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Study of Ultraluminous X-ray Sources in Some Nearby Galaxies

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Abstract: We present the results of the spectral and temporal analysis of eight X-ray point sources in five nearby (distance $<$ 20 Mpc) galaxies observed with *Chandra*. For spectral analysis, an absorbed powerlaw and an absorbed diskblackbody were used as empirical models. Six sources were found to be equally fitted by both the models while two sources were better fitted by the powerlaw model. Based on model parameters, we estimate the X-ray luminosity of these sources in the energy range $0.3 - 10.0$ keV, to be of the order of $\sim 10^{39} ergs\ s^{-1}$ except for one source (X-8) with $L_X > 10^{40} ergs\ s^{-1}$. Five of these maybe classified as Ultraluminous X-ray sources (ULXs) with powerlaw photon index within the range, $\Gamma \sim 1.63 - 2.63$ while the inner disk temperature, kT $\sim 0.68 - 1.93$ keV, when fitted with the disk blackbody model. The black hole masses harboured by the X-ray point sources were estimated using the disk blackbody model to be in the stellar mass range, however, the black hole mass of one source (X-6) lies within the range $68.37 M_\odot \leq M_{BH} \leq 176.32 M_\odot$, which at the upper limit comes under the Intermediate mass black hole range. But if the emission is considered to be beamed by a factor ~ 5, the black hole mass reduces to $\sim 75 M_\odot$. The timing analysis of these sources does not show the presence of any short term variations in the kiloseconds timescales.

Key words: galaxies: general — X-rays: binaries

1. Introduction

Ultraluminous X-ray Sources (ULXs) are a peculiar class of extra galactic, point-like and off-nuclear X-ray sources with isotropic luminosity higher than $10^{39} ergs\ s^{-1}$ (Miller et al. 2004; Kaaret et al. 2017). The Einstein Observatory was the first to obtain resolved images of external galaxies that led to the discovery of ULXs (Fabbiano 1989). A large number of these sources have been discovered now with advanced satellites like Chandra and XMM-Newton (Swartz et al. 2004; Devi et al. 2007). The superior anglular resolution of Chandra allows for a detailed study and understanding of these sources. ULX population studies have revealed that they are most often found in actively star-forming galaxies (Kaaret et al. 2001). Statistically most of the ULXs exist in starbust galaxies than in spiral galaxies (Kilgard et al. 2005). The X-ray luminosity of ULXs are found to exceed the Eddington luminosity of a 10 $M_\odot$ black hole (Makishima et al. 2000). A detailed study of the X-ray spectra and variability properties of these sources suggest that they are accreting compact objects in binary systems (Urquhart et al. 2018). Several models have been proposed to explain the high X-ray luminosities of ULXs. These high luminosities can be explained as due to sub-Eddington accretion on to Intermediate Mass Black Holes (IMBHs) with masses $M_{BH} \sim 10^2 - 10^4 M_\odot$, between those of stellar mass black holes found in Galactic X-ray binaries and supermassive black holes associated with active galactic nuclei (AGN) (Farrell et al. 2009; Pasham et al. 2014). ULX-7 in the galaxy M51 was reported by Earnshaw et al. (2016) to be an IMBH accreting in the hard state with powerlaw photon index around 1.5. Spectral analysis of two ULXs in NGC 1313 revealed the presence of a cool accretion disk component, giving evidence for IMBHs (Miller et al. 2003). Similar results are also found from the spectral analysis of the ULX X-9 in M81 (Miller et al. 2004). Alternatively, it may also be explained as a stellar mass BH accreting at or close to the Eddington limit (Middleton et al. 2015; Roberts et al. 2016). Sutton et al. (2013) reported an ULX in NGC 5907 to be consistent with stellar mass BHs ($\geq 20 M_\odot$) accreting at a super-Eddington rate. Singha & Devi 2017 studied the spectral properties of the X-ray point sources in the galaxy NGC 5643 and NGC 7457 and reported the discovery of three ULXs (X-1, X-2, X-3) in the galaxy NGC 5643 and one ULX (X-5) in the galaxy NGC 7457 in hard state with powerlaw photon index, $\Gamma \sim 1.42 - 1.86$. ULXs X-1 and X-3 were found to be accreting at a sub-Eddington rate on to stellar mass BHs whereas X-2 and X-5 accreting at a super-Eddington rate on to stellar mass BHs.

The high X-ray luminosities of the ULXs may either result from viewing a significantly anisotropic radiation pattern at a favorable angle, or be genuinely super-Eddington or both. This form of 'beaming' need not involve relativistic effects although Markoff et al. (2001) and Kording et al. (2002) have suggested that Doppler boosting in a relativistic jet could explain the high luminosities of ULXs. Hyperluminous X-ray Sources (HLXs, $L_X \geq 10^{41} ergs\ s^{-1}$) are thought to be amongst the strongest IMBHs candidates (Matsumoto et al. 2004). For HLXs to produce such high luminosities while accreting at a sub-Eddington, these sources

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Table 1
Observation log of the sample galaxies

