A&A 406, 299–304 (2003)
DOI: 10.1051/0004-6361:20030770

Astronomy & Astrophysics

XMM-Newton study of the persistent X-ray source 1E 1743.1–2843 located in the Galactic Center direction

D. Porquet[1], J. Rodriguez[1,2], S. Corbel[1,3], P. Goldoni[1], R. S. Warwick[4], A. Goldwurm[1], and A. Decourchelle[1]

[1] Service d'Astrophysique, CNRS URA 2052, CEA Saclay, 91191 Gif-sur-Yvette, France
[2] Integral Science Data Center, Chemin d'Ecogia 16, 1290 Versoix, Switzerland
[3] Université Paris VII, fédération APC, 2 place Jussieu, 75005 Paris Cedex, France
[4] X-Ray Astronomy Group, Department of Physics and Astronomy, Leicester University, LE1 7RH, UK

Received 30 January 2003 / Accepted 20 May 2003

Abstract. We report the results of an *XMM-Newton* observation of the persistent X–ray source 1E 1743.1–2843, located in the Galactic Center (GC) direction. We determine the position of the source at $\alpha_{\rm J2000} = 17^{\rm h}\,46^{\rm m}\,21.0^{\rm s}$, $\delta_{\rm J2000} = -28^\circ\,43'\,44''$ (with an uncertainty of 1.5″), which is the most accurate to date, and will enable cross-identifications at other wavelengths. The source was bright during this observation ($L_{2-10\,{\rm keV}} \sim 2.7 \times 10^{36}\ d^2_{10\,{\rm kpc}}$ erg s^{-1} for a power-law continuum), with no significant variability. We propose that 1E 1743.1–2843 may be explained in terms of a black hole candidate in a low/hard state. There is an indication that the source exhibits different states from a comparison of our results with previous observations (e.g., *ART-P*, *BeppoSAX*). However, the present spectral analysis does not rule out the hypothesis of a neutron star low-mass X-ray binary as suggested previously. If 1E 1743.1–2843 is actually located in the GC region, we might expect to observe significant 6.4 keV fluorescent iron line emission from nearby molecular clouds (e.g., GCM+0.25+0.01).

Key words. X-rays: general – X-rays individual: 1E 1743.1–2843 – stars: neutron – black hole physics – stars: binaries: general

1. Introduction

The source 1E 1743.1–2843 was discovered during the first X–ray imaging observations of the Galactic Center (GC) region performed with the *Einstein* Observatory (Watson et al. 1981). Its column density ($>10^{23}$ cm^{-2}) is one of the highest observed in the bright X–ray sources found in this region of sky, suggesting a distance similar to, or greater, than the GC ($d = 7.9 \pm 0.3$ kpc, McNamara et al. 2000). 1E 1743.1–2843 has been detected by all X-ray satellites with X-ray imaging capability above 2 keV (Watson et al. 1981; Kawai et al. 1988; Sunyaev et al. 1991; Pavlinsky et al. 1994; Lu et al. 1996; Cremonesi et al. 1999), whereas in soft X-rays (e.g. *ROSAT*) the source is not detectable due to the high column density along the line-of-sight (see Predehl & Trümper 1994). Kawai et al. (1988) suggested that part of the measured absorption could be intrinsic, as is the case for Vela X-1 and GX 301-2. The inferred X-ray 2–10 keV luminosity of this bright persistent source is about $2 \times 10^{36} \times d^2_{10\,{\rm kpc}}$ erg s^{-1} ruling out models involving coronal or wind emission from normal stars but, conversely, strongly favoring the presence of an accreting compact object. Cremonesi et al. (1999) suggested that the absence of periodic pulsations (and/or eclipses) and the relatively soft X-ray spectrum favor a low mass X-ray binary (LMXB) containing a neutron star. LMXBs are systems in which a compact object (either a neutron star or a black hole) accretes matter from a low-mass ($<1\,M_\odot$) companion star. Most LMXBs containing neutron stars are characterized by the occurrence of Type I X–ray bursts produced by the thermonuclear flashes of the accreted material on the surface of the neutron star. However, no bursts have been observed from 1E 1743.1–2843 in extensive observations over the last 20 years. If 1E 1743.1–2843 is a neutron star LMXB, the lack of bursts is noteworthy because its X-ray luminosity (10^{36}–10^{37} erg s^{-1}) is in the range which is typical of X–ray bursters. The lack of bursting activity in neutron star LMXB of higher luminosity is generally ascribed to the stable burning of H and He in sources operating close to the Eddington limit (Fujimoto et al. 1981). Such a high luminosity would require 1E 1743.1–2843 to be at a distance greater than several tens of kiloparsecs. Type-I bursts are also suppressed in pulsars due to the higher surface magnetic fields (e.g., Lewin et al. 1995). Cremonesi et al. (1999) did not rule out other interpretations such as an extra-galactic source seen through the Galactic plane.

