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SPECTRAL AND TIMING STUDY OF V404 CYGNI WITH *CHANDRA* OBSERVATIONS

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We present the spectral and timing study of V404 Cygni from all its available Chandra observations and which recently come up in public domain of Chandra data archive. The data reduction and analysis were done using CIAO 4.14 and HEASOFT 6.30.1. The spectral analysis was done using spectral fitting package XSPEC version 12.12.1, available in the Heasoft package. The spectra of the source is fitted in the energy range 0.3 -8.0 keV using two empirical spectral models - the absorbed power law and an absorbed disk-blackbody. The X-ray binary source V404 Cygni is found to be in the quiescent state having the X-ray luminosity in the range with few times 10^{32} erg s^{-1}. The source is found to be in the hard state and is well explained by power-law model with a powerlaw photon index $\Gamma \sim 2$ with n_H in the range ~ (0.7 -1.2) × 10^{22} cm^{-2}. From timing analysis, Src-1 (V404 Cygni), in all the time bins- 0.5, 1 and 2 ks, the probability for the count rate to be constant is 0.17 ×10^{-33} in all the observations in the year 2021 and 2023 (ObsID 23421, ObsID 23422, ObsID 23423 & ObsID 28927). However, in the year 2017 observation it is found to be less variable. This clearly shows the presence of short-term variability in kilo-seconds time-scales with the currently available Chandra data. So, it is indicative that the binary source V404 Cygni is more likely to be variable source both in long-term (years) as well as short-term (kiloseconds) scales.

Keywords: *Accretion, Accretion disks; X-rays; Binaries-stars:individual(V404 Cygni); Black holes*

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1. INTRODUCTION

Among the sky's brightest X-ray sources were X-ray binaries. X-ray binaries (XRBs) are the galaxy's principal X-ray sources. They include neutron star (NSXB) and black hole (BHXB) X-ray binaries, where wind-fed or Roche lobe overflow is responsible for the mass transfer from the companion to the compact star. Black hole X-ray binary (BHXB) is an interacting binary system consisting of a stellar-mass black hole accreting material from a companion star. Black hole X-ray binaries (BHXBs) are usually transient systems that undergo extended periods of (X-ray) quiescence interspersed with comparatively brief outbursts. The abrupt increase in the rate of accretion onto the compact object is what causes the outburst. Most likely, a disk instability is the reason for this increase. The quiescence phase and the outbursting phase are the two stages of a transient black hole candidate's (BHC) life cycle. They spend the most of their life in the quiescence phase, accreting small amounts of matter at low X-ray luminosities. The X-ray luminosity (L_x) during outburst, have been observed within a range of 10^{34-39} erg s^{-1} at very high luminosities in the 0.5–10 keV band. The X-ray luminosity (L_x) during quiescence is mentioned to be ranging from $L_x \sim 10^{30-33}$ erg s^{-1} [1]. The disc instability concept provides a comprehensive explanation for the quiescence to outburst cycle [2],[3]. According to the disc instability concept, which describes how accreting matter accumulates in the accretion disc during quiescence and is abruptly transported to the compact object during outburst. However, there is still debate over where the emission of X-rays from LMXBs during quiescence originates.

Black hole binaries (BHBs) show different X-ray spectral states as they accrete gas during transient outburst episodes [4]. The two primary spectral states are the hard state and the soft state, traditionally known as the low-hard state (LHS) and the high-soft state (HSS), respectively [5]. X-ray binaries within the Milky Way have been extensively studied and are an important benchmark in studying ULXs [6]. Furthermore, X-ray binaries are very helpful in comprehending the nature of compact objects and the physical mechanism of accretion. Also timing study of X-ray binaries will comprehend the nature of compact objects even the presence of temporal variability across a range of timescales will enhance the physical mechanism of accretion. The X-ray light curves of blackhole binaries can be variable over a broad timescale, ranging from milliseconds to years [7],[8].

One of the most researched black hole X-ray binary systems is V404 Cygni. V404 Cygni, a binary system comprising a black hole and a companion star, has been a subject of astronomical interest due to its notable outbursts in both optical and X-ray wavelengths. V404 Cyg, also referred to as GS 2023+338, was discovered on May 22, 1989, by the all-sky monitor aboard the Ginga satellite [9]. It is the most luminous of the quiescent black hole low-mass X-ray binaries (BH LMXBs), with an X-ray luminosity of about 7 ×$10^{32} ergs^{-1}$ at a distance of 2.39 kpc [10]. In 1938, it was initially recognized as an optical nova. In 1956, there was another recorded nova outburst observed within this particular system [11]. Comparing

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V404 Cyg's X-ray outburst behavior to the other BH transients, it is extremely unusual. In 1989, V404 Cygni experienced another outburst [12]. After remaining in a quiescent state for approximately 26 years, V404 Cygni underwent a brief yet intense outburst on June 15, 2015 [13],[14],[15] and again another short-lived burst of activity was observed in December 2015 [16],[17]. V404 Cygni harbors a black hole with a mass of $9.0^{+0.6}_{-0.2}$ $M_\odot$ and a binary inclination of 67^{+3}_{-1} ° [18]. We adopt the distance of V404 Cygni is 2.39 kpc [10].