Galaxy	Distance (Mpc)	Obs. Year	Obs. ID	Exposure (ks)
NGC 4212	15.3 [a]	2017	19395	15.00
NGC 4382	16.6 [b]	2017	20014	52.49
	16.6 [b]	2017	20013	32.00
	16.6 [b]	2017	20012	26.40
	16.6 [b]	2017	19331	22.10
	16.6 [b]	2001	2016	43.00
NGC 6015	13.9 [c]	2017	19349	10.00
NGC 5585	7.0 [d]	2017	19348	05.00
	7.0 [d]	2006	7150	05.20
NGC 4536	17.7 [e]	2017	19387	05.20

References: (*a*) Sanders et al. 2003 (*b*) Swartz et al. 2004 (*c*) Montenegro et al. 1997 (*d*) Matonick & Fesen 1997 (*e*) Saha et al. 2006

are required to host BHs of masses greater than $10^3 M_\odot$ (Sutton et al. 2012). This is strongly supported by the discovery of HLX-1 on the outskirts of the edge-on spiral galaxy ESO 243-49 with a peak luminosity of the order of $10^{42} ergs\ s^{-1}$ in the intermediate-mass range of $3000 M_\odot < M < 3 \times 10^5 M_\odot$ (Godet et al. 2012).There are models suggesting that ULXs form a bright and shortlived but common phase in the evolution of stellar mass X-ray binaries. However only a few such transient ULXs are known due to the lack of repeated X-ray observations over a prolonged period of time. Transient ULXs cross the luminosity of Galactic Black Hole X-ray binaries during their rise and decay. So the study of such sources can establish a relation with the ordinary stellar-mass black hole X-ray binaries (BHBs) in terms of spectral and temporal properties, or the existence of a different type of accretion phenomenon. Two low-luminosity transient ULXs were discovered in M31 (Middleton et al. 2012, 2013) the study of which led to the conclusion that many low-luminosity ULXs are stellar mass BHBs.

In this paper we present the study of the spectral properties of eight X-ray point sources in five nearby galaxies. We also analyse the temporal properties of these sources to check for the presence of variability in kilo-seconds timescale. We present the details of the observations and the methods to perform the data reduction and analysis process in Section 2. In Section 3, we present the results of spectral and temporal analysis and discuss the nature of the X-ray point sources. We present the summary in Section 4.

2. OBSERVATIONS AND DATA ANALYSIS

The data used in this work were obtained from the public data archive of *Chandra* X-ray center. We select five nearby galaxies (distance < 20Mpc) which were observed by the Chandra *Advanced CCD Imaging Spectrometer (ACIS)* and recently archived in the public domain. Previous Chandra observations of these five galaxies were also checked and included in the study as per availability. The observational details of the galaxies are shown in Table 1. Chandra Interactive Analysis of Observations (CIAO) version-4.8 is used to perform the data reduction and Heasoft-6.18 is used for the analysis. The CIAO source detection tool WAVDETECT is used to extract the list of X-ray point sources from the level 2 event lists. Sources having larger data counts can be constrained properly using a two-parameter model. Hence only those sources having data counts above 100 are selected for the present work. The background regions were extracted as source-free regions near the corresponding sources. The source and background spectra are generated using a combination of CIAO tools and calibration data. The spectra are grouped and binned using Heasoft tool *grppha*. Spectral analysis is performed using the spectral fitting package XSPEC version 12.9.0. Two spectral fitting models- the absorbed powerlaw and the absorbed disk blackbody, are used. Absorption is taken into account by using the XSPEC model phabs. Cash-statistics (C statistics) is used for the analysis as some of the sources were of low count($\sim$ 100). However for the relatively higher count sources, both C statistics and χ^2 statistics were checked and the results were found to be consistent with each other. Goodness of fit is determined by $cstat/(degrees\ of\ freedom) \sim 1$. If the C-statistic difference between the two models is greater than 2.7, then the better fit to the data is determined by the model having the closest value of $cstat/degrees\ of\ freedom \sim 1$, as adopted by Devi et al. (2007). If a source can be explained by both the models, then the lower value of the estimated luminosities from the two models is chosen.

As the black hole masses of ULXs cannot be measured directly, an indirect estimation can be made using the spectral properties of these sources. Using the disk blackbody model, the inner disk radius, R_{in}, is calculated from the normalization of the disk blackbody component (taking the values of viewing angle, cosi = 0.5 and color factor, f = 1.7) and then the black hole mass (M) harboured by a ULX can be estimated by assuming $R_{in} \sim 10GM/c^2$ (Devi et al. 2008; Devi & Singh 2014).

For all the 8 sources light curves at different time binnings were also extracted by using *dmextract* tool from CIAO and then timing analysis is performed to check for any signature of the sources varying in kilo seconds (ks) time scale.