Here we present the results of the first observation of 1E 1743.1–2843 with *XMM-Newton*. Section 2 details the observation and data reduction procedures. Section 3 presents the determination of the accurate X-ray position of this object. Sections 4 and 5 describe, respectively, the timing and spectral analysis. The analysis results are discussed in the last section.

Send offprint requests to: D. Porquet,
e-mail: dporquet@mpe.mpg.de (current address)

2. Observations and data analysis

1E 1743.1–2843 was observed by *XMM-Newton* on September 19, 2000 about 5.5′ off-axis from the center of the pointing. The EPIC-MOS cameras were operated in the standard full-frame mode (time resolution: 2.6 s), and the EPIC-PN camera in the extended full frame mode (time resolution: 200 ms), with the medium filter used in both cases. The effective exposure times were ∼29.1 ksec and ∼22 ksec for the MOS and PN cameras, respectively. The data were reprocessed using version 5.3.3 of the Science Analysis Software (SAS) and further filtered using XMMSELECT. The datasets were screened by rejecting periods of high background arising from marked increases in the incident flux of soft protons. After this data cleaning, the useful observing times are respectively for MOS1 and MOS2 about 22.2 ksec and 23 ksec, and 18.4 ksec for PN. Unfortunately, in the MOS1 CCD, 1E 1743.1–2843 is located on a bright pixel column which makes the data difficult to process. Our present analysis is based largely on the PN data for which we use single events (corresponding to pattern 0) to avoid any possibility of pile-up effects, although the MOS2 data (event patterns 0–12) did provide a valuable check of the results. The inferred PN flux in the 2–10 keV energy range is then about 2×10^{-10} erg cm^{-2} s^{-1}, thus implying a negligible pile-up fraction (<2%, see Fig. 98 in the XMM-Newton Users' Handbook[1]).

Counts from 1E 1743.1–2843 were extracted within a radius of 26.4″, thereby avoiding a gap between the PN CCDs. We extracted a source-free local background from an annulus centered on 1E 1743.1–2843 with inner and outer radii of 2′ and 5′ respectively.

3. X-ray position and multi-wavelength counterpart

In the field of view of our pointing, a bright X-ray point source is associated to an optical foreground Tycho-2 source (HD 316297). This very accurate position allow to refine the astrometry and we find for 1E 1743.1–2843 the following position: $\alpha_{\rm J2000}$ = 17h 46m 21.0s, $\delta_{\rm J2000}$ = −28° 43′ 44″, with a final accuracy limited by the systematic residual uncertainties of 1.5″ (Kirsch 2002). The position inferred from *XMM-Newton* data is by far much more accurate than those determined from earlier observations, i.e about 60″.

According to the relation between the visual extinction ($A_{\rm v}$) and the hydrogen column density along the line-of-sight ($N_{\rm H}$) reported in Predehl & Schmitt (1995), we find for 1E 1743-2843 ($N_{\rm H} \sim 2 \times 10^{23}$ cm^{-2}, see Sect. 5) a value of $A_{\rm v}$ of about 110 mag. The source is too absorbed to be detected by 2MASS (Two Micron All Sky Survey; `http://www.ipac.caltech.edu/2mass/`). An examination of the maps of the NVSS, NRAO VLA Sky Survey (Condon et al. 1998) did not reveal any possible radio counterpart at the position of 1E 1743.1–2843 with flux at 20 cm greater than ∼50 mJy (Cremonesi et al. 1999).

