0403	
		0.5–2 (1)			<0.0517	<0.0344
		0.5–2 (2)			<0.0454	
		2–10 (1)			<0.3848	<0.2995
		2–10 (2)			<0.4590	
	2061	0.5–10	133.0/78	100	<0.0447	
		0.5–2			<0.0510	
		2–10			<0.5007	
NGC 2787	4689	0.5–10	33.4/30	70	<0.0357	
		0.5–2			<0.0464	
		2–10			<0.1732	
NGC 3226	860	0.5–10	51.2/45	76	0.0367 ± 0.0227	
		0.5–2			0.0838 ± 0.0649	
		2–10			<0.0784	
NGC 4261	834	0.5–10	35.8/34	62	<0.0063	
		0.5–2			<0.0079	
		2–10			<0.0306	
	9569	0.5–10 (1)	85.7/100	15	<0.0072	<0.0051
		0.5–10 (2)			<0.0072	
		0.5–2 (1)			<0.0095	<0.0068
		0.5–2 (2)			<0.0097	
		2–10 (1)			<0.0285	<0.0198
		2–10 (2)			<0.0274	
NGC 4278	7077	0.5–10 (1)	124.3/111	82	<0.0076	<0.0052
		0.5–10 (2)			<0.0070	
		0.5–2 (1)			<0.0093	<0.0062
		0.5–2 (2)			<0.0083	
		2–10 (1)			<0.0461	<0.0307
		2–10 (2)			<0.0406	
	7081	0.5–10 (1)	91.4/107	14	<0.0090	<0.0062
		0.5–10 (2)			<0.0086	
		0.5–2 (1)			<0.0109	<0.0075
		0.5–2 (2)			<0.0104	
		2–10 (1)			<0.0538	<0.0361
		2–10 (2)			<0.0482	
	7080	0.5–10	41.0/55	8	<0.0095	
		0.5–2			<0.0116	
		2–10			<0.0573	
NGC 4374	5908	0.5–10	77.8/46	97	0.0089 ± 0.0048	
		0.5–2			0.0094 ± 0.0061	
		2–10			<0.0540	
	6131	0.5–10	38.1/39	49	<0.0278	
		0.5–2			<0.0325	
		2–10			<0.1785	

Notes. (Col. 1) name, (Col. 2) obsID, (Col. 3) energy band in keV, (Cols. 4 and 5) $\chi^2/\text{d.o.f.}$ and the probability of being variable in the 0.5–10.0 keV energy band of the total light curve, (Col. 6) normalized excess variance, σ_{NXS}^2 , and (Col. 8) the mean value of the normalized excess variance, $\langle\sigma_{\text{NXS}}^2\rangle$, for each light curve and energy band.

Appendix B: Notes and comparisons with previous results for individual objects

B.1. NGC 315

NGC 315 is a radio galaxy located in the Zwicky cluster 0107.5+3212. It was classified optically as a type 1.9 LINER by Ho et al. (1997) and as an AGN candidate at X-ray frequencies (González-Martín et al. 2009b).

At radio frequencies (VLBI and VLA) the galaxy shows an asymmetric morphology, with a compact nuclear emission and a one-sided jet (Venturi et al. 1993). The jet can also be observed in X-rays (see Appendix C). Using VLA data, Ishwara-Chandra & Saikia (1999) did not find significant variability over a timescale of ~ 12 years.

In X-rays, it was observed twice with *Chandra* in 2000 and 2003 and once with *XMM-Newton* in 2005. Younes et al. (2011) found variations in Γ (from $1.5^{+0.1}_{-0.2}$ to $2.1^{+0.1}_{-0.2}$), and a decreasing in the hard luminosity of 53% between 2003 and 2005. They included the emission of the jet in *XMM-Newton* data to derive the nuclear spectral parameters. With the same data set, we obtained very similar individual spectral fittings and luminosities (see Tables A.2 and A.3 for *Chandra* data and Table A.4 for the nuclear region in *XMM-Newton* data). However, we do not find spectral variations, since SMF0 was used both for *Chandra* data and when comparing *Chandra* and *XMM-Newton*. The difference found with the results reported by Younes et al. (2011) might be due to the different errors. A large set of X-ray observations would be desirable to obtain conclusive results.

