Astronomy Letters, Vol. 26, No. 11, 2000, pp. 725–729. Translated from Pis'ma v Astronomicheskiĭ Zhurnal, Vol. 26, No. 11, 2000, pp. 842–847.

A Preliminary Version of a Catalog of High-Low-Mass X-ray Binaries

O. H. Guseĭnov[1]*, A. T. Sayagac[2], A. Allakhverdiev[1], H. Caliskan[2], S. Ozdemir[3], S. K. Yerli[4], and A. Ankay[4]

[1] *University of Akdeniz, Faculty of Science and Education, Department of Physics, Antalya, Turkey*
[2] *University of Istanbul, Faculty of Science, Department of Astronomy and Space Sciences, Istanbul, Turkey*
[3] *Ankara University, Department of Astronomy and Space Science, Ankara, Turkey*
[4] *Middle East Technical University, Department of Physics, Ankara, 06531 Turkey*

Received October 1, 1999; in final form, December 27, 1999

Abstract—We introduce a catalogue of X-ray binaries. The full catalogue is available at http://astroa.physics.metu.edu.tr/XRBC/. The aim of this catalogue is to provide basic information about X-ray sources and their counterparts. The catalog contains positions, information about distances and counterparts, spectral, photometric and timing properties of the X-ray sources in the X-ray and optical bands, as well as references. The list of references, comments and the catalog as a whole will be periodically updated to include the most up-to-date information about all X-ray binaries and guide users to the recent literature on individual sources. In some cases, there is some doubt about the nature of an X-ray source, which has been noted. The sources are ordered according to right ascension. Here, we present a guide to the organization of the full catalogue. The full catalogue is represented here with an excerpt containing two HMXBs and two LMXBs as examples. *© 2000 MAIK "Nauka/Interperiodica".*

Key words: *catalogs, X-ray binaries, neutron stars, X-rays*

INTRODUCTION

The discovery of the first point X-ray source Sco X-1 (Giacconi *et al.* 1963) outside the solar system was a surprise, because the only previously known stellar X-ray emission, that of the solar corona, did not lead to an expectation of bright point X-ray sources. The general properties of point X-ray sources in the Galaxy were understood in terms of accretion onto compact objects (Zel'dovich and Guseinov 1965; Shklovskii 1967; Guseinov 1970) just before the first UHURU satellite sky survey in 1971. The results of the UHURU sky survey (Forman *et al.* 1978) were followed by publications from various rocket and satellite observations (Ariel V sky survey, McHardy *et al.* 1981; Warwick *et al.* 1981; MIT OSO-7, Markert *et al.* 1979; HEAO A-1 sky survey, Wood *et al.* 1984), and catalogs were compiled to bring together data from different experiments (Amnuel *et al.* 1979, 1982).

The first X-ray transient (nova) Cen X-2 was discovered from a rocket (Harries 1967). The first X-ray pulsar Cen X-3 was observed in 1971 (Giacconi *et al.* 1971; Schreier 1972). The first burster LMXB 1820-303 was discovered in 1976 (Grindlay *et al.* 1976); Cyg X-1 was discovered in 1965 and discussed as a black-hole candidate in 1972. The first quasi-periodic oscillation (QPO) behavior was also noted from Cyg X-1 (Frontera and Fuligni 1975). The classic QPO phenomenon from LMXBs was first discovered by Van der Klis *et al.* (1985) from the source LMXB 1758-250.

The first comprehensive catalog of X-ray binaries was presented by Van Paradijs (1995). Our catalog includes, as X-ray binaries, the point X-ray sources powered by accretion onto neutron stars and black holes. The weak sources powered by stellar coronas, Wolf-Rayet stars, and cataclysmic variables are not included. Among those X-ray binaries presented in the catalog, there are 78 HMXBs (35 and 5 of which are pulsars and possible pulsars, respectively) and 138 LMXBs (only 9 of which are pulsars), 89 transient and possible transient sources, and 25 possible black holes (6 HMXBs+19 LMXBs). There are also 43 bursters (all of which are Galactic LMXBs) and 21 QPOs. The present catalog extends the work by Van Paradijs, tabulates further information on the compact objects and their companions, as discussed below, as well as attempts to provide a more comprehensive guide to the literature. Where different authors obtained different values for system parameters, we have quoted all parameter values together with the references to guide the reader to the relevant literature for the derivation of the parameters. We introduce the catalog with four examples given in tabular form below.