3. RESULTS

3.1. Spectral Analysis

We identify eight X-ray point sources having counts above 100 from the sample of five galaxies with characteristics as shown in Table 2. The source positions were compared with the NASA/IPAC Extragalactic Database (NED) coordinates of the galactic center to exclude any potential AGNs. All the sources are located in regions of low diffuse emission and have net count rate $< 0.05\ count\ s^{-1}$ and hence are not affected by pileup in Chandra detectors. We fitted the spectral data in the energy range $0.3 - 10.0$ keV using the two spectral fitting models- the absorbed powerlaw and

Table 2
Characteristics of the point sources

Source Name	Galaxy Name	R.A., Dec. (hh min sec, deg arcmin arcsec)	Off-nuclear Distance (arcsec)	Data Counts	Count Rate
X-1	NGC 4212	12 15 39.58, 13 53 42.19	23.64	152	0.009916
X-2	NGC 4382	12 25 17.19, 18 13 46.53	170.21	391 (Obs ID 20014)	0.006863
				491 (Obs ID 2016)	0.001049
X-3	NGC 4382	12 25 17.65, 18 13 49.94	168.18	155	0.002665
X-4	NGC 6015	15 51 28.66, 62 20 05.06	91.68	109	0.010660
X-5	NGC 5585	14 19 39.37, 56 41 37.75	145.81	131 (Obs ID 19348)	0.019440
				250 (Obs ID 7150)	0.004397
X-6	NGC 4536	12 34 36.93, 02 08 51.22	207.16	138	0.007308
X-7	NGC 4536	12 34 26.16, 02 11 22.28	14.59	114	0.007315
X-8	NGC 4536	12 34 33.63, 02 13 11.63	150.20	309	0.018670

the absorbed disk blackbody model. The spectra of the point sources fitted with the powerlaw model and the disk blackbody model are shown in Figure 1 and Figure 2 respectively. The spectral parameters of the point sources are given in Table 3. In what follows, we shall consider each of the sources in turn.

3.1.1. NGC 4212

NGC 4212 is an elliptical galaxy observed by Chandra in 2017 (Obs ID 19395). A point source (X-1) having 152 counts was detected in this observation. The spectrum of this source can be fitted by both the models. The X-ray luminosity of X-1 was estimated to be $7.79 \times 10^{39} ergs\ s^{-1}$ in the energy range $0.3 - 10.0$ keV with a hard powerlaw photon index, $\Gamma \sim 1.97$. The bolometric luminosity was determined to be $9.17 \times 10^{39} ergs\ s^{-1}$ with an inner disk temperature, kT $\sim$ 1.28 keV, thereby suggesting that this source to be a newly detected Ultraluminous X-ray source candidate in the hard state. Based on the disk blackbody spectral fit, we estimate the black hole mass harboured by this ULX to be in the stellar mass black hole range, $M_{BH} \sim 31.62^{+19.89}_{-22.01} M_{\odot}$ accreting at its super-Eddington rate.

3.1.2. NGC 4382

Chandra ACIS-S has observed the galaxy NGC 4382 five times: four times in 2017 and once in 2001. For the analysis, we selected the data from 2001 (Obs ID 2016) and the data with higher exposure from 2017 (Obs Id 20014). Two point sources (X-2, X-3) from Obs ID 20014 and one source (equivalent to X-2 of Obs ID 20014) having counts greater than 100 were obtained. X-2 is a previously well studied source while X-3 is a newly detected source. The powerlaw model estimates the X-ray luminosity of X-2 to be $L_X \sim 3.97 \times 10^{39} ergs\ s^{-1}$ within the energy range $(0.3 - 10.0)$ keV with $\Gamma \sim 2.29$ in the year 2017 which within its uncertainty limits are nearly similar to the observation in 2001 (**?**). If explained by the disk blackbody model, the bolometric luminosity of X-2 is estimated to be $L_X \sim 4.94 \times 10^{39} ergs\ s^{-1}$ with inner disk temperature, kT $\sim$ 0.81 keV in 2017 which appears to have slightly decreased from $L_X \sim 6.35 \times 10^{39} ergs\ s^{-1}$ in 2001 with a relatively soft inner disk temperature, kT $\sim$ 0.68 keV. From the ObsID 20014, it is observed that X-2 is accreting at a sub-Eddington rate harbouring a black hole of mass $M_{BH} \sim 58.05^{+12.62}_{-9.79}$ while from ObsID 2016, $M_{BH} \sim 92.33^{+18.30}_{-14.85} M_{\odot}$. The X-ray luminosity of X-3, estimated by both the models is found to be of the order of $\sim 10^{39} ergs\ s^{-1}$ with powerlaw photon index, $\Gamma \sim 2.51$ and the inner disk temperature, kT $\sim$ 0.96 keV. The spectral properties suggest X-3 to be another ULX detected in the galaxy NGC 4382. The black hole mass estimated by the disk blackbody model is in the stellar mass black hole range, $M_{BH} \sim 29.98^{+28.05}_{-16.27} M_{\odot}$, accreting at $\sim 0.7 L_{Edd}$. X-3 was poorly detected in all the others observations of 2017 and hence the spectral parameters could not be constrained due to low counts.