XMM-Newton data were used to study short-term variations. From its PSD analysis, González-Martín & Vaughan (2012) did not find them in any of the energy bands (soft, hard, total). From the light curve in the 0.5–10 keV energy band, Younes et al. (2011) reported no variations. We found $\sigma^2_{\text{NXS}} > 0$ at 1.6σ confidence level in the 2–10 keV energy band, consistent with no variability.

At UV frequencies, Younes et al. (2012) derived the luminosities from the OM onboard *XMM-Newton* with UVM2 and UVM2 filters that agree with our results. Variability cannot be studied since OM data are only available at one epoch.

B.2. NGC 1052

This is the brightest elliptical galaxy in the Cetus I group. Previously classed as a LINER in the pioneering work by Heckman (1980), it was classified optically as a type 1.9 LINER (Ho et al. 1997) and as an AGN candidate at X-ray frequencies (González-Martín et al. 2009b). VLA data show a core-dominated and a two-sided jet structure at radio frequencies (Vermeulen et al. 2003).

NGC 1052 was observed twice with *Chandra* and five times with *XMM-Newton*. Long-term variability studies are not found in the literature. We find variations caused by the nuclear power, Norm₂ (49%) and the column density, $N_{\text{H}2}$ (31%), both at hard energies, in an eight-year period.

González-Martín & Vaughan (2012) studied short term variations from the PSD with *XMM-Newton* data and did not find variations in any of the energy bands. We analyzed *Chandra* and *XMM-Newton* light curves and found no variations. Short-term variations were previously studied with other instruments; Guainazzi et al. (2000) studied *BeppoSAX* data and did not find short-term variations. The most recent observation in X-rays reported so far is a 100 ks observation taken with *Suzaku* in 2007, the derived spectral characteristics reported by

Brenneman et al. (2009) appear to be similar to those from *XMM-Newton*, which are compatible with the values in González-Martín et al. (2009b), Brightman & Nandra (2011), and this paper (intrinsic luminosity of $\log(L(2-10 \text{ keV})) \sim 41.5$), and no variations along the observation.

In the UV range, Maoz et al. (2005) studied this galaxy with HST ACS and found a decrease by factor of 2 in the flux of the source between the 1997 data reported by Pogge et al. (2000) and their 2002 dataset. We found UV flux variations of a factor of 1.3 using XMM-OM data in a seven-month period.

B.3. NGC 1961

NGC 1961 is one of the most massive spiral galaxies known (Rubin et al. 1979). It was classified as a type 2 LINER by Ho et al. (1997). MERLIN and EVN data show a core plus two-sided jet structure for this source at radio frequencies (Krips et al. 2007), which makes it a suitable AGN candidate.

This galaxy was observed once with *Chandra* in 2010 and twice with *XMM-Newton* in 2011. X-ray variability from these data was not studied before. We did not find variations in a one-month period.

No information in the UV is found for this object in the literature.

B.4. NGC 2681

The nucleus of this galaxy was optically classified as a type 1.9 LINER (Ho et al. 1997). Classified as an AGN and as a Compton-thick candidate in X-rays (González-Martín et al. 2009b,a), a nuclear counterpart at radio frequencies has not been detected (Nagar et al. 2005).

The source was observed twice with *Chandra* in January and May 2001. Younes et al. (2011) did not find short-term variations from the analysis of the light curves or long-term variations from the spectral analysis. These results agree with our variability analysis.

At UV frequencies, no variations were found (Cappellari et al. 1999).