[1] `http://xmm.vilspa.esa.es/external/xmm_user_support/documentation/uhb/`

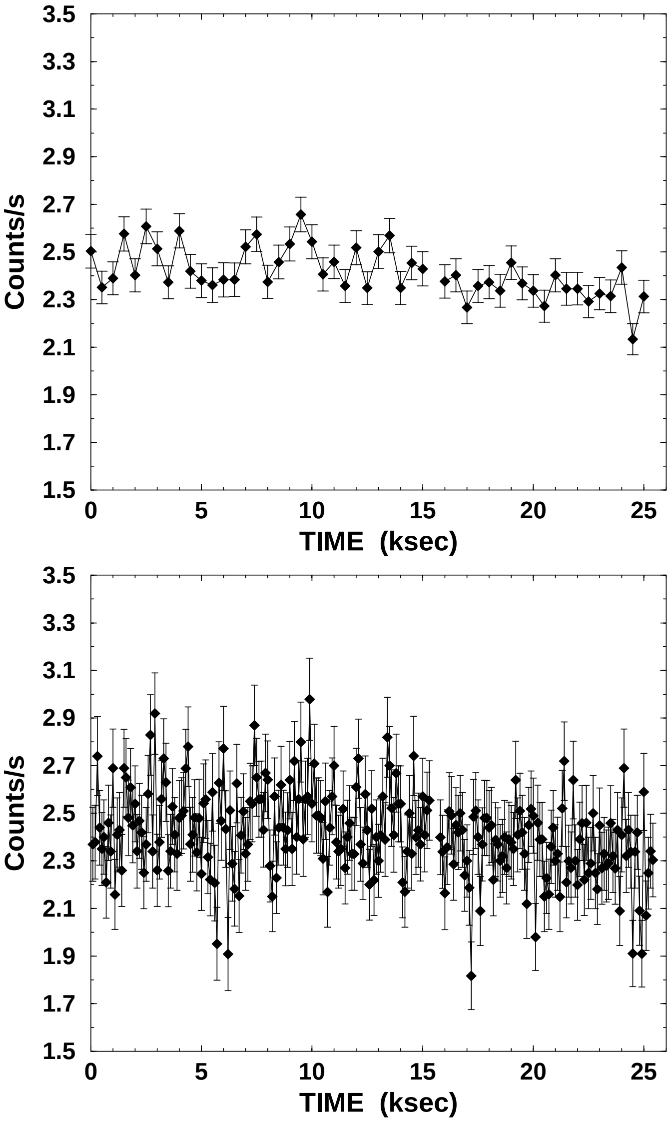

Fig. 1. The 2–10 keV light curve of 1E 1743-2843 measured with *XMM-Newton* PN detector after background subtraction. *Top panel*: time binning of 500 s. *Bottom panel*: time binning of 100 s.

4. Timing analysis

The 2–10 keV background subtracted light curves of 1E 1743.1–2843 obtained during the *XMM-Newton* observation are presented in Fig. 1 for two different time binnings (100 s and 500 s). The light curve shows some variation around the mean value of 2.42 ± 0.10 cts s^{-1} (Fig. 1). Fitting the light curve binned at 500 s with a constant count rate gives a moderate fit with χ^2/d.o.f. = 104/49. In order to determine whether or not this variability was significant, we produced a power spectrum using POWSPEC v1.0, between 2.4 mHz and 2.5 Hz. The resultant power spectrum is flat, and the (leahy) normalized power density spectrum is well fit with a constant value of 1.99 ± 0.01 (χ^2 = 25 for 28 d.o.f.). This value is compatible with the expected value of 2 for a purely poissonian noise (white noise). The data mode employed in the present observation allows timing studies only up to a frequency of 2.5 Hz, which is quite limited, since many

XRBs present quasi periodic variations above that value. No pulsations or quasi periodic oscillations (QPO) are detected in the 2.4 mHz–2.5 Hz frequency range, down to a relatively low level. Indeed using the relation

$$N_\sigma = 0.5 \times \frac{S^2}{S+B}\, r^2 \left(\frac{T}{\Delta\nu}\right)^{\frac{1}{2}},$$

with S the source net count rate, B the background count rate, T the exposure time, r the fractional amplitude, we can estimate a 3 sigma upper limit for a given pulsation (whose width is equal to the frequency resolution of the power spectrum). In our case, this leads to a 3σ upper limit of ∼2.4% for a periodic pulsation and higher for any QPO (which by definition posseses a natural width higher than the frequency resolution).

