X-ray luminosity function of faint point sources in the Milky Way

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Abstract. We assess the contribution to the X-ray (above 2 keV) luminosity of the Milky Way from different classes of low-mass binary systems and single stars. We begin by using the RXTE Slew Survey of the sky at |b| > 10° to construct an X-ray luminosity function (XLF) of nearby X-ray sources in the range 10^{30} erg s^{-1} < L_x < 10^{34} erg s^{-1} (where L_x is the luminosity over 2–10 keV), occupied by coronally active binaries (ABs) and cataclysmic variables (CVs). We then extend this XLF down to L_x \sim 10^{27.5} erg s^{-1} using the Rosat All-Sky Survey in soft X-rays and available information on the 0.1–10 keV spectra of typical sources. We find that the local cumulative X-ray (2–10 keV) emissivities (per unit stellar mass) of ABs and CVs are \(2 \times 10^{27}\) erg s^{-1} M_{\odot}^{-1}, and in addition to ABs and CVs, representing old stellar populations, young stars emit locally \(5 \times 10^{26}\) erg s^{-1} M_{\odot}^{-1}. We finally attach to the XLF of ABs and CVs a high luminosity branch (up to \(\sim 10^{39}\) erg s^{-1}) composed of neutron-star and black-hole low-mass X-ray binaries (LMXBs), derived in previous work. The combined XLF covers \(12\) orders of magnitude in luminosity. The estimated combined contribution of ABs and CVs to the 2–10 keV luminosity of the Milky Way is \(\sim 2 \times 10^{38}\) erg s^{-1}, or \(\sim 3\%) of the integral luminosity of LMXBs (averaged over nearby galaxies). The XLF obtained in this work is used elsewhere (Revnivtsev et al.) to assess the contribution of point sources to the Galactic ridge X-ray emission.

Key words. Stars: luminosity function – Galaxy: structure – X-rays: binaries – X-rays: galaxies – X-rays: stars

1. Introduction

X-ray (above 2 keV) emission is a ubiquitous property of different classes of low-mass close binaries, ranging in order of increasing luminosity from chromospherically and coronally active binaries (ABs) through cataclysmic variables (CVs, magnetic and non-magnetic) and related white-dwarf accretors (symbiotic stars) to neutron-star and black-hole binaries (LMXBs). Although each of these classes has been thoroughly investigated for decades, there remains significant uncertainty as regards the contribution of ABs and CVs, both cumulative and as a function of luminosity, to the integral X-ray luminosity of the Galaxy. On the other hand, the luminosity function (XLF) of LMXBs has been measured with good precision for the Milky Way and nearby galaxies (Grimm et al. 2002, Gilfanov 2004).

There are several important astrophysical problems urging a detailed study of the XLF of ABs and CVs. First, there is a long-standing puzzle of the origin of the Galactic ridge X-ray emission (e.g. Worrall et al. 1982, Warwick et al. 1983). Although there were early suggestions that this apparently diffuse X-ray emission might be composed of thousands and millions of CVs and ABs (Worrall & Marshall 1983, Ottmann & Schmitt 1992, Mukai & Shiokawa 1993), recent deep surveys by Chandra and XMM-Newton in the Galactic plane and in the Galactic Center region resolved only \(\sim 10–30\)\% of the ridge emission (above 2 keV) into point sources (Muno et al. 2004, Ebisawa et al. 2005, Hands et al. 2004), leaving open the question as to what fraction of the unresolved emission is truly diffuse.

Secondly, with the advent of Chandra it has become possible to obtain high-quality X-ray maps of nearby elliptical galaxies and resolve on them individual LMXBs. The underlying diffuse emission is usually attributed to the hot (\sim 0.5 keV) interstellar gas. However, in gas poor galaxies unresolved point X-ray sources associated with the old stellar population may contribute significantly to or even dominate the apparently diffuse emission, especially at high energies (e.g. Canizares et al. 1987, Matsumoto et al. 1997, Irwin et al. 2003). The interpretation of X-ray observations of gas poor ellipticals thus depends critically on our knowledge of the XLF of low-mass binaries in these galaxies, which is expected to resemble the XLF of ABs, CVs and LMXBs in our Galaxy scaled by the stellar mass.