B.5. NGC 2787

The nucleus of NGC 2787 is surrounded by diffuse emission extending up to $\sim 30''$ (Terashima & Wilson 2003). It was optically classified as a type 1.9 LINER (Ho et al. 1997) and as an AGN candidate at X-ray frequencies (González-Martín et al. 2009b).

Nagar et al. (2005) detected a radio core with VLA, while evidence of a jet structure has not been found in the literature. Flux variations were obtained at 2 and 3.6 cm on timescales of months (Nagar et al. 2002).

In X-rays, this galaxy was observed twice with *Chandra* in 2000 (snapshot) and 2004 and once with *XMM-Newton* in 2004. Younes et al. (2011) found this to be a non-variable object at long-timescales after correcting *XMM-Newton* data from contamination of X-ray sources. Because of the high contamination from the extranuclear emission in *XMM-Newton* data, we did not perform a simultaneous fit for this object.

From one *Chandra* light curve, Younes et al. (2011) calculated an upper limit of σ^2_{NXS} , with which our value agrees.

No UV data are found in the literature.

B.6. NGC 2841

Ho et al. (1997) optically classified NGC 2841 as a type 2 LINER. It was classified as an AGN candidate at X-ray frequencies by González-Martín et al. (2009b). This galaxy shows some X-ray sources in the surroundings (González-Martín et al. 2009b). A core structure was found with VLA by Nagar et al. (2005), without evidence of any jet structure.

NGC 2841 was observed twice with *Chandra* in 1999 (snapshot) and 2004 and once with *XMM-Newton* in 2004. We did not use in the analysis the snapshot *Chandra* data because it does not have a high enough count rate for the spectral analysis. Moreover, since the extranuclear emission in *Chandra* data contributed with 60% in the 0.5–10.0 keV energy band, we cannot analyze the spectral variations in this source. No information on variability is reported in the literature for this source.

B.7. NGC 3226

NGC 3226 is a dwarf elliptical galaxy that is strongly interacting with the type 1.5 Seyfert NGC 3227, located at 2' in projected distance (see Fig. C.19 in González-Martín et al. 2009b). NGC 3226 was optically classified by Ho et al. (1997) as a type 1.9 LINER, and as an AGN candidate at X-ray frequencies by González-Martín et al. (2009b). A compact source is detected with VLA (Nagar et al. 2005), without evidence of any jet structure.

This galaxy was observed twice with *Chandra* in 1999 and 2001 and four times with *XMM-Newton* from 2000 to 2006. The possible contamination of NGC 3227 prevents an analysis of long-term variations. We refer to HG13 for details on this subject.

We analyzed one *Chandra* light curve and obtained $\sigma_{\text{NXS}}^2 > 0$ below 2σ , consistent with no short-term variations.

UV variations are not found in the literature. We found 11% variations in the *UVW1* filter from OM data.

B.8. NGC 3608

NGC 3608 is a member of the Leo II group, which forms a non-interacting pair with NGC 3607. It was optically classified as a type 2 LINER (Ho et al. 1997). No hard nuclear point source was detected in *Chandra* images (González-Martín et al. 2009b), thus it was classified in X-rays as a non-AGN candidate, and also it appears to be a Compton-thick candidate (González-Martín et al. 2009a). A compact nuclear source at radio frequencies has not been detected (Nagar et al. 2005).

This galaxy was observed once with *Chandra* and twice with *XMM-Newton* in 2000 and 2012. Variability studies are not found at any frequency in the literature. We did not find variations in the 12-year period analyzed.

B.9. NGC 3718

NGC 3718 has a distorted gas and a dusty disk, maybe caused by the interaction with a close companion (Krips et al. 2007). It was optically classified as a type 1.9 LINER (Ho et al. 1997). It shows a point-like source in the 4.5–8.0 keV energy band (see Fig. B.1), and therefore we can classify it as an AGN candidate following González-Martín et al. (2009b).