As already pointed out by Cremonesi et al. (1999), a typical Type I X–ray burst with a peak luminosity close to the Eddington limit would have produced in 1E 1743.1–2843 a very large count rate increase. For EPIC-PN assuming that 1E 1743.1–2843 is located at the Galactic Center ($d \sim 8$ kpc), a factor of 50 increase would be observed between the "quiescent state" and the "burst" count rates. Then such bursts would be readily seen even in a light curve with a time binning as low as 1 s, which is very short compared to the typical duration of a few tens of seconds in LMXB. In addition the non-detection of eclipses in the X-ray light curve implies that the orbital inclination of the system is smaller than 70° (Cowley et al. 1983). We do not see any indication of an orbital variation on long time scale as suggested by Cremonesi et al. (1999) but this is consistent with our shorter observation duration.

Analysis of the Power Density Spectrum indicates that the fractional variability of 1E 1743.1–2843 in the frequency range 10^{-4}–2.5 Hz is less than 18% rms (3 sigma upper limit). This is not a strong constraint, regarding the state of the source (if it is a black hole for example), as only a limited frequency domain has been explored, and such a limit is compatible with either a soft or hard state (Nowak 1995).

5. Spectral analysis

For spectral fitting, the data were rebinned with a minimum of 25 counts per bin to allow use of the χ^2 statistic. XSPEC (v11.1.0) is used for the spectral fitting. The response matrice (.rmf) and ancillary (.arf) files were computed using the SAS package. The spectrum of 1E 1743.1–2843 was fitted between 2 and 12 keV. The photo-electric absorption cross-sections of Wilms et al. (2000) are used throughout this paper with abundances taken from Anders & Grevesse (1989). All errors are quoted at 90% confidence.

We fit the background-subtracted source spectrum with various single-component spectral models as follows: blackbody (BB), power-law (POW), and multi-color disk black-body (MCD, DISKBB). In all cases the hydrogen column density ($N_{\rm H}$) was included as a free parameter. The results of this analysis are presented in Table 1. All of the simple models noted above provided a statistical good fit to the observed spectrum.

For the single BB and DISKBB models, the fits are good but the inferred temperatures are higher ($kT \sim 1.9$ keV and $kT \sim 3.4$ keV, respectively) than those found in general for neutron star LMXBs, i.e., 0.5–1.5 keV (e.g., Barret 2001). The parameters found here for the bb model are consistent, within the error bars, with those found with *BeppoSAX* in April 1998, i.e. $N_{\rm H} = 1.3 \pm 0.1 \times 10^{23}$ cm^{-2}, and $kT = 1.8 \pm 0.1$ keV. The unabsorbed 2–10 keV flux found in the present data appears slightly lower than the one found in April 1998, i.e. 1.65×10^{-10} erg cm^{-2}s^{-1}.

Table 1. The results of fitting different continuum models to the PN data in the 2–12 keV energy range. The fluxes correspond to the 2–10 keV band and are corrected for absorption. The units are 10^{-10} erg cm^{-2} s^{-1}.

Models	$N_{\rm H}$ (10^{23} cm^{-2})	kT (keV) or Γ	χ^2/d.o.f.	Flux (2–10 keV)
pow	2.02 ± 0.04	1.83 ± 0.05	1111/1141	2.40 ± 0.23
bb	1.31 ± 0.03	1.93 ± 0.03	1206/1141	1.52 ± 0.02
diskbb	1.69 ± 0.03	3.4 ± 0.1	1099/1141	1.89 ± 0.21

Recently, absorption features associated to H-like and/or He-like K_α resonance lines of Fe, Ca, Ne, O, and N have been observed in several neutron star LMXBs (e.g, GX 13+1: Ueda et al. 2001; EXO0748-676: Cottam et al. 2001; MXB1659-298: Sidoli et al. 2001; X1624-490: Parmar et al. 2002). Such features are not statistically required in the present data, with equivalent width (*EW*) upper limits (at 90% confidence) of about 10 eV, 1 eV, and 15 eV, respectively for Fe XXVI (∼7 keV), Fe XXV (∼6.7 keV), and Ca XX (∼4.1 keV). The others lines of Ne, O, and N, below 2 keV, are not accessible due to the very large absorption in the line-of-sight.