* E-mail address for contacts: huseyin@sci.akdeniz.edu.tr

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Data for 2 HMXBs and 2 LMXBs

Table 1 (sample)

Name	Location	Type	RA (2000)	Dec (2000)	RA (1950)	Dec (1950)
0115+634		P, T	$01^n18^m32^s$	63°44′24″	$01^n15^m13\overset{s}{.}8$	63°28′38″
0115–737	SMC	P	01 17 05	−73 26 35	01 15 45.6	−73 42 22
J0422+32		Q, R	04 21 42.7	32 54 27.1	04 18 29.9	32 47 24
0620–003		R	06 22 44.4	00 20 44.7	06 20 11.1	−00 19 11

Table 2 (sample)

Name	l^{II}	b^{II}	P_{orb}, days	P_{pulse}, s	P_{rem}	kT, keV	α	Distance, kpc
0115+634	125.9	1.0	24.309	3.61451	*			*
0115–737	300.4	–43.6	3.89239	0.717	*	0.18*		57
J0422+32	165.9	–11.9	0.212140			2		1.2*
0620–003	210	–6.5	0.325		*	*	~1.6	1*

Table 3 (sample)

Name	$\log N_H$, cm^{-2}	A_V, mag.	L_X, erg s^{-1}	L_X/L_0	SpecT	V, mag.	$B–V$, mag.
0115+634	22.08	>5	*	1.7	OBe	14.8*	1.61*
0115–737	<21.60	0.1	6.0×10^{38}	*	B0 Ib	13.3	–0.14
J0422+32	<21.7*	1.2*	2.7×10^{37}	*	M2 V	22.24*	0.15*
0620–003	21.2*	1.2	$1.0\times10^{38*}$	200	K4–K7 V	18.3	1.4

Table 4 (sample)

Name	$U–B$, mag.	$E(B–V)$, mag.	M_X, $M_\odot$	M_{opt}, $M_\odot$	$f_X(M)$, $M_\odot$	$f_{opt}(M)$, $M_\odot$	e_{opt}
0115+634	0.3	1.7		>20*	5		0.34
0115–737	–0.98	~0.1*	1.17*	15.2*	10.8		$<10^{-5}$*
J0422+32	–0.5	0.2*	>3*	0.39*	3.1*	0.9	
0620–003	–0.8	0.35*	5.17	*		2.9	

Table 5 (sample)

Name	K_X, km s^{-1}	K_{opt}, km s^{-1}	γ, km s^{-1}	$a_1 \sin i$, light-s	$a_2 \sin i$, light-s	i, deg
0115+634	133.7		365	140		
0115–737	299.5	*	180	53.46*		70*
J0422+32	41.6	380*				≤45*
0620–003	43*	442*	–28	0.311	2.03	90*

THE CATALOG

This paper aims at providing a guide in print to the long and comprehensive full catalog of X-ray binaries at the Web site http://astroa.physics.metu. edu.tr/XRBC/. Below, we present the data and references of HMXBs 0115+634, 0115-737 and LMXBs J0422+32, 0620-003 as examples. The full catalog on the Web will be updated periodically.

The full catalog mainly consists of two parts, hmxb and lmxb, each of which has four files:

(1) The main catalog is composed of hmxb_cat and lmxb_cat. The most recent and/or the most reliable data are given in these files.

(2) All of the cross catalog names of the sources and the names of the optical counterparts are given in hmxb_nam and lmxb_nam.

Table 6 (sample)

Name	Names of optical counterparts	Other names of sources
0115+634	V635 Cas	2E 0115.1+6328
		H 0115+634, 1H 0115+635
		3U 0115+63, 4U 0115+63
		1XRS 01152+634
		PSR B0115+63.4
0115–737	Sk 160	SMC X-1
		2A 0116–737, 3A 0115–737
		1E 0115.5–7342, 2E 0115.8–7342
		H 0115–737
		3U 0115–73, 4U 0115–73
		1XRS 01157–737
		SK 160, WW 63
J0422+32	V518 Per	GRO J0422+32
		Nova Persei 1992
0620–003	V616 Mon	A 0620–00
		N Mon 1917, 1975

(3) The intensity values (in units of μJy, erg cm^{-1} s^{-2}, and mCrab), energy bands, dates of observations, names of satellites for these observations, and the references of all these data are given in hmxb_obs and lmxb_obs.