At radio frequencies, NGC 3718 was observed with the VLA by Nagar et al. (2005), and with *MERLIN* at 18 cm by Krips et al. (2007), where it shows a core and a compact jet.

Fig. B.1. *Chandra* image in the 4.5–8.0 keV energy band of NGC 3718, where a point-like source can be distinguished.

Nagar et al. (2002) reported radio variability at 2 cm with VLA data, although the result “is not totally reliable”.

In X-rays, this galaxy was observed once with *Chandra* in 1999 and twice with *XMM-Newton* in 2004. Younes et al. (2011) studied all the available data for this object and reported it as variable. When jointly fit *Chandra* and *XMM-Newton* data, we found spectral variations in Norm₂ (37%).

Younes et al. (2011) did not find short-term variations from the analysis of the light curves. We did not analyze short-term variations because the length of the observations is <30 ks.

At UV frequencies, Younes et al. (2012) studied this galaxy with *XMM-Newton*, but the nucleus was not detected, so they estimated upper limits for the flux in one epoch.

B.10. NGC 4261

Ho et al. (1997) optically classified this galaxy as a type 2 LINER. González-Martín et al. (2009b) classified it as an AGN candidate at X-ray frequencies. NGC 4261 contains a pair of symmetric kpc-scale jets (Birkinshaw & Davies 1985) and a nuclear disk of dust roughly perpendicular to the radio jet (Ferrarese et al. 1996).

It was observed twice with *Chandra*, in 2000 and 2008, and with *XMM-Newton* in another three epochs from 2001 to 2007. Long-term variability studies are not found in the literature. We did not find variations in six years period.

Sambruna et al. (2003) found variations of 3–5 ks in the 2–10 keV and 0.3–8.0 keV energy bands in the light curve from 2001, and argued in favor of these variations being more closely related to the inner X-ray jet than to an advection-dominated accretion flow (ADAF), since the expected timescale for the light-crossing time of an ADAF was ~ 2 orders of magnitude longer than the observed variability timescale. In HG13 we analyzed the same observation in the 0.5–10 keV band and reported it as non-variable. However, we notice that $\sigma_{\text{NXS}}^2 = 0.109 \pm 0.099$ at 1σ confidence level. In the present paper we did not analyze this light curve since the net exposure time is shorter than 30 ks. Other light curves were studied. González-Martín & Vaughan (2012) did not find short-term variations from the PSD analysis of *XMM-Newton* data. In the present study we analyzed two *Chandra* observations and cannot confirm rapid variations in this source, since upper limits for the σ_{NXS}^2 were obtained in both cases.

No information from the UV is found in the literature. We found variation of a 10% (33%) in the *UVW1*(*UVW2*) filter.

B.11. NGC 4278

The north-northwest side of NGC 4278 is heavily obscured by large-scale dustlanes, whose distribution shows several dense knots interconnected by filaments (Carollo et al. 1997). It is an elliptical galaxy with a relatively weak, broad H_α line, which caused Ho et al. (1997) to classify it optically as a type 1.9 LINER. It was classified at X-ray frequencies as an AGN candidate (González-Martín et al. 2009b).

A two-sided jet is observed at radio frequencies with VLBA and VLA (Giroletti et al. 2005). Nagar et al. (2002) reported radio variability at 2 and 3.6 cm with VLA data. However, these results “are not totally reliable”.

In X-rays this galaxy was observed on nine occasions with *Chandra* from 2000 to 2010 and once with *XMM-Newton* in 2004. Brassington et al. (2009) used six *Chandra* observations and found 97 variable sources within NGC 4278, in a 4' elliptical area centered on the nucleus, none of them within the aperture we used for the nuclear extraction. Pellegrini et al. (2012) studied *Chandra* observations of NGC 4278 and found an X-ray luminosity decrease by a factor of ~ 18 between 2005 and 2010. Younes et al. (2010) detected a factor of ~ 3 flux increase on a timescale of a few months and a variation of a factor of 5 between the faintest and brightest observations (separated by about three years). We used three of these observations (others were affected by pileup or did not meet the minimum count number), and found that our spectral fittings agreed well with theirs, although we found weaker variations in luminosities.