The excellent power-law fit ($\chi^2_{\rm red} = 0.975$) contrasts with the corresponding results from Cremonesi et al. (1999) where a power-law model gave $\chi^2_{\rm red} = 1.49$. Moreover, fixing the parameters at the values found by Cremonesi et al. (i.e., $N_{\rm H} = 2 \times 10^{23}$ cm^{-2}, and $\Gamma = 2.2$), we also obtain a bad fit for the power-law model ($\chi^2_{\rm red} = 1.53$). Figure 2 shows the PN spectrum of 1E 1743.1–2843 and the residuals of the best-fitting power-law model to the present data. This implies that 1E 1743.1–2843 could be in the present observation a black hole candidate (BHC) in its *low/hard state* or, conceivably, an Active Galactic Nucleus (AGN) observed through the obscuration of the Galactic Plane. The inferred photon index for 1E 1743.1–2843 is about 1.8 which is within the range found in both type of objects (e.g., Wu et al. 2001; Malizia et al. 1999). BHC in our Galaxy are usually associated with weak (few mJy) radio counterpart (e.g., Fender & Hendry 2000; Corbel et al. 2000). For example, the BHC 1E 1740.7–2942 located in the GC region, has a radio flux at 20 cm of about 1.4 mJy (Gray et al. 1992), and an unabsorbed 2–10 keV flux of about 5×10^{-10} erg cm^{-2} s^{-1} (Sidoli et al. 1999), which corresponds to a luminosity of about $5.7 \times 10^{36} d^2_{10\,\rm kpc}$ erg s^{-1}. Similarly, Seyfert galaxies are also rather weak radio sources (Nagar et al. 2000). It follows that both the BHC and AGN

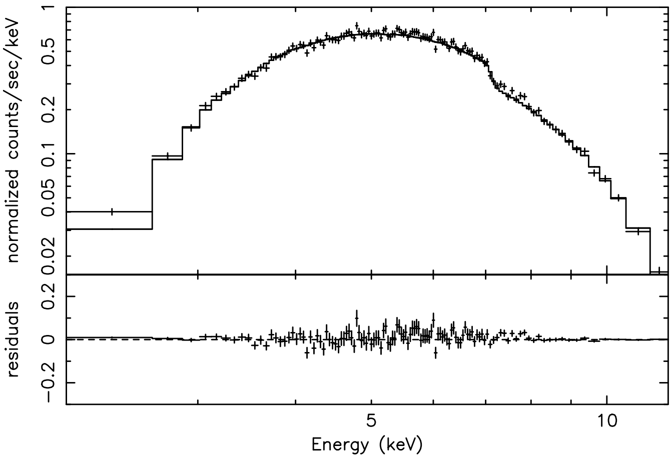

Fig. 2. The 2–12 keV PN spectrum of 1E 1743.1–2843 (binning at 15σ) and the best-fit power-law continuum model. The lower panel shows the residuals of the data to the model.

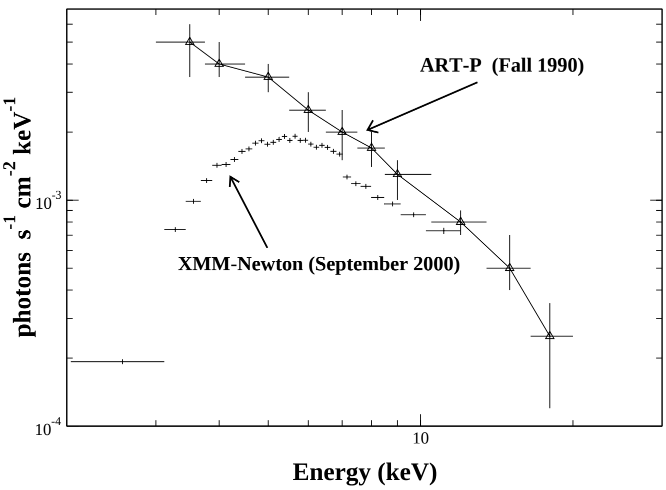

Fig. 3. Photon index spectra of 1E 1743.1–2843. *Filled circles*: present *XMM-Newton* observation (power-law model). *Diamonds*: average spectrum obtained with *ART-P* during Fall 1990 (Pavlinsky et al. 1994).