With the above motivation in mind, we construct below a combined XLF of ABs, CVs and LMXBs covering the very broad luminosity range from \(L_x \sim 10^{27.5}\) to...
the solar neighborhood YSs produce Galaxy and other galaxies. It will be shown below that in
borhood may not be representative of other parts of the
constructed for this class of sources in the solar neigh-
governed by local star formation history, so that an XLF
sources (see Güdel 2004 for a review), is expected to be
been observationally demonstrated for LMXBs (Gilfanov
2004). In contrast, the statistics of young coronal stars
also between different types of galaxies. This has already
be identified with extragalactic objects. 60 sources have
intermediate polar (Gänsicke et al. 2003), we estimated the distance using available information about the
secondary star Gänsicke et al. 2003. Specifically, this
CV star contributes $\sim 15\%$ to the R-band flux of the
binary. Given the system’s visual magnitude ($RV = 15.4$) and interstellar extinction toward it $[E(B-V) \sim 0.45]$, and assuming that the secondary is on the main se-
sequence, we find a distance $\sim$2300–3100 pc. However, the
very long orbital period of the binary (15.4 hours) im-
plies that the Roche-lobe filling secondary is evolved (e.g.
Smith & Dhillon 1998). This yields a more likely distance
of $\sim 3,300$ pc, which we adopt here.

Using the distance estimates and measured source count rates in the $3–8$ keV and $8–20$ keV bands, we
determined source luminosities in the $2–10$ keV ($L_2$) and
3–20 keV ($L_3$) band, respectively. A Crab-like spectrum
was assumed for this calculation, which is expected to en-
sure reasonable accuracy of energy flux estimation for our
sources given their measured hardness ratios ($8–20$ keV
counts over $3–8$ keV counts). We note that the quoted lu-
minosities are observed ones, i.e. they are not corrected
for any absorption intrinsic to the sources. The interstel-
lar absorption toward our (high Galactic latitude) sources
is not expected to have a significant effect on the RXTE
measured fluxes. This is true even in the case of XY Ari,
the only source in our sample known to be located behind
a molecular cloud, for which we estimate a line-of-sight ab-
sorption of $N_H \sim 2 \times 10^{22}$ cm$^{-2}$ from the measured visual
extinction $AV \sim 11.5$ Littlefair et al. 2001. Similarly the uncertainty in source distances is unlikely to significantly
affect the statistical results obtained below.

Our XSS sample includes 6 known or suspected ABs and 24 known CVs. Among the former there are 3 RS
CVn binaries, the prototype Algol system ($\beta$ Per) and 2
late-type main-sequence stars (HD125599 and HD130693)
which we consider candidate ABs based on their optical
spectral class, X-ray luminosities and relative X-ray soft-
ness compared to CVs. The CV subsample includes 4 non-
magnetic CVs (dwarf novae), 19 magnetic CVs (6 polars
and 13 intermediate polars) and 1 symbiotic star.

In Fig. 1 we plot the XSS hardness ratio as a func-
tion of luminosity for our identified sample. One can see
that, as expected, the ABs have softer spectra than the

\[ L_x \sim 10^{39} \text{ erg s}^{-1} \] (where $L_x$ is the luminosity in the $2–10$ keV
band). Since these classes of objects represent old stellar populations (in particular ABs maintain high levels of ac-
tivity throughout their lives due to tidal locking of rapid
stellar rotation) their XLF normalized to the stellar mass
is not expected to vary significantly across the Galaxy and
also between different types of galaxies. This has already
Our assessment of source space densities at $L_x < 10^{34}$ erg s$^{-1}$ will be based
on the RXTE Slew Survey (Revnivtsev et al. 2004, hereafter R04) and Rosat All-Sky Survey
(http://wwwxraysmpgeb/cgi-bin/rosat/rosat-survey Voges et al. 1999). In the latter case we also employ spec-
tral information from various X-ray missions to convert
the derived XLF from a soft X-ray band to the standard
X-ray band. The high-luminosity ($L_x > 10^{34}$ erg s$^{-1}$)
branch of the XLF is adopted from previous work of
Gilfanov 2004.