While the different *Chandra* observations did not show short-term variability, during the *XMM-Newton* observation Younes et al. (2010) found a flux increase of a 10% in few hours. With the same dataset, HG13 obtained a 3% variation in the same time range, the difference being most probably due to the different apertures used for the analysis (10'' vs. 25'').

In the UV, Cardullo et al. (2008) found that the luminosity increased by a factor of 1.6 in about six months using data from *HST* WFPC2/F218W.

B.12. NGC 4374

NGC 4374 is one of the brightest giant elliptical galaxies in the center of the Virgo cluster. Optically classified as a type 2 LINER (Ho et al. 1997), at X-ray frequencies it is a Compton-thick AGN candidate (González-Martín et al. 2009a,b).

It shows a core-jet structure at radio frequencies, with two-sided jets emerging from its compact core (Xu et al. 2000). Nagar et al. (2002) reported flux variations at 3.6 cm with VLA, and variations at 2 cm that “are not fully reliable”.

This galaxy was observed four times with *Chandra*, twice in 2000 (ObsID 401 is a snapshot) and twice in 2005, and once with *XMM-Newton* in 2011. No information about variability in X-ray or UV is found in the literature. Here we report strong variations at hard energies (73% in Norm₂).

We analyzed two *Chandra* light curves, one of them with $\sigma^2_{\text{NXS}} > 0$ below 2σ confidence level, which is compatible with no variations.

B.13. NGC 4494

NGC 4494 is an elliptical galaxy located in the Coma I cloud. It was optically classified as a type 2 LINER (Ho et al. 1997), and at X-rays as an AGN candidate (González-Martín et al. 2009b). The nucleus of this galaxy was not detected in radio with VLA data (Nagar et al. 2005).

This galaxy was observed twice with *Chandra* in 1999 (snapshot) and 2001 and once with *XMM-Newton* in 2001. Variability analyses are not found in the literature. We report the source as variable at X-ray frequencies.

B.14. NGC 4636

NGC 4636 was optically classified as a type 1.9 LINER by Ho et al. (1997). At X-rays it does not show emission at hard energies and therefore was classified as a non-AGN candidate (González-Martín et al. 2009b). It was also classified as a Compton-thick candidate (González-Martín et al. 2009a).

At radio frequencies, it shows a compact core with VLA data (Nagar et al. 2005). Recently, Giacintucci et al. (2011) found bright jets at radio frequencies. No variations were found at 2 cm with VLA data (Nagar et al. 2002).

This galaxy was observed four times with *Chandra* data between 1999 and 2003, and three times with *XMM-Newton* between 2000 and 2001. O'Sullivan et al. (2005) studied the X-ray morphology of the galaxy and suggest that it can be the result of a past AGN that is actually quiescent. Long-term variations were not found in the present analysis.

González-Martín & Vaughan (2012) did not find short-term variations from the analysis of *XMM-Newton* light curves. From one *XMM-Newton* light curve, we found $\sigma^2_{\text{NXS}} > 0$ at 1.4σ confidence level. We did not find long term variations.

No UV variability studies are found in the literature. Our analysis lets us conclude that it is variable at UV frequencies.

B.15. NGC 4736

NGC 4736 is a Sab spiral galaxy, member of the Canes Venatici I cloud (CVn I) (de Vaucouleurs 1975). Optically classified as a type 2 LINER (Ho et al. 1997), it is an AGN candidate at X-ray frequencies (González-Martín et al. 2009b). Nagar et al. (2005) reported an unresolved nuclear source at its nucleus, using 0.15'' resolution VLA data, without evidence of any jet structure.