Table 2. The results of fitting to the PN data with two-component models, in the 2–12 keV energy range.

parameters	BB+POW	DISKBB+POW
N_H (10^{23} cm^{-2})	$2.10^{+0.07}_{-0.06}$	$2.11^{+0.06}_{-0.05}$
kT (keV)	$0.15^{+0.05}_{-0.04}$	$0.16^{+0.04}_{-0.05}$
Γ	1.89 ± 0.05	1.89 ± 0.05
χ^2/d.o.f.	1078.7/1139	1078.6/1139

hypotheses cannot be ruled out by the radio flux limits for 1E 1743.1–2843 quoted earlier.

We found that the presence of an iron K_α emission line at 6.4 keV (from neutral to moderatly ionized iron, i.e. <Fe XVII), is not statistically required by our data with $\Delta\chi^2 < 1$ for one additional parameter. We found an upper limit (at 90% confidence) for the *EW* of 12 eV. This value is compatible with the known properties of LMXBs (i.e., less than 10 to 170 eV; Asai et al. 2000), and with extremely high luminosity Radio-Quiet quasars (George et al. 2000), but rather weak for a typical Seyfert galaxy ($EW \sim 100-150$ eV, Nandra & Pounds 1994).

Although the single power-law component model provides a rather good fit to the PN spectrum, it is worth investigating whether constrained 2-component models add any further information. We fitted a model combining a power-law with a bb (or a MCD). We let all the parameters free in the fitting procedure. We found a very good representation of the present data, and we found a $\Delta\chi^2$ of about 32 for only two additional parameters compared to the one-component power-law model. The results are shown in Table 2. The low value of the temperature together with the hard spectral index found are compatible with a BH in a low hard state, as already observed for example in GX 339-4 ($kT \sim 0.12$ keV, Wilms et al. 1999). Due to the very high absorption below 2 keV, we cannot obtain a strong constraint on the normalization factor of the disk component (which is related to the inner radius of the disk), and hence no reliable constraints on the inner radius of a 0.1 keV accretion disk.

A possible explanation of the differences between our spectral fits and those of Cremonesi et al. (1999) may be due to a different state of the object. We checked for possible spectral variations compared to previous observations obtained from the X-ray coded mask telescope *ART-P* in the 4–20 keV band (Pavlinsky et al. 1994). On the basis of the *XMM-Newton* measurements (specifically the power-law model) we obtain $1.31^{+0.13}_{-0.12} \times 10^{-2}$ photon cm^{-2} s^{-1}, in the 4–20 keV band which is smaller that the average flux determined using *ART-P* during Fall 1990 ($1.77 \pm 0.08 \times 10^{-2}$ photon cm^{-2} s^{-1}; Table 11 in Pavlinsky et al. 1994). In fact 1E 1743.1–2843 is known to be variable in hard X-rays from ART-P observations carried out from Spring 1990 to Winter 1992. Figure 3 compares the photon spectrum inferred from the *XMM-Newton* observation with the average photon spectrum measured by *ART-P* during Fall 1990. In the more recent observation, the intensity is significantly lower at energies below 6 keV. For example the flux at 3.5 keV is about 7 times lower than during fall 1990. The difference could be due to a change in absorption between the two observations. Above 6 keV the spectral slope appears flatter. This is at least weak evidence for the fact that the source changes of state from time to time.

The observation of 1E 1743.1–2843 at higher energies ($E > 30$ keV) would certainly help to determine the nature of the object, indeed up to 12 keV a very absorbed black-body model with kT about 1.8 keV and a very absorbed power-law model have similar shapes. Unfortunately no significant detection above 30 keV of 1E 1743.1–2843 has ever been obtained (see e.g. Goldwurm et al. 1994). This has previously been justified in terms of the source having a soft thermal spectrum; however the *XMM-Newton* observation indicates that the source can enter states where the spectral form is relatively hard.

6. Summary and discussion

We report an *XMM-Newton* observation of the bright X-ray source 1E 1743-2843. During the observation the source flux remained relatively steady at a level corresponding to a 2–10 keV luminosity of about $2.7 \times 10^{36}\ d^2_{10\,\rm kpc}$ erg s^{-1} (assuming a power-law continuum). As in previous X-ray observations, there was no evidence for either X-ray bursts, strong chaotic variability or significant pulsations.