2. Medium luminosity range: RXTE Slew Survey

Recently, a serendipitous survey of the whole sky in the
$3–20$ keV energy band was performed based on slew observ-
ations with the PCA instrument on the RXTE spacecraft
(RXTE Slew Survey, or XSS), and a source catalog at high
Galactic latitude ($|b| > 10^\circ$) was produced (R04). The survey achieved a flux limit of $2.5 \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$
($3–20$ keV) or better for $90\%$ of the $|b| > 10^\circ$ sky.

The majority of the 294 detected XSS sources have
been identified with extragalactic objects. 60 sources have
been identified with objects in the Galaxy, while 21 sources
still remain unidentified. The identified Galactic sample
includes 14 LMXBs and HMXBs, which will not be con-
idered below. We also exclude from the current con-
consideration 4 star forming complexes with multiple X-ray
sources as unresolved by RXTE (Orion, Chamaeleon 1,
Chamaeleon 2 and $\rho$ Ophiuchi), the hot supergiant star
$\zeta$ Ori as also belonging to the Orion complex, the un-
resolved globular cluster NGC 6397, and supernova remnant
SN 1006 as an extended X-ray source. This leaves us with
a total of 40 identified ABs (including 2 candidates, see
below) and CVs. Of these we additionally excluded 10
sources for either of the following reasons: 1) the source
is not detectable on the average XSS map and was origi-
ally included in the XSS catalog based on its transient
detection, 2) the source was the target of pointed RXTE
observations and would not have been detected in slew
observations otherwise.

We have thus obtained a sample (see Table 1) of 30
ABs and CVs detected with $\geq 4 \sigma$ significance on the av-
average XSS sky map ($3–20$ keV). This sample is well suited
for statistical studies.

For each source, the XSS catalog provides RXTE/PCA
count rates in the $3–8$ keV and $8–20$ keV bands. We
found published distances to all sources except for the
intermediate polar V1025 Cen (for which we assumed a
distance of 400 pc, a value typical for intermediate
polars in our sample), the polar CD Ind (for which
we used the available lower limit) and the source XSS
J17309–0552 discussed below. Parallax measurements,
in many cases adopted directly from the Hipparcos or
Tycho catalog, were used wherever available. For XSS
J17309–0552/RXS J173021.5–055933, a recently discov-
ered intermediate polar (Gänsicke et al. 2003), we esti-
ated the distance using available information about the
secondary star Gänsicke et al. 2003. Specifically, this
CV star contributes $\sim 15\%$ to the R-band flux of the
binary. Given the system’s visual magnitude ($RV = 15.4$) and interstellar extinction toward it $[E(B-V) \sim 0.45]$, and assuming that the secondary is on the main se-
sequence, we find a distance $\sim$2300–3100 pc. However, the
very long orbital period of the binary (15.4 hours) im-
plies that the Roche-lobe filling secondary is evolved (e.g.
Smith & Dhillon 1998). This yields a more likely distance
of $\sim 3,300$ pc, which we adopt here.
Table 1. XSS sources identified with ABs and CVs

