High resolution spectroscopy of the Low Mass X-ray Binary XB 1832-330

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High resolution X-ray spectroscopy: towards IXO MSSL, 2009-19-03

Why an XMM-Newton observation of XB 1832-330?

XB 1832-330 is a luminous LMXB and a type I X-ray burster in a Galactic globular cluster (NGC 6652)

It is a *candidate* Ultracompact X-ray Binary (UCXB) (XRB with Porb < 1 hr) Why an XMM-Newton observation of XB 1832-330?

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It is a *candidate* Ultracompact X-ray Binary (UCXB) (XRB with Porb < 1 hr)

UCXB=both stars are **compact and degenerate** (hydrogen deficient)

UCXBs are probes of the **stellar and binary evolution** (how do they form?) Particularly interesting are UCXBs **in globular clusters:** their overabundance point to a **different origin**

Sidoli et al. 2008

Confirmed Ultracompact Binaries

J.-P. Lasota et al.: Stability of irradiated helium discs

Table 1. UCXBs ($P_{orb} \leq 60 \text{ min}$).

System	$P_{\rm orb}$ (min)	$\dot{M} (M_{\odot} \mathrm{y}^{-1})^a$	Type ^b	Comment ^c
4U 1820-30 ¹	11.42	5.1×10^{-9}	Р	(in GC)
4U 1543-624 ²	18.2	5.5×10^{-10}	Р	
4U 1850-087 ³	20.6	1.3×10^{-10}	Р	(in GC)
M15 X-2 ⁴	22.58	1.2×10^{-10}	Р	(in GC)
XTE J1807-294 ⁵	40.07	1.9×10^{-12}	Т	(MSP)
4U 1626-67 ⁶	41.4	2.0×10^{-10}	Т	(young pulsar)
XTE J1751-3057	42.42	4.5×10^{-12}	Т	(MSP)
XTE J0929-314 ⁸	43.6	4.1×10^{-12}	Т	(MSP)
4U 1916-05 ⁹	49.48	7.6×10^{-10}	Р	
SWIFT J1756.9-250810	54.7	9.3×10^{-13}	Т	(MSP)

^a See comments in the text; ^b P - persistent, T - transient; ^c GC - globular cluster, MSP - millisecond pulsar.

¹ Zdziarski et al. (2007); ² Wang & Chakrabarty (2004); ³ Sidoli et al. (2006); ⁴ Dieball et al. (2005); ⁵ Markwardt et al. (2003); Falanga et al. (2005); ⁶ Krauss et al. (2007); ⁷ Markwardt et al. (2002); Gierliński & Poutanen (2005); ⁸ Galloway et al. (2002); Juett et al. (2003); ⁹ Juett & Chakrabarty (2006); ¹⁰ Krimm et al. (2007).

from Lasota et al. 2008

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XB 1832-330



FIG. 1.—HRC-I Chandra image of NGC 6652. Image smoothed by wavelet detection algorithm WAVDETECT, part of Chandra analysis software package CIAO. The large circle represents one core radius (4".2; Harris 1996), and the cross marks the location and estimated uncertainty in the cluster center (J. E. Grindlay et al. 2001, in preparation). The small circles (radius 0".25, WF/PC2 FWHM for point sources) represent the locations (shifted to HRC frame) of the three likely optical counterparts, as well as the blue star near source D.

Heinke et al.2001

XB1832-330: a <u>candidate</u> Ultracompact X-ray Binary (XRB with Porb < 1 hr)

 A modulation in the optical counterpart (Mv= 3.7; HST data) one of the possible periods is shorter than 1 hr
 Mv is similar to other firm UCXBs: e.g. X1820-303; X1850-087



Ultracompact Binaries

ASCA

Neon rich degenerate donors?



low resolution spectra suggested the presence of an emission line at 0.7 keV, but later...

Juett et al. 2001

Ultracompact Binaries

Neon rich degenerate donors

Wavelength (Å)

High resolution observations with *Chandra* and *XMM-Newton* revealed that it can be explained by **excess neutral Ne absorption**



Juett et al. 2003

Ultracompact Binaries

Neon rich degenerate donors

High resolution observations with *Chandra* and *XMM-Newton* revealed that it can be explained by **excess neutral Ne absorption**

Ne/O number ratio

2S0918-549 **Ne/O =** 0.52+/- 0.12 *(Chandra)*

4U1543-624 Ne/O = 1.5 +/- 0.3(Chandra) Ne/O = 0.54 +/- 0.01(XMM-Newton; softer and fainter emission) variable Ne/O -> it is local

Is this a spectral signature of ultracompactness?

Juett et al. 2003



XMM-Newton observation

to investigate the low energy absorption towards the candidate UCXB XB 1832-330 in the Galactic globular cluster NGC 6652



²⁰⁰⁶ Sep 22 (28 ks)



2006 Sep 22 (28 ks)

2006 Oct 20 (34 ks)





September 2006 RGS12+EPIC



October 2006 RGS12+EPIC



RGS 12 - September 2006 observation



RGS 12 - October 2006 observation



RESULTS on the absorption towards XB 1832-330

Obs	Edge	$ au_{ ext{edge}}$	$N_{\rm Z}$ (10 ¹⁷ cm ⁻²)	Ne/O
Sep06	Ne K O K	$\begin{array}{c} 0.040\substack{+0.009\\-0.010}\\ 0.345\substack{+0.024\\-0.029}\end{array}$	$\begin{array}{c} 1.1 \pm 0.3 \\ 6.1^{+0.4}_{-0.5} \end{array}$	0.18 ± 0.06
Oct06	Ne K O K	$\begin{array}{c} 0.055^{+0.009}_{-0.009} \\ 0.505^{+0.025}_{-0.025} \end{array}$	1.5 ± 0.3 8.9 ± 0.4	0.17 ± 0.03

uncertainties are 1-sigma

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to be compared with ISM Ne/O = 0.18 (Wilms et al 2000)

-> NO EVIDENCE of a local neutral Ne overabundance -> NO EVIDENCE of a Ne-rich degenerate donor uncertainties are 1-sigma

Confirmed Ultracompact Binaries

J.-P. Lasota et al.: Stability of irradiated helium discs

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Ne overabundance?

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possible ionization effect (Juett et al.)

from Lasota et al. 2008

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Timing analysis EPIC pn data

P1= 9200 +/- 240 s



September 2006

Lomb Scargle periodogram

Timing analysis EPIC pn data

P2~18600 +/- 500 s

P1= 9200 +/- 240 s



September 2006

October 2006

Lomb Scargle periodogram



CONCLUSIONS

High Resolution SPECTROSCOPY

Analysis of the **low energy absorption towards** the candidate UCXB XB 1832-330 in the Globular cluster NGC 6652

Ne/O number ratio consistentent with ISM value No evidence for a Ne-rich degenerate donor

BUT note that also other firm UCXBs do not show Ne overabundance

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TIMING ANALYSIS

This periodicities are NOT the same as previously claimed by Heinke et al (2001)

The period P2 (~2.5 hr) found in October is ~ 2 P1 (September)

These periods, if real, would exclude the ultracompact nature