The *XMM-Newton* spectrum of 1E 1743.1–2843 can be well fitted with simple very absorbed ($N_{\rm H}$ = 13–20 × 10^{22} cm^{-2}), featureless, one-component emission models, such as power-law continuum. We found that the present data are compatible with a black hole candidate in a low/hard state. The fact that the measured spectrum is slightly harder than measured earlier by *BeppoSAX* and *ART-P* observations is a tentative indication to a change of state but our spectral coverage is too limited to draw a firm conclusion. The hypothesis of a neutron star LMXB, as proposed earlier by Cremonesi et al. (1999), is not ruled out by our spectral analysis. It could be also an extragalactic source seen through the Galactic Plane. Unfortunately, the data mode employed in the present observation is not suitable for advanced timing analysis, in particular we are unable to investigate whether the source exhibits millisecond X-ray pulsations, which may be detectable from neutron star LMXBs.

It is noteworthy that the X-ray source 1E 1743.1–2843 is located within 20′ of the Galactic Center and, in projection, lies on the periphery of SNR G0.33+0.04 where the SNR emission is the brightest at 90 cm (Kassim & Frail 1996). Also 1E 1743.1–2843 lies very close, again in projection, to a giant molecular cloud core GCM+0.25+0.01 ($\alpha_{\rm J2000}$ = 17h 46m 10.1s, $\delta_{\rm J2000} = -28° 42' 48.4''$), which appears to be located at the GC region, and to contain embedded low-mass star formation (Lis et al. 1994). If 1E 1743.1–2843 is located in the GC region, and behind this cloud, this could explain the high absorption of its soft X-ray flux. In such circumstances we might expect to observe significant 6.4 keV fluorescent line emission in this cloud due to the high X-ray illumination from 1E 1743.1–2843. Indeed, Lis et al. (1994) have already remarked that this cloud might be a further example of an X-ray irradiated reflection nebula. If no significant Fe K_α line at 6.4 keV (neutral or moderately ionized iron) is detected, then one can infer that 1E 1743.1–2843 is far from the Galactic Center region, i.e. at a distance greater than 8 kpc, and has an X-ray luminosity higher than 10^{36} erg s^{-1}. A mosaic with a higher S/N of the Galactic Center region may answer this point (Decourchelle et al. 2003, in preparation). According to the formula of Sunyaev & Churazov (1998) and assuming a minimum projected distance, we obtained a line flux of about 10^{-5} erg s^{-1}, i.e. approximatively 6 times lower than the very bright line emission observed from the giant molecular cloud Sgr B2 (5.6×10^{-5} erg s^{-1}, Murakami et al. 2001). Then 1E 1743.1–2843 could also be a contributor in a smaller part as shown above to the 6.4 keV, iron line observed in Sgr B2 (1E 1743.1–2843 which lies 63 pc away, in terms of the minimum projected distance, Murakami et al. 2000). Long-term monitoring of 1E 1743.1–2843 coupled with a more detailed investigation into its interaction with GC molecular clouds (if any) could therefore be useful for the development of a more complete view of GC activity.

The greatly improved positional constraints from *XMM-Newton* should, in the future, help in the search for a possible counterpart which, in term, would contribute greatly to our understanding of its true nature. Observations at higher energies are needed to determine the source spectral state, but up to now the location of the source in the crowded Galactic Center region and the limited sensitivity and spatial resolution of the available instrumentation have hampered such an investigation. Observations with the IBIS instrument onboard the *INTEGRAL* mission, will bring information about the hard X-ray (i.e. >30 keV) and possible gamma-ray emission of 1E 1743.1–2843 without any spatial confusion, which should help in the determination of its nature. In particular, significant hard X-ray and gamma-ray emissions are expected from BHC in low/hard states.

Acknowledgements. This work is based on observations obtained with *XMM-Newton*, an ESA science mission with instruments and contributions directly funded by ESA Member States and the USA (NASA). We would like to thank the anonymous referee for a careful reading of the manuscript. D. P. and J. R. acknowledges financial support from a postdoctoral fellowship from the French Spatial Agency (CNES).