In this paper, we present the spectral and timing study of V404 Cygni from all its available *Chandra* observations and which recently come up in public domain of Chandra data archive. The observation and data analysis are described in Section 2. Results and discussion are presented in Section 3. Section 4 represents the timing analysis of X-ray binary source V404 Cygni and summarized in Section 5.

2. OBSERVATION AND DATA ANALYSIS

In the present work, we have carried out spectral and timing analysis of V404 Cygni as detected by *Chandra* ACIS-S detector. V404 Cygni has been observed by *Chandra* ACIS-S detector five times - first in the year 2017 (ObsID 19000) and three times in the year 2021 (ObsID 23421, ObsID 23422 and ObsID 23423) and then in the year 2023 (ObsID 28927). The detail Chandra observational log of V404 Cygni is given in Table 1.

Table 1. Chandra ACIS-S Observation log for V404 Cygni

Source	Distance (Kpc)	ObsID*	Exposure (ks)	Observation Year	References for distance
V404 Cygni	2.39	19000	49.00	2017-08-11	Miller-Jones et al. 2009
		23421	22.00	2021-01-23	
		23422	22.00	2021-02-06	
		23423	22.00	2021-02-21	
		28927	15.00	2023-10-14	

*ObsID - *Chandra* Observation ID

The data reduction and analysis were done using CIAO 4.14 and HEASOFT 6.30.1. X-ray point source was extracted from the level 2 event lists by using the CIAO source detection tool *Wavdetect*. Using a combination of CIAO tools and calibration data, the source (and background) spectrum were extracted. Spectra were grouped and rebinned so that each bin had a minimum of 30 counts. As adopted by Devi et al.2007 [19], a conservative threshold of the count rate ≥ 0.05 counts s^{-1} is considered as pileup affected, however in our present study it is found that all the sources are not pileup affected as the count rates were all ≤ 0.04 counts s^{-1}.

The spectral analysis was done using spectral fitting package XSPEC version 12.12.1, available in the Heasoft package. The spectra of the two sources are fitted in the energy range 0.3 -8.0 keV using two empirical spectral models - the absorbed power law and an absorbed disk-blackbody. XSPEC model -*phabs* was used to take into account the absorption in the spectrum. A measure of the goodness of fit is determined by $\chi 2$/(degrees of freedom(dof)), which should be approximately one. Taking care of the possibility of many local minima in the discerning statistic space while fitting low-count data with a two parameter (plus normalization) model, we compute the $\chi 2$ statistics for a range of parameter values (using the XSPEC command *steppar*) and find the global minimum instead of fitting the data using the XSPEC minimization routine. Finally, from the model parameters obtained from the spectral fitting, the corresponding luminosity of the point sources are estimated.

For the disk blackbody model, the bolometric luminosity is defined as $L_{bol} = 4\pi R_{in}^2 \sigma T_{in}^4$, where R_{in}, the inner disk radius from where the X-rays are emitted, is given by $R_{in} = (\sqrt{Normalisation} \times \text{Distance}_{10kpc})/\sqrt{\cos\theta}$ km; θ is the viewing angle, T_{in} is the inner disk temperature & σ is the Stefan Boltzmann constant. However, for the powerlaw model, considering *Chandra*'s energy sensitivity range, only the luminosity in the 0.3-8.0 keV range is estimated for the present work.

3. RESULTS AND DISCUSSION

The details of the V404 cygni source is tabulated in Table 2. Spectral properties of the source V404 Cygni is given in Table 3. The observed normalized net count distribution of V404 Cygni source fitted with powerlaw model and disk blackbody model is shown in Figure 1 and Figure 2 respectively. The detail study and findings of V404 Cygni is discussed below.

Table 2. Details of the V404 Cygni X-ray source

Source name	R.A.*	Decl.**	ObsId	Net count rate
Src-1	+20:24:03.82	+33:52:01.90	19000	0.015
			23421	0.018
			23422	0.020
			23423	0.016
			28927	0.042

*R.A - in (hours, minutes and seconds); **Decl. in (degrees, arcminutes and arcseconds)