3.1.3. NGC 6015

NGC 6015 is a nearby spiral galaxy in the Draco constellation. Chandra ACIS-S has observed NGC 6015 on 19-03-2017 (obs ID 19349). One point source (X-4) having data counts $\sim$ 109 was detected. The source X-4 can be almost equally well fitted by both models. The X-ray luminosity in $0.3 - 10.0$ keV range as estimated by the powerlaw model is $\sim 4.39 \times 10^{39} ergs\ s^{-1}$ with a hard powerlaw photon index, $\Gamma \sim 1.97$, which could indicate that inverse comptonization of soft photons to be the radiative mechanism. Also, fitting the spectrum with the disk blackbody model, its bolometric luminosity was found to be $\sim 6.11 \times 10^{39} ergs\ s^{-1}$ with a relatively hard spectra with inner disk temperature, kT $\sim$ 1.14 keV. Thus, the $0.3 - 10.0$ keV luminosity of X-4 as estimated by both the models is above $10^{39} ergs\ s^{-1}$, potentially qualifying it as a ULX. The disk blackbody model estimates X-4 to harbour a stellar mass black hole, $M_{BH} \sim 32.86^{+23.88}_{-13.38} M_{\odot}$ accreting at $\sim$ 1.55 times the Eddington luminosity.

3.1.4. NGC 5585

NGC 5585 is a spiral galaxy which has been observed by Chandra ACIS in 2007 (Obs ID 7150) and 2017 (Obs ID 19348). One point source (X-5) is detected in both the observations with counts above 100. X-5 was first reported to be a ULX by Swartz et al. (2011), with an X-ray luminosity of the order of $10^{39} ergs\ s^{-1}$.

The spectrum of X-5 can be equally well explained by both models. Spectral analysis of X-5 reveals this source to have decreased its X-ray luminosity from $L_X \sim 8.07 \times 10^{39} ergs\ s^{-1}$ in the year 2007 to $L_X \sim 5.9 \times 10^{39} ergs\ s^{-1}$ in 2017 within the energy range $0.3 - 10.0$ keV, thereby hardening the spectrum with a sharp decrease in the powerlaw photon index (Γ) from~ 2.41 in the year 2007 to $\Gamma \sim 1.86$ in 2017. Likewise, if explained by disk blackbody model, the spectrum hardens with the inner disk temperature varying from kT $\sim$ 0.98 keV in 2007 to kT $\sim$ 1.38 keV in 2017 whereby its bolometric luminosity (L_X) is $\sim 7 \times 10^{39} ergs\ s^{-1}$ in both cases . Hence the spectral parameters estimated by both the models imply that the source has undergone a spectral state transition from a relatively soft to hard state within a period of 10 years. The black hole mass could not be constrained well for Obs ID 19348 which may be due to the relatively low counts of the source while from the Obs ID 7150, the black hole mass is estimated to be $M_{BH} \sim 48.99^{+27.42}_{-19.43} M_{\odot}$ accreting at $\sim$ 1.29 times the Eddington luminosity.

3.1.5. NGC 4536

NGC 4536 is a nearby spiral galaxy in the constellation Virgo. Chandra ACIS-S has observed NGC 4536 in 2017 (Obs ID 19387). Three X-ray point sources (X-6, X-7 and X-8) with counts greater than 100 are obtained from this observation. X-6 and X-7 can be fitted by both the models whereas X-8 is better fitted by the powerlaw model. The X-ray luminosity of X-6, estimated by both the models is found to be of the order of $\sim 10^{39} ergs\ s^{-1}$ with a relatively soft powerlaw photon index, $\Gamma \sim 2.63$ and the inner disk temperature, kT $\sim$ 0.68 keV. The black hole mass estimated by the disk blackbody model is in the range, $(69.37 \leq M_{BH} \leq 176.32) M_{\odot}$ which at the upper limit falls under the Intermediate mass black hole range and hence it can't be totally ruled out that this source harbors an Intermediate masss black hole. However if the emission is anisotropic and considered to be beamed by a factor η, then the inner disk radius R_{in} would be overestimated by $\eta^{1/2}$ (King et al. 2001). For extreme beaming, $\eta \sim 5$ (Misra & Sriram 2003), the inner disk radius remains around $\sim 4 \times 10^7 cm$ corresponding to a black hole mass of $\sim 75 M_{\odot}$, which is in the higher side of stellar mass range. Thus incase of extreme beaming, there is chance for this source to harbor stellar mass black hole.

The X-ray luminosity of X-7 was estimated to be $8.05 \times 10^{39} ergs\ s^{-1}$ in the energy range $0.3 - 10.0$ keV with $\Gamma \sim 1.64$ and the bolometric luminosity to be $1.14 \times 10^{40} ergs\ s^{-1}$ with kT $\sim$ 1.93 keV. The black hole mass was estimated to be $M_{BH} \sim 15.55^{+4.08}_{-1.7} M_{\odot}$ accreting at a super-Eddington rate. Spectral analysis of X-8 suggest this source to be an extremely luminous X-ray source (ELX) with X-ray luminosity estimated to be $L_X \sim 1.21 \times 10^{40} ergs\ s^{-1}$ in the $0.3 - 10.0$ keV energy range with a hard powerlaw photon index, $\Gamma \sim 1.63$, which may be due to inverse comptonization of soft photons. The bolometric luminosity is estimated to be $L_X \sim 1.84 \times 10^{40} ergs\ s^{-1}$ with an inner disk temperature, kT $\sim$ 1.28 keV. The estimated X-ray luminosity of X-8 is consistent with an independent analysis by Liu & Bregman (2005) using ROSAT High Resolution Imager (HRI) data. The black hole mass of X-8 is estimated to be $M_{BH} \sim 44.85^{+15.46}_{-13.62} M_{\odot}$ accreting at 3.4 times its Eddington rate.