| XSS source (J2000.0) | Name     | Class | $D^a$ | $L_b^a$ | $L_x^a$ | Hardness ratio | $1/V_{gen}^b$ |
|----------------------|----------|-------|-------|---------|---------|---------------|--------------|
| 02290−6931           | RBS 324  | P     | 250   | 31.88   | 31.70   | 0.41±0.25     | 4.9×10^{-8} |
| 02569+1931           | XY Ari   | IP    | 270   | 32.43   | 32.12   | 0.88±0.42     | 1.2×10^{-8} |
| 03089+4101           | β Per    | AL    | 28    | 30.91   | 30.77   | 0.28±0.06     | 8.9×10^{-7} |
| 03385+0029           | V711 Tau | RS    | 29    | 30.23   | 30.15   | 0.10±0.19     | 8.2×10^{-6} |
| 05019+2444           | V1062 Tau| IP    | 1100  | 33.77   | 33.51   | 0.69±0.12     | 1.2×10^{-9} |
| 05295−3252           | TV Col   | IP    | 370   | 33.08   | 32.80   | 0.77±0.09     | 3.1×10^{-9} |
| 05432−4116           | TX Col   | IP    | 500   | 32.71   | 32.50   | 0.52±0.21     | 6.3×10^{-9} |
| 05450+6049           | BY Cam   | P     | 190   | 31.96   | 31.74   | 0.55±0.24     | 3.9×10^{-8} |
| 06132+4755           | SS Aur   | DN    | 280   | 32.17   | 31.97   | 0.48±0.24     | 2.2×10^{-8} |
| 07514+1442           | PQ Gem   | IP    | 400   | 32.79   | 32.54   | 0.68±0.20     | 5.3×10^{-9} |
| 08010+6241           | HT Cam   | IP    | 400   | 32.72   | 32.46   | 0.70±0.29     | 6.2×10^{-9} |
| 08142+6231           | SU Uma   | DN    | 260   | 32.16   | 31.99   | 0.37±0.17     | 2.3×10^{-8} |
| 11474+7143           | DO Dra   | IP    | 155   | 32.02   | 31.78   | 0.62±0.10     | 3.3×10^{-8} |
| 12392−3820           | V1025 Cen| IP    | 400   | 32.36   | 32.19   | 0.37±0.14     | 1.4×10^{-8} |
| 12529−2911           | EX Hya   | IP    | 65    | 31.79   | 31.62   | 0.40±0.02     | 6.2×10^{-8} |
| 13553+3714           | BH CVn   | RS    | 45    | 31.15   | 31.07   | 0.11±0.11     | 4.2×10^{-7} |
| 14100−4500           | V834 Cen | P     | 150   | 31.72   | 31.48   | 0.61±0.12     | 7.6×10^{-8} |
| 14241−4803           | HD125599 | ?     | 90    | 32.70   | 32.62   | 0.15±0.15     | 1.6×10^{-6} |
| 14527−2414           | HD130693 | ?     | 27    | 30.07   | 29.93   | 0.28±0.08     | 1.4×10^{-5} |
| 16167−2817           | V893 Sco | DN    | 150   | 32.10   | 31.92   | 0.40±0.08     | 2.7×10^{-8} |
| 17309−0552           | IRXS J17309.1−055933 | IP | 3300 | 34.28 | 34.06 | 0.54±0.29 | 8.1×10^{-10} |
| 17597−0821           | V2301 Oph| P     | 150   | 31.90   | 31.67   | 0.56±0.10     | 4.6×10^{-8} |
| 18080+0622           | V426 Oph | DN    | 200   | 32.07   | 31.85   | 0.56±0.25     | 2.9×10^{-8} |
| 18164+5004           | AM Her   | P     | 79    | 31.77   | 31.50   | 0.74±0.05     | 6.6×10^{-8} |
| 18553−3111           | V1223 Sgr| IP    | 510   | 33.73   | 33.45   | 0.76±0.02     | 1.2×10^{-9} |
| 19243+5041           | CH Cyg   | SS    | 250   | 32.26   | 31.87   | 1.25±0.26     | 1.8×10^{-8} |
| 21155−5836           | CD Ind   | P     | 250   | 31.90   | 31.64   | 0.70±0.24     | 4.6×10^{-8} |
| 22178−0822           | FO Aqr   | IP    | 300   | 32.85   | 32.53   | 0.94±0.09     | 4.7×10^{-9} |
| 22526+1650           | IM Peg   | RS    | 97    | 31.65   | 31.46   | 0.42±0.03     | 9.3×10^{-8} |
| 22551−0309           | AO Psc   | IP    | 250   | 32.57   | 32.33   | 0.60±0.10     | 8.6×10^{-9} |