(4) All of the data other than the most recent and/or the most reliable ones are presented in hmxb_rem and lmxb_rem. The values given in intervals are also presented in these two files (e.g., a distance value of 4–5 kpc of a source is given in hmxb_rem or lmxb_rem (not in hmxb_cat or lmxb_cat) even if it is the most recent and/or the most reliable distance value of that source).

The columns in the main catalog (hmxb_cat and lmxb_cat) present: (1) numbers of the sources according to right ascension (RA), (2) names, (3) locations, (4) types (H—black hole, B—burster, P—pulsar, T—transient, R—recurrent tr., Q—QPO), (5) right ascension RA (2000), (6) declination (dec) (2000), (7) RA (1950), (8) dec (1950), (9) Galactic longitude (l^{II}), (10) Galactic latitude (b^{II}), (11) orbital period (P_{orb}), (12) pulse period (P_{pulse}), (13) remarks on period values (P_{rem}) (shown with asterisks), (14) X-ray temperature *kT*, (15) spectral index (α), (16) distance, (17) logarithm of neutral hydrogen column density ($\log N_H$), (18) optical absorption (A_V), (19) X-ray luminosity (L_X), (20) X-ray to optical luminosity (L_X/L_0), (21) spectral type (SpecT), (22) *V* (stellar magnitude), (23) *B–V* (stellar magnitude), (24) *U–B* (stellar magnitude), (25) *E(B–V)* (stellar magnitude), (26) mass of the compact object (M_X), (27) mass of the

Table 7 (sample)

Name	References	Dates	Satellites	Energy bands, keV
0115+634	1994IAUC.5990....1S	Jan., 1971	Uhuru	2–6
	1994IAUC.5999....2W	May 15, 1994	BATSE	20–40
	1997MNRAS.284..859N	May 18, 1994	BATSE	20–50
		May 28, 1994	BATSE	20–50
		May 30, 1994	BATSE	20–50
	Intensity, μJy	Intensity, erg cm^{-2} s^{-1}	Intensity, mCrab	
	120			
			45	
			65	
			75	
			180	
0115–737	1977ApJ..217...543P	1971–73	Uhuru	2–6
	60			
J0422+32	1995ApJ...441..786C	Aug. 8, 1992	GRO	20–300
	1992IAUC.5580....1P		GRO	2–11
	1993A&A...280L...1S		ROSAT	0.1–2.4
	1995ApJ...461..351C	1994	BATSE	2–11
			≫3	
		9.3×10^{-9}		
			0.3	
		9.3×10^{-9}		
0620–003	1975Nat..257...656E	Aug. 14, 1975	ArielV	2–18
		Jan. 7, 1976	S3	2–6
		Feb. 1976	ArielV	2–6
		Mar. 1976	ArielV	2–6
	83500		~25	
	300			
	1500			
	<70			

Table 8 (sample)