Table 3. Spectral properties of the V404 Cygni X-ray source

		Powerlaw				Disk-blackbody			
Source	Obs Id.	n_H ($10^{22} cm^{-2}$)	Γ	$\log(L_x)$ (ergs s^{-1})	$\chi 2$/dof	n_H ($10^{22} cm^{-2}$)	KT_{in} keV	$\log(L_x)$ (ergs s^{-1})	$\chi 2$/dof
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Src-1	19000	$0.94^{+0.24}_{-0.27}$	$2.19^{+0.32}_{-0.22}$	$32.55^{+0.15}_{-0.10}$	30.66/36	$0.38^{+0.17}_{-0.17}$	$1.40^{+0.22}_{-0.16}$	$32.57^{+0.02}_{-0.02}$	39.08/36
	23421	$0.75^{+0.49}_{-0.41}$	$2.12^{+0.44}_{-0.39}$	$32.43^{+0.23}_{-0.14}$	8.87/21	$0.21^{+0.30}_{-0.19}$	$1.46^{+0.38}_{-0.25}$	$32.48^{+0.04}_{-0.04}$	6.69/21
	23422	$0.96^{+0.39}_{-0.42}$	$2.19^{+0.32}_{-0.33}$	$32.69^{+0.18}_{-0.14}$	17.52/22	$0.27^{+0.33}_{-0.25}$	$1.51^{+0.43}_{-0.28}$	$32.71^{+0.04}_{-0.04}$	18.25/22
	23423	$1.01^{+0.41}_{-0.50}$	$2.41^{+0.43}_{-0.44}$	$32.67^{+0.26}_{-0.21}$	22.89/17	$0.21^{+0.37}_{-0.18}$	$1.39^{+0.37}_{-0.26}$	$32.58^{+0.05}_{-0.04}$	26.70/17
	28927	$1.29^{+0.33}_{-0.37}$	$2.29^{+0.33}_{-0.22}$	$32.98^{+0.18}_{-0.12}$	31.05/32	$0.51^{+0.26}_{-0.28}$	$1.47^{+0.27}_{-0.17}$	$32.95^{+0.03}_{-0.03}$	33.0/32

Columns: (1): Source (2): Observation ID. (3): n_H, equivalent hydrogen column density. (4): Γ,the powerlaw photon index. (5):(L_x),X-ray luminosity in the 0.3 -8.0 keV energy range, (6): $\chi 2$/Degrees of freedom. (7): n_H, equivalent hydrogen column density. (8): KT_{in},the inner disk temperature. (9):(L_x), bolometric X-ray luminosity. (10):$\chi 2$/Degrees of freedom.

In the present study, the binary source, Src-1 (V404 Cygni) is found to be in the quiescent state having the X-ray luminosity in the range with few times 10^{32} erg s^{-1} in all the observations. In all the observations, the binary source V404 Cygni is found to be spectrally hard with powerlaw photon index, $\Gamma \sim 2$ as explained by the powerlaw model and an inner disk temperature, $kT_{in} \sim 1$ keV as explained by the disk blackbody model. The source is well explained by power-law model with a powerlaw photon index $\Gamma \sim 2$ with n_H in the range $\sim (0.7 - 1.2) \times 10^{22}$ cm^{-2}. In the year 20017 observation having ObsID 19000, the binary source Src-1 (V404 Cygni) is found to be having the X-ray luminosity with $\sim 3.54 \times 10^{32}$ erg s^{-1} fitted with powerlaw model. But in the year 2021 observations, the source is found to be $\sim 2.69 \times 10^{32}$ erg s^{-1} in one observation having ObsID 23421, however, in two observations having ObsID 23422 and ObsID 23423, it is found to be $\sim 4 \times 10^{32}$ erg s^{-1}. The source luminosity is found to be a slight increase to $\sim 9 \times 10^{32}$ erg s^{-1} in the latest observation of 2023 having ObsID 28927. This clearly shows the presence of long-term variability (years) with the currently available Chandra data.

This result is in agreement with many other earlier works. Wagner et al.(1994)[20] estimated the luminosity of the source to be 8×10^{33} erg s^{-1} at a distance 3.5 kpc by Rosat observational data. Also, Narayan et al. 1997 [21], Kong et al. 2002 [22] and Bradley et al. 2007 [23] found this source to have a luminosity of $\sim 1.0 \times 10^{33}$ erg s^{-1} and its spectrum is well fitted by a simple power-law model with photon index $\Gamma \sim 2$ with n_H in the range $\sim (0.7 - 2.3) \times 10^{22}$ cm^{-2}. The quiescent X-ray spectrum has a power-law photon index $\Gamma \sim 2$ seen through a a total column density of $n_H = (1.0 \pm 0.1) \times 10^{22}$ cm^{-2} [24]. However, in latter observations the source seems to get dimmer such as- luminosity approaches several times 10^{32} erg s^{-1} [25]. Rana et al. 2016 [26] reported the quiescent luminosity of this source is 8.9×10^{32} erg s^{-1} for a distance of 2.4 kpc at energies (0.3-30keV)using NuStar observation. This later observations seem to agree well with the present finding of X-ray luminosity around 10^{32} erg s^{-1} in the 0.3-8.0 keV by using the latest Chandra observational data of the year 2017, 2021 & 2023.