This galaxy was observed three times with *Chandra* between 2000 and 2008 and three times with *XMM-Newton* between 2002 and 2006. No long-term variability information is found in the literature. In the present work we did not find any variation in a four-year period.

It harbors a plethora of discrete X-ray sources in and around its nucleus (see Appendix C). Eracleous et al. (2002) studied *Chandra* data from 2000. They found a very dense cluster of ten discrete sources in the innermost 400×400 pc of the galaxy. They studied the brightest four sources (namely X-1 to X-4) and found that spectra are well described by a single power-law with photon indices in the range 1.1–1.8, and 2–10 keV luminosities between $4\text{--}9 \times 10^{39}$ erg s⁻¹. They also studied short-term variability from the analysis of the light curves. They estimated the normalized excess variance ($\sigma^2 = 0.06 \pm 0.04$) of the nucleus of NGC 4736 (X-2), and reported it as variable. The other sources also showed short-term variations (see Table 5 in Eracleous et al. 2002). They argued that there is no evidence for the presence of an AGN and concluded that this LINER spectrum could be the result either of a current or recent starburst or of an AGN.

Fig. B.2. *Chandra* image of NGC 5195 in the 4.5–8.0 keV energy band, where a point-like source can be distinguished.

However, they noted that X-2 is the only source with an UV counterpart detected by HST. [González-Martín et al. \(2009b\)](#) assigned X-2 to the nucleus of the galaxy, since it coincides with the 2MASS near-IR nucleus within $0.82''$.

By studying *BeppoSAX* and *ROSAT* data, [Pellegrini et al. \(2002\)](#) excluded variations of the 2–10 keV flux higher than ~50% on timescales on the order of one day. Comparing data from both instruments, they did not find variations between 1995 and 2000. They concluded that the X-ray emission is caused by a recent starburst in NGC 4736. However, they mentioned that an extremely low-luminosity AGN could still be present, because of a compact nonthermal radio source that is coincident with an X-ray faint central point source.

[González-Martín & Vaughan \(2012\)](#) studied the PSD of the *XMM-Newton* data from 2006 and found no short-term variations.

We analyzed *Chandra* and *XMM-Newton* light curves. Variations were found, but were throughout below the 2σ confidence level, in agreement with [Eracleous et al. \(2002\)](#).

At UV frequencies, [Maoz et al. \(2005\)](#) found long-term variations between 1993 and 2003, the nucleus being 2.5 times brighter in 2003. From the OM data, we found variations of 66% in the *U* filter between 2002 and 2006.

B.16. NGC 5195

NGC 5195 is tidally interacting with a companion SB0 galaxy NGC 5194 (M51). It was optically classified as a type 2 LINER by [Ho et al. \(1997\)](#). It shows a point-like source in the 4.5–8.0 keV energy band (see Fig. B.2), and therefore we can classify it as an AGN candidate following [González-Martín et al. \(2009b\)](#). A radio counterpart was found by [Ho & Ulvestad \(2001\)](#) with VLA data at 6 and 20 cm, without any jet indications.

This source was observed eight times with *Chandra* between 2000 and 2012 and five times with *XMM-Newton* between 2003 and 2011. [Terashima & Wilson \(2004\)](#) studied *Chandra* data from 2000 and 2001 and found neither long term, nor short-term variability in the full, soft, or hard energy bands. Since the *Chandra* observations from 2000 and 2001 were rejected from our sample because of the low number counts, we cannot compare our spectral fittings with theirs. However, our estimate of the luminosity in *Chandra* data agrees with their results. We found this object to be variable on long-timescales, while short-term variations were not detected.

At UV frequencies, no references are found in the literature. We found variations in the *UVW1* filter.