3.2. Temporal Analysis

ULXs are typically not highly variable on ks timescales, except for some ultra-soft ones with soft inner disk temperature. Devi et al. (2008) has shown that a highly luminous ULX, X-7 in NGC 6946 revealed a decrease of 1.5 in the count rate over 5000s making it one of the few ULXs that have clearly shown variability on ks timescales. The lightcurve of the eight sources are shown in Figure 3. Temporal analysis of the eight X-ray point sources have been carried out to check the presence of any such variablity. A source can be considered as variable if the probability that the count rate was constant during the observation is less than 0.01, i.e., the source is variable with a significance of $> 99\%$ (Liu 2011). With this criteria, the light curve of these eight sources binned over 0.5, 1.0, 2.0 and 4.0 ks time-scales have not shown any short-term variability in kilo-seconds time scales. The probability that the count rate was constant during the observation, were all greater than 0.2 in all these time bins. For checking long-term variability we need repeated observations of these sources. X-2 which was observed in 2001 and then in 2017 showed no significant changes in its X-ray luminosity. However the X-ray luminosity of X-5 within the energy range $(0.3 - 10.0)$ keV decreased marginally from 2007 to 2017. So, detailed temporal study of these sources with future observations are required for a better understanding of the nature of these sources.

4. SUMMARY

We present the results of the spectral and temporal analysis of the Chandra data of five nearby galaxies (distance $<$ 20Mpc) which have recently come up on the *Chandra* public data archive. Chandra Interactive Analysis of Observations (CIAO) version-4.8 and Heasoft-6.18 is used to perform the data reduction and analysis. All the X-ray point sources are extracted from the level 2 event list by using the CIAO source detection tool WAVDETECT. Eight X-ray point source having counts greater than 100 are detected from these observations. These sources are located in the region of low diffuse emission and are not affected by pile-up. The source spectra and their corresponding background spectra are extracted using a combination of CIAO tools and calibration data. The spectral study was carried out using XSPEC version 12.9.0. Two spectral fitting empirical models were used: the absorbed powerlaw and the absorbed disk blackbody. The light curve of the eight sources were extracted using *dmextract* tool of CIAO and the temporal analysis was performed.