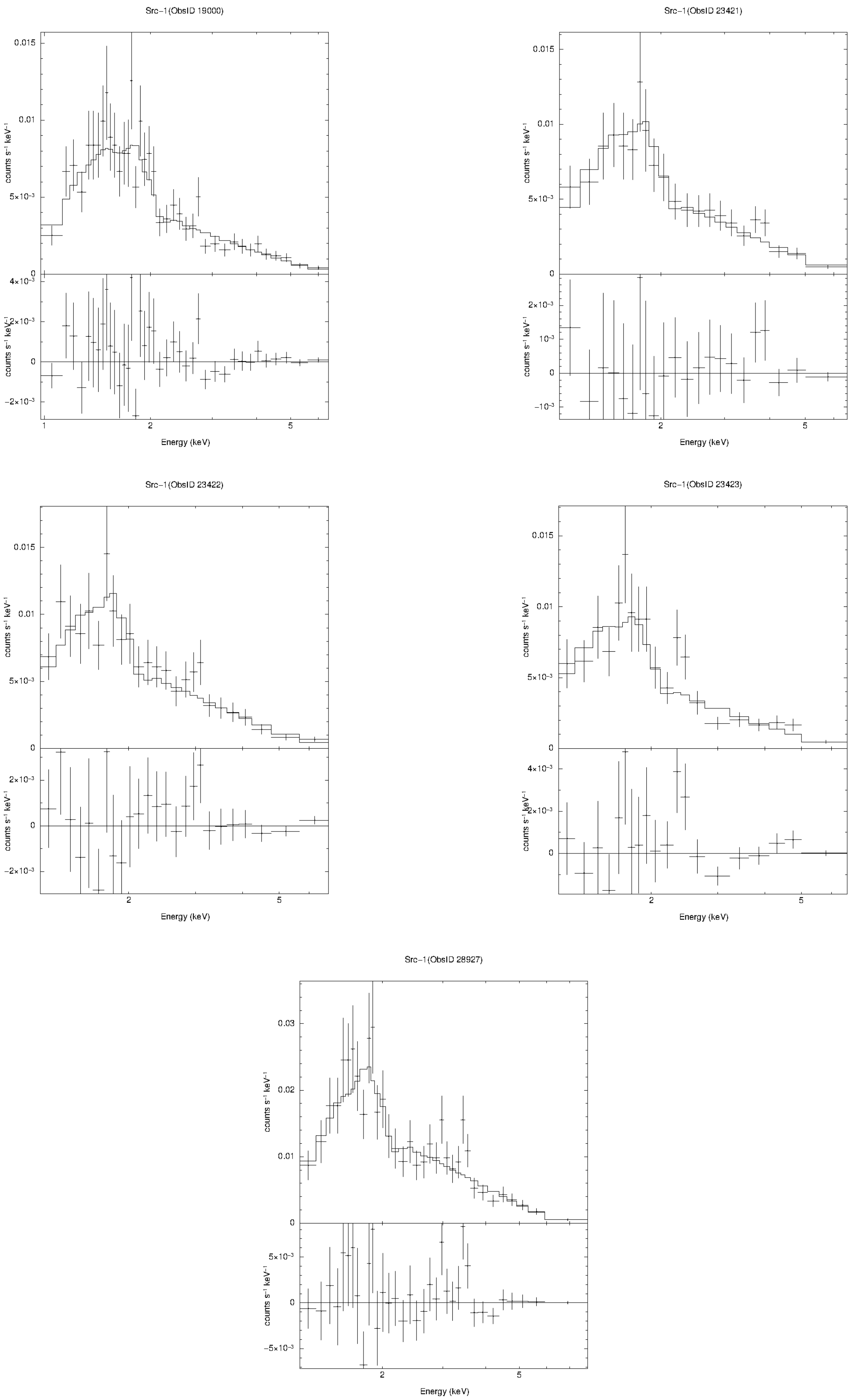


Figure 1. Powerlaw Spectra of the V404 Cygni X-ray Binary Source

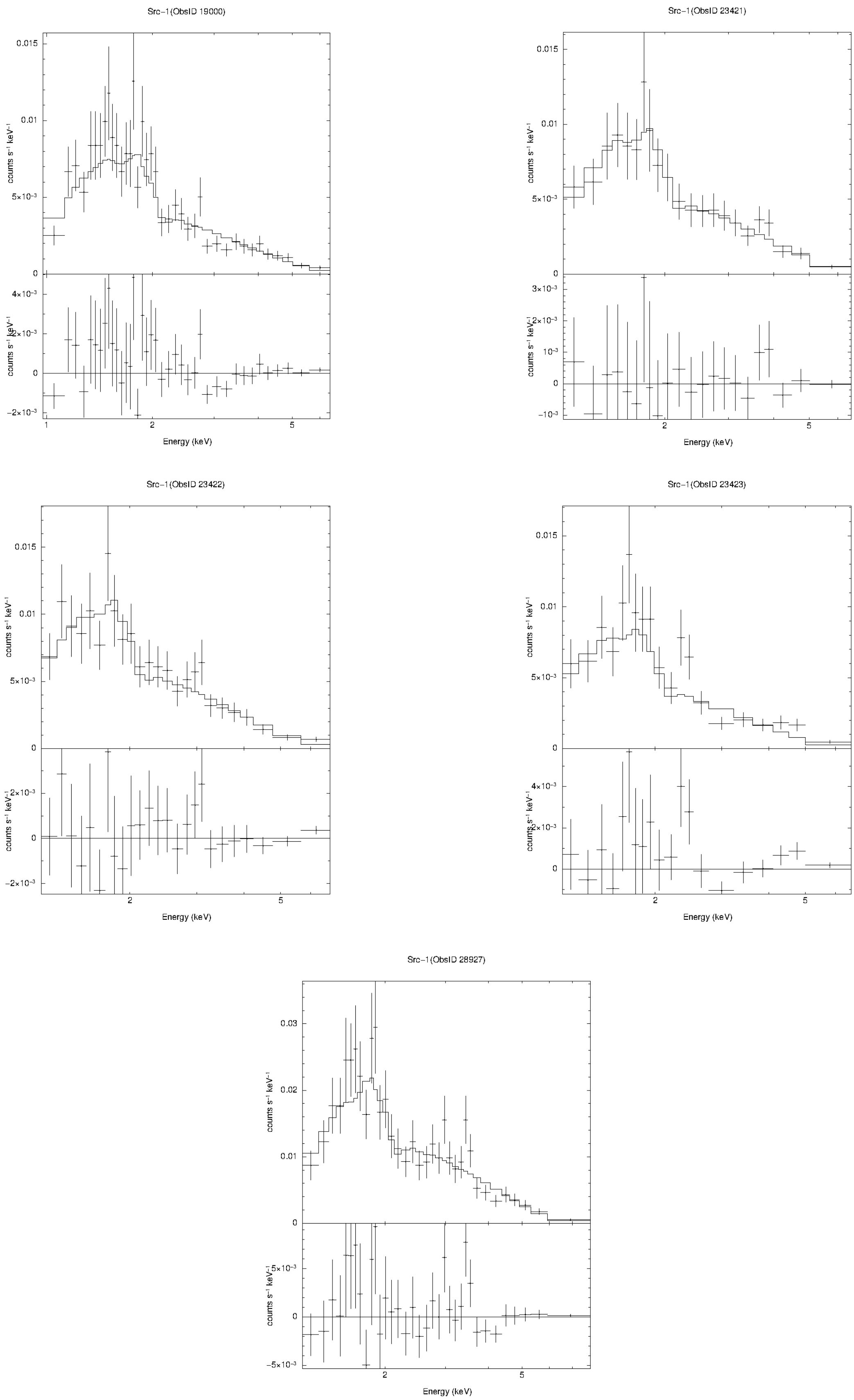


Figure 2. Disk blackbody Spectra of the V404 Cygni X-ray Binary Source

4. TEMPORAL PROPERTY OF THE BINARY SOURCE V404 CYGNI

To check the presence of any short-term/kiloseconds variability for V404 Cygni X-ray binary source detected in the present study, temporal analysis was carried out. The lightcurve of V404 Cygni binned over 0.5, 1, 2 ks for the *Chandra* observations is shown in Figure 3.