Name	References	Other Data	Values of Other Data
0115+634	1978Nat..273...367C	P_{pulse}	3.61 s
	1979Nat..282...240W	$P/\dot{P}$	5.9×10^{-11} s
	1983ApJ..270...711W	Distance	4.4, 3.5, 4, 3 kpc
	1991ApJ..375L...49N	Distance	5–7 kpc
	1992ApJ..389...657T	L_X	8×10^{36} erg s^{-1}
	1989A&A..217...115V	L_X	$(0.7–3) \times 10^{37}$ erg s^{-1}
	1978ApJ..223L...71J	M_{opt}	35 $M_\odot$
	1981ApJ..247...222H	Spec. Type	O–Be
		V	$14\overset{m}{.}5$–$16\overset{m}{.}3$, $15\overset{m}{.}5$
		$B–V$	$1\overset{m}{.}4$
0115–737	1986A&A..154....77T	Energy	2.17 keV
	1984ApJ..283...546W	L_X/L_{opt}	1.2–8
	1983ApJ..266...814M	M_X	1.6 $M_\odot$
	1981A&A...97...134B	M_{opt}	16 $M_\odot$
	1995A&A..303...497V	e_{opt}	<0.0007, 0
	1993MNRAS.261...337R	K_{opt}	19, 23 km s^{-1}
	1981A&A..101...184B	K_{opt}	23–27.5 km s^{-1}
	1984ApJ..283...249H	$a_1 \sin i$	53.5 light-s
	1982A&A..106...339V	i	67°
	1983ApJ..266...814M	$E(B–V)$	$0\overset{m}{.}03$
J0422+32	1993A&A...273L..11P	P_{orb}	$0\overset{d}{.}2157$, 0.211, 0.216
	1995A&A..297...103C	Distance	~2, >1, 2.4, ≤2.2 kpc
	1993A&A..288L...1S	L_X/L_{opt}	44, ~500
	1995PASJ..47...31K	L_X/L_{opt}	4–75
	1993A&A..276L...37C	L_X	6.7×10^{36}, 1.5×10^{38}, 8×10^{36}
	1995ApJ..455...614F	$\log N_H$	21.23
	1995ApJ..446L...59O	A_V	$1\overset{m}{.}25$
	1996A&A..312...105C	M_X	>2.4, 3.57, 4–6, 2.9–6.2 $M_\odot$
	1995ApJ..441...779V	M_{opt}	<0.5 $M_\odot$
	1997ApJ..476L...23V	K_{opt}	~340, 300–400 km s^{-1}
	1992PASJ..44L...15F	i	41°–43°, <59°, 48°
	1992ApJ..399L..145R	Spec. Type	M0 V
	1995MNRAS.276L.35C	V	$13–20\overset{m}{.}7$, $12\overset{m}{.}6$, $22\overset{m}{.}4$
	1996MNRAS.282.191D	$B–V$	$0\overset{m}{.}3$, $0\overset{m}{.}38$
	1995ApJ..442...786C	$E(B–V)$	$0\overset{m}{.}3$, $0\overset{m}{.}4$
0620–003	1995ApJ..442...358M	P_{orb}	$0\overset{d}{.}323$
	1974A&SS..29...331A	Distance	0.9–1.1, 0.6–1.4, 0.87 kpc
	1977ApJ..212...203K	Energy	1.5–3.0 keV
	1986ApJ..308...110V	L_X	10^{38}, 1.6×10^{38}, 6×10^{30} erg s^{-1}
	1977ApJ..212...209K	$\log N_H$	21.59
	1994MNRAS.268.763S	M_X	6, ~10, 2.7–3.2, 3.19–3.82 $M_\odot$
	1988ApJ..334...336D	M_{opt}	0.6, 0.36, 0.5–0.8 $M_\odot$
	1977ApJ...217..181O	K_X	43 km s^{-1}
	1983ApJ...266L..27M	K_{opt}	457 km s^{-1}
	1994MNRAS.271L.10S	i	57°
	1990ApJ..359L...47H	Spec. Type	K3, K5V, K4–K5V
		V	$12–18^m$
		$B–V$	$0\overset{m}{.}2$
		$E(B–V)$	$0\overset{m}{.}4$

optical companion (M_{opt}), (28) mass function from X-ray observations (f_X), (29) mass function from optical observations (f_{opt}), (30) eccentricity of the orbit from optical observations (e_{opt}), (31) semi-amplitude velocity of the compact object (K_X), (32) semi-amplitude velocity of the optical companion (K_{opt}), (33) center-of-mass velocity (γ), (34) semi-major axis multiplied by inclination ($a_1 \sin i$), (35) ($a_2 \sin i$), and (36) inclination (i). An asterisk (*) shows that there are remarks on the related data.

ACKNOWLEDGMENTS

We are grateful to M.A. Alpar, H. Ögelman and Ü. Kiziloğlu for valuable discussions and helpful remarks. We thank M.A. Gürkan for his help in the preparation of the manuscript and T. Özişik for Internet Web Site support. This work was supported by the Scientific and Technical Research Council of Turkey, *TÜBITAK*, under the High Energy Astrophysics Research Unit TBAG Ü-18, and by the Research Fund of the University of Istanbul (project no. 952/0900 597).

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Translated by V. Astakhov