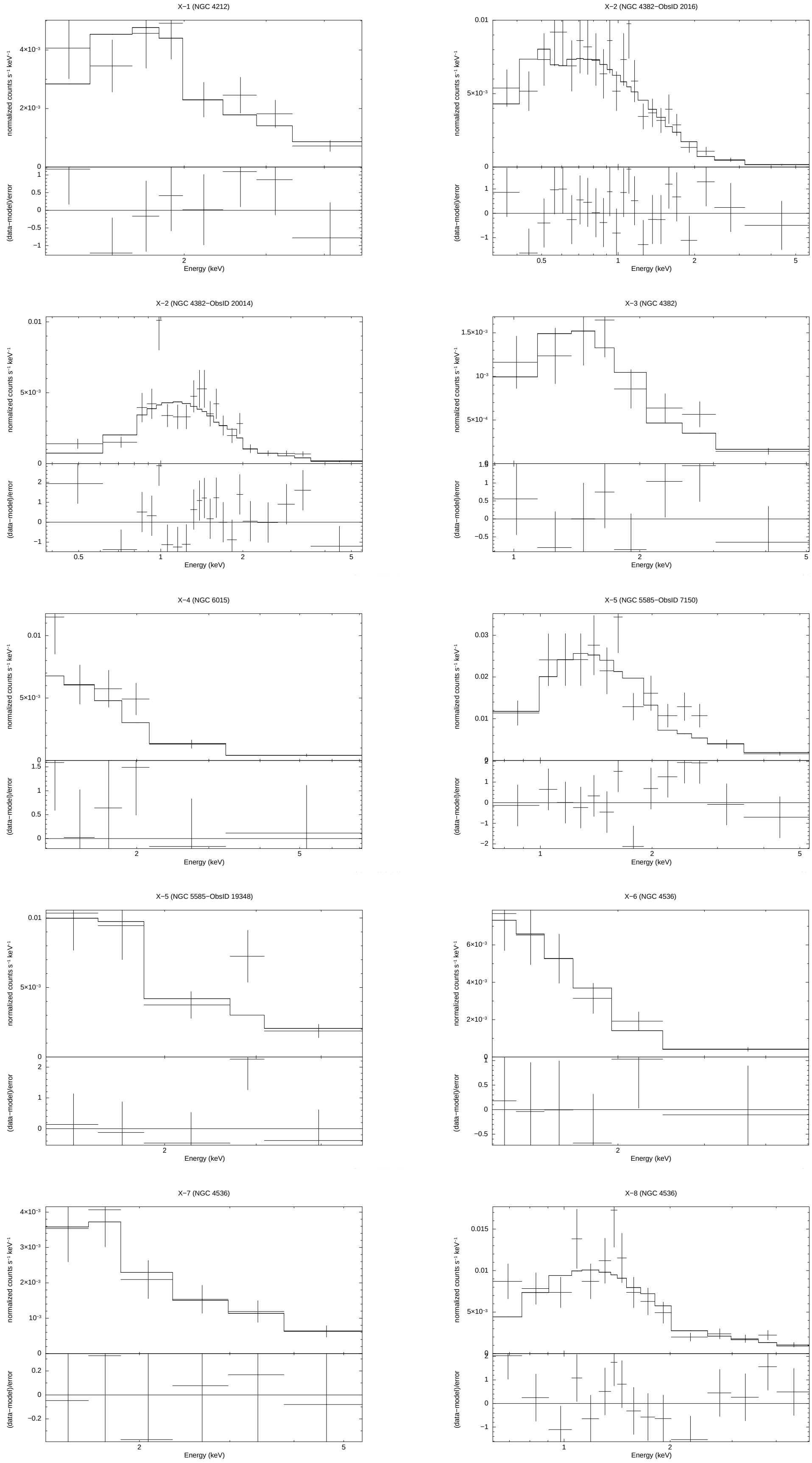

Figure 1. Absorbed powerlaw spectra of the X-ray sources

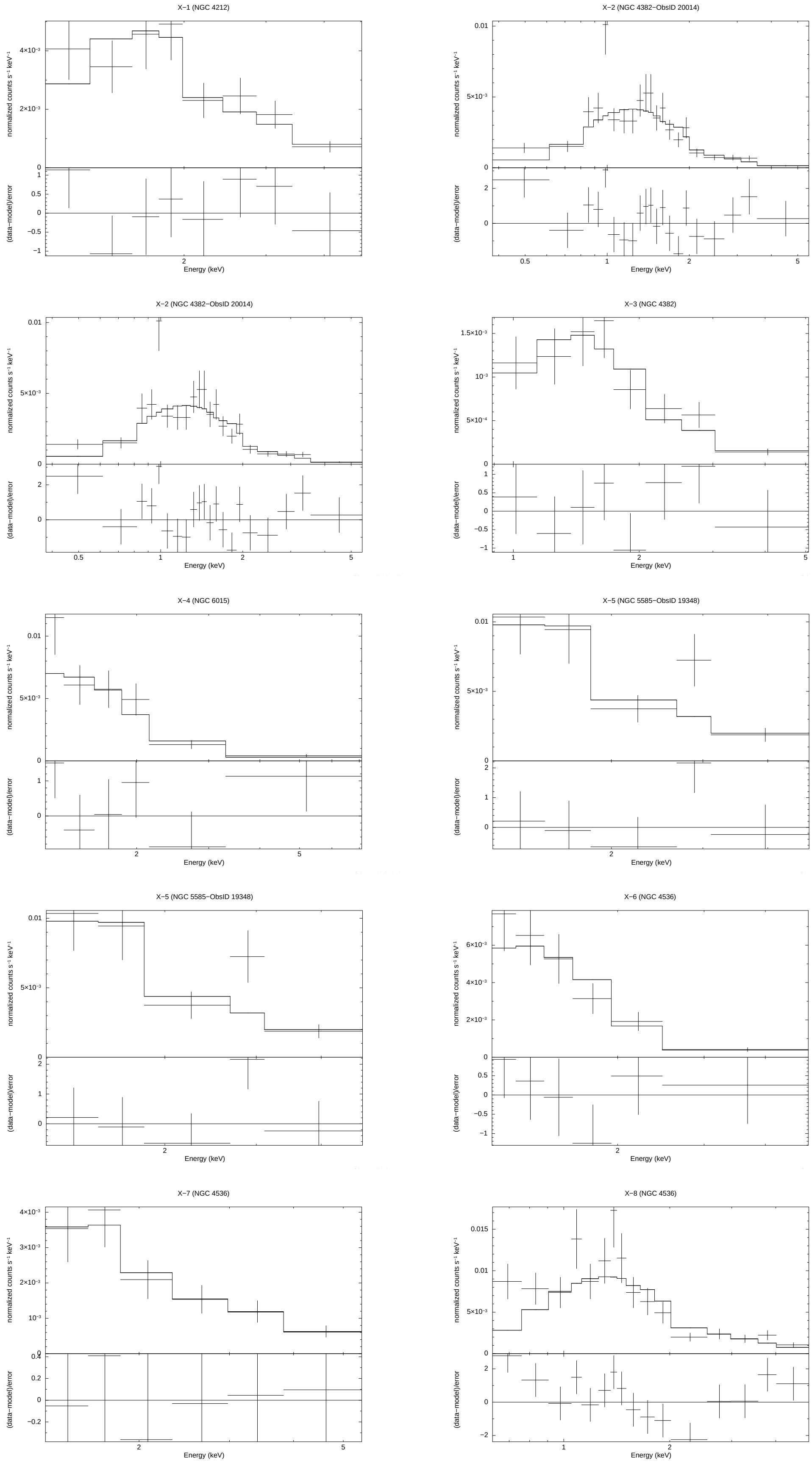

Figure 2. Absorbed diskblackbody spectra of the X-ray sources

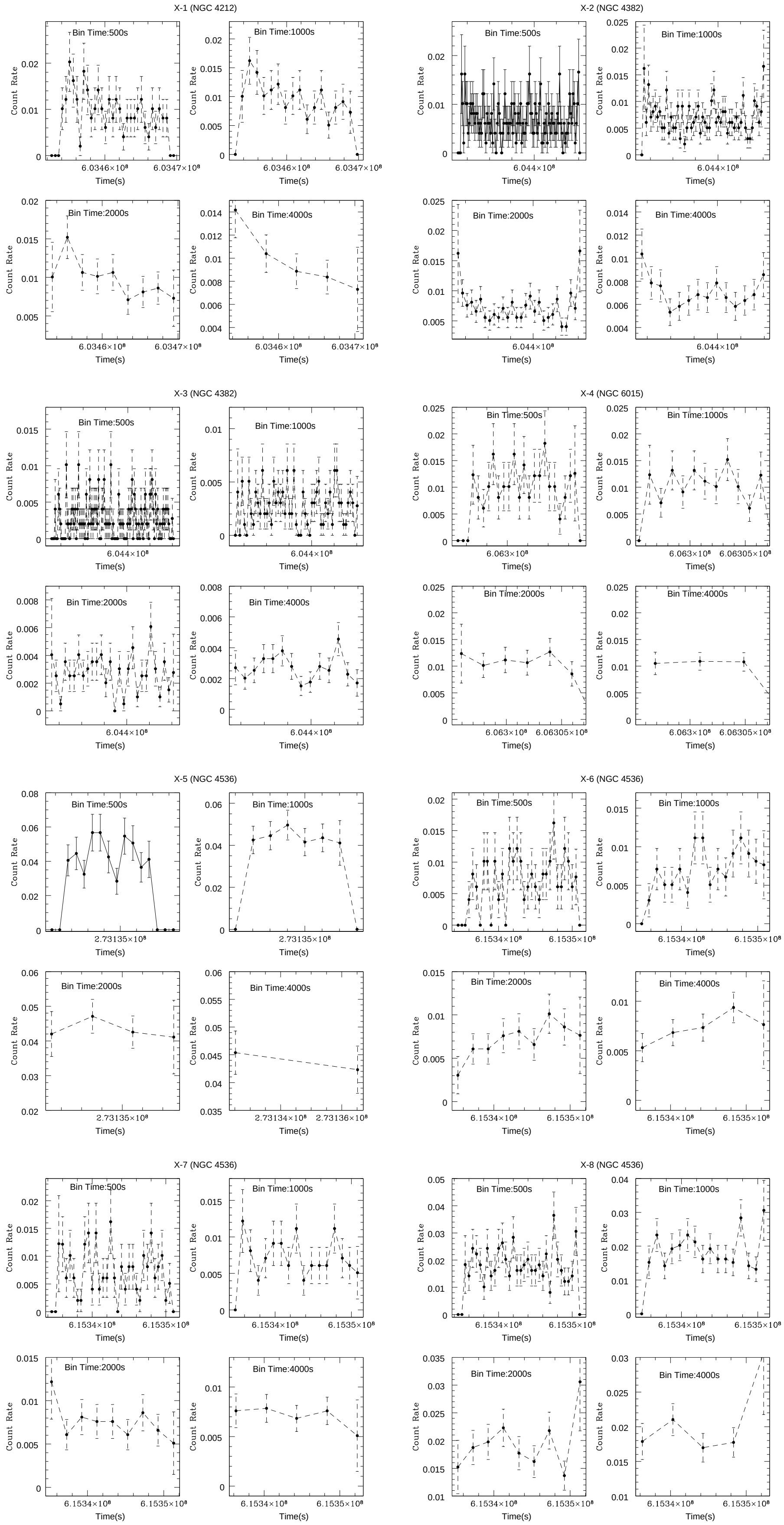

Figure 3. Lightcurves Of The X-ray point sources

Table 3
Spectral properties of the X-ray point sources

		Powerlaw				Diskblackbody			
Source	Obs. ID	n_H (10^{22}cm^{-2})	Γ	log(L) (ergs s^{-1})	cstat/dof	n_H (10^{22}cm^{-2})	kT_{in} (keV)	log(L) (ergs s^{-1})	cstat/dof
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
X-1	19395	$0.75^{+0.00}_{-0.00}$	$1.97^{+0.32}_{-0.33}$	$39.89^{+0.04}_{-0.01}$	5.70/5	$0.45^{+0.49}_{-0.44}$	$1.28^{+1.18}_{-0.39}$	$39.96^{+0.11}_{-0.08}$	4.14/5
X-2	20014	$0.08^{+0.08}_{-0.08}$	$2.29^{+0.33}_{-0.22}$	$39.59^{+0.10}_{-0.07}$	36.00/18	$0.00^{+0.01}_{-0.00}$	$0.81^{+0.08}_{-0.07}$	$39.69^{+0.01}_{-0.00}$	41.14/18
	2016	$0.06^{+0.00}_{-0.00}$	$2.19^{+0.10}_{-0.11}$	$39.67^{+0.01}_{-0.01}$	20.12/21	$0.00^{+0.00}_{-0.00}$	$0.68^{+0.06}_{-0.06}$	$39.80^{+0.01}_{-0.01}$	31.87/21
X-3	20014	$0.64^{+0.00}_{-0.00}$	$2.51^{+0.32}_{-0.32}$	$39.49^{+0.09}_{-0.06}$	6.83/5	$0.25^{+0.34}_{-0.22}$	$0.96^{+0.45}_{-0.24}$	$39.41^{+0.13}_{-0.08}$	5.03/5
X-4	19349	$0.00^{+0.10}_{-0.00}$	$1.97^{+0.55}_{-0.33}$	$39.64^{+0.12}_{-0.01}$	3.48/3	$0.00^{+0.32}_{-0.00}$	$1.14^{+0.38}_{-0.24}$	$39.79^{+0.07}_{-0.01}$	5.54/3
X-5	19348	$0.63^{+1.25}_{-0.62}$	$1.86^{+1.02}_{-0.99}$	$39.77^{+0.74}_{-0.14}$	8.4/2	$0.32^{+0.90}_{-0.30}$	$1.38^{+2.61}_{-0.56}$	$39.87^{+0.32}_{-0.09}$	7.63/2