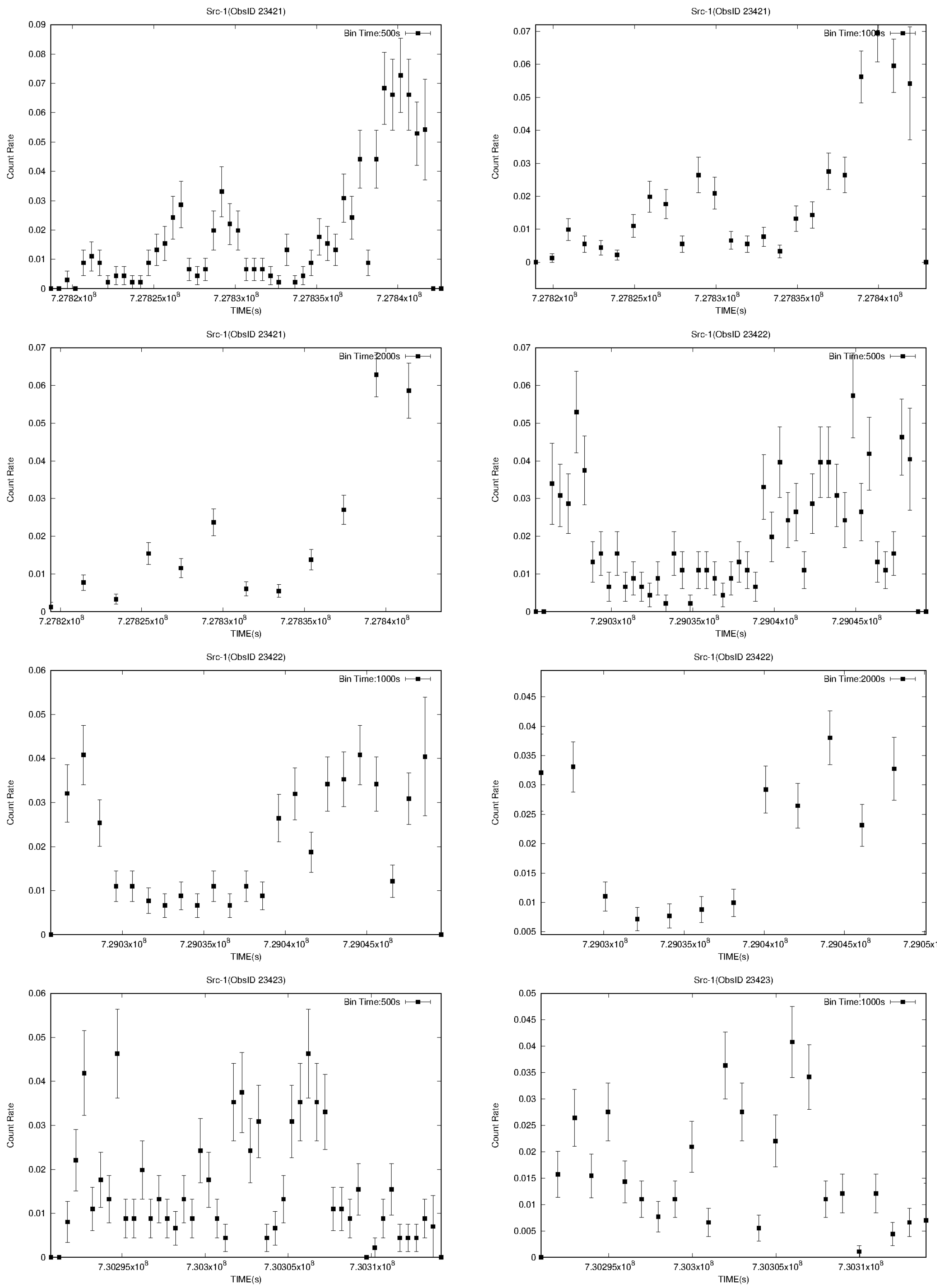
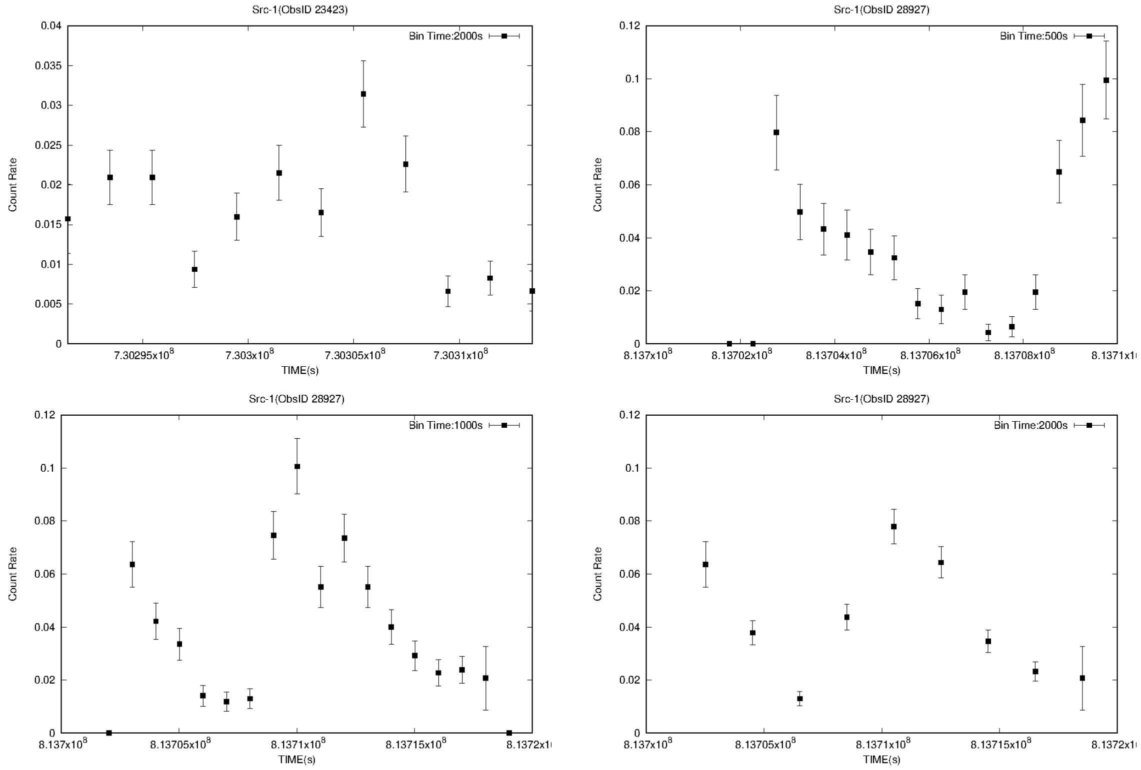


Figure 3. Lightcurve of V404 Cygni in its observations - ObsID 23421, ObsID 23422, ObsID 23423 and ObsId 28927, in different time bins (500 s, 1000 s, 2000 s)

Figure 3 continued



In our analysis, Src-1 (V404 Cyg), in all the time bins- 0.5, 1 and 2 ks, the probability for the count rate to be constant is 0.17 $\times 10^{-33}$ in all the observations in the year 2021 and 2023 (ObsID 23421, ObsID 23422, ObsID 23423 & ObsID 28927). However, in the year 2017 observation it is found to be less variable. Previous studies have found significant variations in the quiescent X-ray flux of V404 Cyg over a few-year timescale. It is evident from the light curve that the source's flaring activity causes significant variability. Over the course of the XMM-Newton observation, the count rate varies by a factor of 4-5 over a few-hour timescale. Hence, V404 Cyg exhibits distinct variability in the form of several flares on short timescales (one to two hours) in the radio, soft X-ray, and hard X-ray bands [26]. This clearly shows the presence of short-term variability in kilo-seconds time-scales with the currently available Chandra data. So, it is indicative that the binary source V404 Cygni is more likely to be variable source both in long-term (years) as well as short-term (kiloseconds) scales.