B.17. NGC 5813

NGC 5813 is one of the galaxies in the group catalog compiled by [de Vaucouleurs \(1975\)](#), with NGC 5846 being the brightest member of the group. It was classified as a type 2 LINER by [Ho et al. \(1997\)](#). The X-ray morphology is extremely diffuse, with very extended emission at softer energies and without emission above 4 keV, which caused [González-Martín et al. \(2009b\)](#) to classify it as a non-AGN candidate. It was also classified as Compton-thick candidate ([González-Martín et al. 2009a](#)). At radio frequencies, it shows a compact core ([Nagar et al. 2005](#)) and a jet-like structure ([Randall et al. 2011](#)).

This source was observed nine times with *Chandra* between 2005 and 2011 and three times with *XMM-Newton* between 2005 and 2009. Variability studies at X-ray and UV frequencies are not reported in the literature. We did not find either long-term or short-term variations in X-rays. UV variations were found in the *UVW1* filter.

B.18. NGC 5982

NGC 5982 is the brightest galaxy in the LGG 402 group, which is composed of four members ([Garcia 1993](#)). Recently, [Vrtilek et al. \(2013\)](#) found a compact radio core in the position of the source using *GMRT* 610 MHz observations, which indicates that this is an AGN-like object; jets were not detected.

This galaxy was observed twice with *XMM-Newton* in 2011 and 2012. Variability studies are not reported in the literature. We found variations in the nuclear power (50%) in a one-year period, while UV variations were not found.

Appendix C: Images

In this appendix we present the images from *Chandra* (left) and *XMM-Newton* (right) that were used to compare the spectra from these two instruments in the 0.5–10 keV band. In all cases, the gray levels extend from twice the value of the background dispersion to the maximum value at the center of each galaxy.

Fig. C.1. Images for *Chandra* data (left) and *XMM-Newton* data (right) for the sources in the 0.5–10 keV band. Big circles represent *XMM-Newton* data apertures. Small circles in the figures to the left represent the nuclear extraction aperture used with *Chandra* observations (see Table A.1).

Fig. C.1. continued.

Fig. C.1. continued.

Fig. C.1. continued.

Appendix D: Light curves

In this appendix the plots corresponding to the light curves are provided. Three plots per observation are presented, corresponding to soft (left), hard (middle), and total (right) energy bands. Each light curve has a minimum of 30 ks (i.e., 8 h) exposure time, while long light curves are divided into segments of 40 ks (i.e., 11 h). Each segment is enumerated in the title of the light curve. Count rates versus time continua are represented. The solid line represents the mean value, dashed lines the $\pm 1\sigma$ from the average.

Fig. D.1. Light curves of NGC 315 from *Chandra* data.

Fig. D.2. Light curves of NGC 1052 from *XMM-Newton* data.

Fig. D.3. Light curves of NGC 1052 from *Chandra* data.

Fig. D.4. Light curves of NGC 2681 from *Chandra* data. Note that ObsID. 2060 is divided into two segments.

Fig. D.5. Light curves of NGC 2787 from *Chandra* data.

Fig. D.6. Light curves of NGC 3226 from *Chandra* data.

Fig. D.7. Light curves of NGC 4261 from *Chandra* data. Note that ObsID. 9569 is divided into two segments.

Fig. D.8. Light curves of NGC 4278 from *Chandra* data. Note that ObsID. 7077 and 7081 are divided into two segments.

Fig. D.8. continued.

Fig. D.9. Light curves of NGC 4374 from *Chandra* data.

Fig. D.10. Light curves of NGC 4636 from *XMM-Newton* data.

Fig. D.11. Light curves of NGC 4736 from *XMM-Newton* (top) and *Chandra* (bottom) data.

Fig. D.12. Light curves of NGC 5195 from *Chandra* data. Note that ObsID. 13813 is divided into four segments and ObsID. 13812 into three segments.

Fig. D.12. continued.

Fig. D.13. Light curves of NGC 5813 from *Chandra* data. Note that ObsID. 9517 and 13253 are divided into two segments.

Fig. D.13. continued.

Fig. D.13. continued.