	7150	$0.70^{+0.00}_{-0.00}$	$2.41^{+0.22}_{-0.22}$	$39.90^{+0.04}_{-0.03}$	19.87/11	$0.40^{+0.18}_{-0.15}$	$0.98^{+0.26}_{-0.17}$	$39.88^{+0.06}_{-0.05}$	16.39/11
X-6	19387	$0.00^{+0.77}_{-0.00}$	$2.63^{+1.42}_{-0.44}$	$39.89^{+0.90}_{-0.08}$	1.72/3	$0.00^{+0.31}_{-0.00}$	$0.68^{+0.16}_{-0.13}$	$39.93^{+0.16}_{-0.01}$	2.69/3
X-7	19387	$0.69^{+1.39}_{-0.69}$	$1.64^{+1.32}_{-0.88}$	$39.90^{+0.59}_{-0.11}$	0.30/3	$0.23^{+1.02}_{-0.22}$	$1.93^{+0.50}_{-0.87}$	$40.05^{+0.63}_{-0.10}$	0.30/3
X-8	19387	$0.00^{+0.05}_{-0.00}$	$1.63^{+0.11}_{-0.22}$	$40.08^{+0.04}_{-0.01}$	20/13	$0.00^{+0.02}_{-0.00}$	$1.28^{+0.31}_{-0.19}$	$40.26^{+0.06}_{-0.19}$	34.69/13

Columns: (1): Source Name. (2): Observation ID. (3): n_H, equivalent hydrogen column density. (4): Γ, the powerlaw photon index. (5): L, X-ray luminosity in the $0.3-10.0keV$ energy range. (6): C-statistics/Degrees of freedom. (7): n_H, equivalent hydrogen column density. (8): kT_{in}, the inner disk temperature. (9): L, bolometric X-ray luminosity. (10): C-statistics/Degrees of freedom

From the spectral analysis, it is found that the spectra of X-1, X-3, X-4, X-5, X-6 and X-7 could be fitted by both the models whereas X-2 and X-8 are better fitted by the powerlaw model. The X-ray luminosity of these point sources, within the energy range $0.3-10.0$ keV, are estimated to be above $10^{39} ergs\ s^{-1}$, hence resulting X-1, X-3, X-4, X-6 and X-7 to be newly discovered Ultraluminous X-ray sources (ULXs). The spectral parameters of both the models suggest X-1, X-2, X-3, X-4, X-5 and X7 to be in hard states while X-6 to be in a relatively soft state. We also report that the source X-5 has undergone a spectral state transition from a comparatively soft