However, due to limited timing capabilities of many sensitive X-ray instruments aboard X-ray satellites, the transient nature of BH binaries of many variable sources have eluded detections. So, a more detail future work with high quality data from other missions may enable us to ascertain the real physical nature of this binary in more details.

5. CONCLUSION

We present the results of spectral and timing analysis of V404Cygni X-ray binary which has been observed by *Chandra* and which recently come up in the public domain of Chandra archive. The spectra of the binary source V404 Cygni was fitted with two empirical models - the absorbed power law and an absorbed disk black-body. The binary source V404 Cygni, was observed in three *Chandra* observational epochs. In all the epochs, the binary source, Src-1 (V404 Cygni) is found to be in the quiescent state having the X-ray luminosity in the range with few times 10^{32} erg s^{-1}. In all the observations, the binary source V404 Cygni is found to be spectrally hard with powerlaw photon index, $\Gamma \sim 2$ as explained by the powerlaw model and an inner disk temperature, kT$_{in}$ $\sim$ 1 keV as explained by the disk blackbody model. The source is well explained by power-law model with a powerlaw photon index $\Gamma \sim 2$ with n$_H$ in the range $\sim$ (0.7 -1.2) $\times$ 10^{22} cm^{-2}. In the year 20017 observation having ObsID 19000, the binary source Src-1 (V404 Cygni) is found to be having the X-ray luminosity with $\sim 3.54 \times 10^{32}$ erg s^{-1} fitted with powerlaw model. But in the year 2021 observations, the source is found to be $\sim 2.69 \times 10^{32}$ erg s^{-1} in one observation having ObsID 23421, however, in two observations having ObsID 23422 and ObsID 23423, it is found to be $\sim 4 \times 10^{32}$ erg s^{-1}. The source luminosity is found to be a slight increase to $\sim$ 9×10^{32} erg s^{-1} in the latest observation of 2023 having ObsID 28927. Timing analysis of Src-1 (V404 Cyg), in all the time bins- 0.5, 1 and 2 ks, the probability for the count rate to be constant is 0.17 $\times 10^{-33}$ in all the observations in the year 2021 and 2023 (ObsID 23421, ObsID 23422, ObsID 23423 & ObsID 28927). However, in the year 2017 observation it is found to be less variable. This clearly shows the presence of short-term variability in kilo-seconds time-scales with the currently available Chandra data. So, it is indicative that the binary source V404 Cygni is more likely to be variable source both in long-term (years) as well as short-term (kiloseconds) scales. However, due to limited timing capabilities of many sensitive X-ray instruments aboard X-ray satellites, the transient nature of BH binaries of many variable sources have eluded detections. So, a more detail future work with high quality data from other missions may enable us to ascertain the real physical nature of this binary in more details.

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REFERENCES

[1] J.E. McClintock, and R.A. Remillard, *Compact Stellar X-ray Sources*, edited by W.H.G. Lewin, and M. van der Klis, (Cambridge University Press, 2006).

[2] J.K. Cannizzo, Astrophysical Journal, **419**, 318 (1993).

[3] J.P. Lasota, New Astron Review, **45**, 449 (2001). https://doi.org/10.1016/S1387-6473(01)00112-9

[4] T.M. Belloni, and S.E. Motta, in: *Astrophysics of Black Holes: From Fundamental Aspects to Latest Developments*, edited by C. Bambi, Astrophys. Space Sci. Libr. **440**, (Springer, Berlin, Heidelberg, 2016). pp. 61-67. https://doi.org/10.1007/978-3-662-52859-4_2

[5] H. Tananbaum, H. Gursky, E. Kellogg, R. Giacconi, and C. Jones, ApJ, 177, L5 (1972). https://doi.org/10.1086/181042

[6] R.A. Remillard, and J.E. McClintock, Ann. Rev. A & A, **44**, 49 (2006). https://doi.org/10.1146/annurev.astro.44.051905.092532

[7] T.M. Belloni, and L. Stella, Space Science Review, **183**, 43 (2014). https://doi.org/10.1007/s11214-014-0076-0

[8] A.R. Ingram, and S.E. Motta, New Astron. Rev. **85**, 101524 (2019). https://doi.org/10.1016/j.newar.2020.101524

[9] F. Makino, IAUC, 4782, 1 (1989).

[10] J.C.A. Miller-Jones, P.G. Jonker, V. Dhawan, W. Brisken, M.P. Rupen, G. Nelemans, and E. Gallo, ApJ, **706**, L230 (2009). https://doi.org/10.1088/0004-637X/706/2/L230

[11] A. Jana, J.-R. Shang, D. Debnath, S.K. Chakrabarti, D. Chatterjee, and H.-K. Chang, Galaxies, **9**, 39 (2021). https://doi.org/10.3390/galaxies9020039

[12] Y. Tanaka, in: *Proc. 23rd ESLAB Symp. On Two-Topics in X-ray Astronomy, ESA SP-296*, **1**, edited by J. Hunt, and B. Battrick, (ESA, Paris, 1989).