References

Anders, E., & Grevesse, N. 1989, Geochim. Cosmochim. Act., 53, 197
Asai, K., Dotani, T., Nagase, F., & Mitsuda, K. 2000, ApJS, 131, 571
Barret, D. 2001, Adv. Space Res., 28, 307
Condon, J. J., Cotton, W. D., Greisen, E. W., et al. 1998, AJ, 115 1693
Corbel, S., Fender, R. P., Tzioumis, A. K., et al. 2000, A&A, 359, 251
Cottam, J., Kahn, S. M., Brinkman, A. C., den Herder, J. W., & Erd, C. 2001, A&A, 365, L277
Cowley, A. P., Crampton, D., Hutchings, J. B., Remillard, R., & Penfold, J. E. 1983, ApJ, 272, 118
Cremonesi, D. I., Mereghetti, S., Sidoli, L., & Israel, G. L. 1999, A&A, 345, 826
Fender, R. P., & Hendry, M. A. 2000, MNRAS, 317, 1
Fujimoto, M. Y., Hanawa, T., & Miyaji, S. 1981, ApJ, 247, 267
George, I. M., Turner, T. J., Yaqoob, T., et al. 2000, ApJ, 531, 52
Goldwurm, A., Cordier, B., Paul, J., et al. 1994, Nature, 371, 589
Gray, A. D., Cram, L. E., & Ekers, R. D. 1992, MNRAS, 256, 277
Kassim, N. E., & Frail, D. A. 1996, MNRAS, 283, L51
Kawai, N., Fenimore, E. E., Middleditch, J., et al. 1988, ApJ, 330, 130
Kirsch, M. 2002, XMM-EPIC Status of Calibrations and Data Analysis, XMM-SOC Documentation, ESA-SOC, Vilspa, Spain [http://xmm.vilspa.esa.es]
Lewin, W. H. G., van Paradijs, J., & Taam, R. E. 1995, X-Ray Binaries (Cambridge University Press), 175
Lis, D. C., Menten, K. M., Serabyn, E., & Zylka, R. 1994, ApJ, 423, L39
Lu, F. J., Li, T. P., Sun, X. J., Wu, M., & Page, C. G. 1996, A&AS, 115, 395
Malizia, A., Bassani, L., Zhang S. N., et al. 1999, ApJ, 519, 637
McNamara, D. H., Madsen, J. B., Barnes, J., & Ericksen, B. F. 2000, PASP, 112, 202

Murakami, H., Koyama, K., Sakano, M., Tsujimoto, M., & Maeda, Y. 2000, ApJ, 534, 283
Murakami, H., Koyama, K., & Maeda, Y. 2001, ApJ, 558, 687
Nagar, N. M., Falcke, H., Wilson, A. S., & Ho, L. C. 2000, ApJ, 542, 186
Nandra, K., & Pounds, K. A. 1994, MNRAS, 268, 405
Nowak, M. 1995, PASP, 107, 1207
Parmar, A. N., Oosterbroek, T., Boirin, L., & Lumb, D. 2002, A&A, 386, 910
Pavlinsky, M. N., Grebenev, S. A., & Sunyaev, R. A. 1994, ApJ, 425, 110
Predehl, P., & Trümper, J. 1994, A&A, 290, L29
Predehl, P., & Schmitt, J. H. M. M. 1995, A&A, 293, 889
Sidoli, L., Mereghetti, S., Israel, G. L., et al. 1999, ApJ, 525, 215
Sidoli, L., Oosterbroek, T., Parmar, A. N., & Lumb, D., Erd, C. 2001, A&A, 379, 540
Sunyaev, R. A., Churazov, E., Gilfanov, M., et al. 1991, A&A, 247, L29
Sunyaev, R., & Churazov, E. 1998, MNRAS, 297, 1279
Ueda, Y., Asai, K., Yamaoka, K., Dotani, T., & Inoue, H. 2001, ApJ, 556, L87
Watson, M. G., Willingale, R., Hertz, P., & Grindlay, J. E. 1981, ApJ, 250, 142
Wilms, J., Nowak, M. A., Dove, J. B., Fender, R. P., & di Matteo, T. 1999, ApJ, 522, 460
Wilms, J., Allen, A., & McCray R. 2000, ApJ, 542, 914
Wu, K., Soria, R., Page, M. J., et al. 2001, A&A, 365, L267