state to a hard state within a period of 10 years. Also a marginal decrease is observed in the X-ray luminosity of this source within the energy range $(0.3 - 10.0)$ keV during this time period. Our spectral analysis of X-8 estimates an X-ray luminosity of the order of $10^{40} ergs\ s^{-1}$ and is consistent with the result of Liu & Bregman (2005), thereby confirming this source to be an Extremely luminous X-ray source (ELX) in a hard state with a black hole mass estimated to be, $M_{BH} \sim 44.85^{+15.46}_{-13.62} M_\odot$ accreting at a super-Eddington rate. The radiative mechanism of this hard ELX may be due to inverse comptonization of soft photons.

The black hole mass of X-6 as estimated by the disk blackbody model is found to be in the range $69.37 M_\odot \leq M_{BH} \leq 176.32 M_\odot$ which on the upper limit falls under the Intermediate mass black hole range. However, if the emission is considered to be beamed by a factor, $\eta \sim 5$, the emitting region would be decrease implying a black hole mass, $M_{BH} \sim 75 M_\odot$. The other seven sources were estimated to harbour stellar mass black holes within the range $(15 - 58) M_\odot$.

Temporal analysis of the eight sources were performed to check the presence of any short term variability in the kiloseconds timescale. The lightcurve of these sources binned at 0.5, 1.0, 2.0, 4.0 kiloseconds were generated. For all the sources implies the absence of any short term variability. However, future observations of these sources and detailed temporal analysis can simplify the nature of these sources.

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