[13] J. Rodriguez, M.Cadolle Bel, J. Alfonso-Garzón, *et al.*, A & A, **581**, L9 (2015). https://doi.org/10.1051/0004-6361/201527043

[14] J.P. Roques, E. Jourdain, A. Bazzano, *et al.*, ApJ, **813**, L22 (2015). https://doi.org/10.1088/2041-8205/813/1/L22

[15] P.A. Jenke, C.A. Wilson-Hodge, H. Jeroen, *et al.*, ApJ, **826** 37 (2016). https://doi.org/10.3847/0004-637X/826/1/37

[16] T. Munoz-Darias, J. Casares, M.D. Sánchez, *et al.*, MNRAS: Letters, **465**, L124 (2017). https://doi.org/10.1093/mnrasl/slw222

[17] J.J.E. Kajava, S.E. Motta, *et al.*, A & A, **616**, A129 (2018). https://doi.org/10.1051/0004-6361/201731768

[18] J. Khargharia, C.S. Froning, and E.L. Robinson, ApJ, **716**, 1105 (2010). https://doi.org/10.1088/0004-637X/716/2/1105

[19] A.S. Devi, R. Misra, V.K. Agrawal, and K.Y. Singh, ApJ, **664**, 458 (2007). https://doi.org/10.1086/518533

[20] R.M. Wagner, S.G. Starrfield, R.M. Hjellming, S.B. Howell, and T.J. Kreidl, ApJL, **429**, L25 (1994). https://doi.org/10.1086/187404

[21] R. Narayan, D. Barret, and J.E. McClintock, ApJ, 482, 448 (1997). https://doi.org/10.1086/304134

[22] A.K.H. Kong, J.E. McClintock, M.R. Garcia, S.S. Murray, and D. Barret, ApJ, 570, 277 (2002). https://doi.org/10.1086/339501

[23] C.K. Bradley, R.I. Hynes, A.K.H. Kong, *et al.*, ApJ, 667, 427 (2007). https://doi.org/10.1086/520323

[24] M.T. Reynolds, R.C. Reis, J.M. Miller, E.M. Cackett, and N. Degenaar, MNRAS, **441**, 3656 (2014). https://doi.org/10.1093/mnras/stu832

[25] J. Martí, P.L. Luque-Escamilla, and M.T. García-Hernández, A& A, **586**, A58 (2016). https://doi.org/10.1051/0004-6361/201527239

[26] V. Rana, A. Loh, S. Corbel, *et al.*, ApJ, 821, 103 (2016). https://doi.org/10.3847/0004-637X/821/2/103

СПЕКТРАЛЬНІ ТА ЧАСОВІ ДОСЛІДЖЕННЯ V404 CYGNI ЗА ДОПОМОГОЮ *CHANDRA* СПОСТЕРЕЖЕНЬ

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Ми представляємо спектральне та часове дослідження V404 Cygni з усіх доступних спостережень Chandra, які нещодавно опубліковані в архіві даних Chandra. Обробку та аналіз даних проводили за допомогою CIAO 4.14 і HEASOFT 6.30.1. Спектральний аналіз проводився за допомогою пакета спектрального підбору XSPEC версії 12.12.1, доступного в пакеті Heasoft. Спектр джерела встановлюється в діапазоні енергій 0,3-8,0 кеВ з використанням двох емпіричних спектральних моделей - поглиненого степеневого закону та поглиненого диска-чорного тіла. Встановлено, що подвійне джерело рентгенівського випромінювання V404 Cygni знаходиться в стані спокою, його рентгенівська світність у кілька разів перевищує 10^{32} ерг $с^{-1}$. Виявлено, що джерело перебуває у жорсткому стані та добре пояснюється степеневою моделлю зі степеневим індексом фотона Γ ~ 2 з n_H у діапазоні ~ (0,7 -1,2) × 10^{22} cm^{-2}. Згідно з аналізом часу, Src-1 (V404 Cygni), у всіх інтервалах часу - 0,5, 1 і 2 кс, ймовірність того, що швидкість рахунку буде постійною, становить 0,17 $\times 10^{-33}$ у всіх спостереженнях у 2021 та 2023 роках (ObsID 23421, ObsID 23422, ObsID 23423 & ObsID 28927). Однак у спостереженнях за 2017 рік він виявився менш мінливим. Це чітко демонструє наявність короткочасної мінливості в кілосекундних масштабах часу з доступними на даний момент даними Chandra. Отже, показово, що бінарне джерело V404 Cygni, швидше за все, буде змінним джерелом як у довгостроковому (роки), так і в короткостроковому (кілосекунди) масштабах.

Ключові слова: *акреція, акреційні диски; рентгенівські промені; подвійні зірки: індивідуальні (V404 Cygni); чорні діри*