a: Class: RS – RS CVn, AL – Algol, DN – dwarf nova, P – polar, IP – intermediate polar, SS – symbiotic star

b: Reference for distance: 1 – [Schwope et al. 2002], 2 – [Littlefair et al. 2001], 3 – Hipparcos, 4 – [Patterson 1994], 5 – [McArthur et al. 1993], 6 – [Warner 1993], 7 – [Thorstensen 2003], 8 – [Tovmassian 2003], 9 – assumed, 10 – [Eisenhart et al. 2002], 11 – [Aranjo-Betancor et al. 2005], 12 – Tycho, 13 – based on Gansicke et al. (2005), see main text, 14 – [Silber et al. 1994], 15 – [Hessman 1998], 16 – [Beuermann et al. 2004], 17 – [Sokoloski & Kenyon 2003], 18 – lower limit (The MSSL Polar Page, http://www.mssl.ucl.ac.uk/www/astro/gal/polar.html)

Refer to other papers for uncertainty in $L_x$.

Log of $3-20$ keV luminosity

Log of $2-10$ keV luminosity

Bright (V=8.5) F7/8V star associated with the bright ROSAT source 1RXS J142148.7−480420

Bright (V=8.2) G6V star associated with the bright ROSAT source 1RXS J145017.6−242558=RBS 1436 [Schwope et al. 2000]
at which a given XSS source is detectable (Tinney et al. 1993; Schwope et al. 2002):

\[
\delta V_{\text{gen}} = \delta \Omega \frac{b^3}{\sin b} \left[ 2 - (\xi^2 + 2\xi + 2)e^{-\xi} \right],
\]

where \( \xi = \frac{d_{\text{max}} \sin b}{h} \). Each sampled source then contributes \( \frac{1}{\sum \delta V_{\text{gen}}} \) to the estimated space density and \( \frac{1}{(\sum \delta V_{\text{gen}})^2} \) to the associated variance, where the sum is taken over the total solid angle of the survey.

We show in Fig. 2 the resulting differential XLF of ABs and CVs in the 3–20 keV energy band, covering the luminosity range \( 10^{30}–10^{34} \) erg s\(^{-1}\). This XLF was normalized to the local stellar mass density, assumed to be 0.04 \( M_\odot \) pc\(^{-3}\) throughout the paper (Jahreiß & Wielen 1997; Robin et al. 2003). The values of \( \frac{1}{V_{\text{gen}}} \) for individual XSS sources are given in Table 2. Note that we excluded the intermediate polar XSS J17309–0552/RXS J173021.5–055933 from the XLF construction since its inferred X-ray luminosity exceeds \( 10^{34} \) erg s\(^{-1}\) making it the only source with such high luminosity in our sample.

It is necessary to check whether the derived XLF suffers from incompleteness of the input sample. There are in fact 18 unidentified XSS sources\(^1\) – see Table 2. Although, we suspect (see R04) that most of these sources are active galactic nuclei, this has not yet been verified and therefore we must take this additional sample into account.

**Table 2. Unidentified XSS sources**

| XSS source (J2000.0) | Hardness ratio | Counterpart from RASS |
|----------------------|----------------|-----------------------|
| 00050–6904           | 0.46 ± 0.11    | 1RXS J005528.0+461143 |
| 00564+4548           | 0.52 ± 0.08    | 1RXS J005528.0+461143 |
| 02087–7418           | 0.86 ± 0.23    | 1RXS J005528.0+461143 |
| 05188+1823           | 0.70 ± 0.34    | 1RXS J005528.0+461143 |
| 12270–4859           | 0.52 ± 0.13    | 1RXS J122758.8–485343 |
| 13563–7342           | 0.46 ± 0.26    | 1RXS J122758.8–485343 |
| 14101–2936           | 1.19 ± 0.47    | 1RXS J122758.8–485343 |
| 14138–4022           | 0.46 ± 0.23    | 1RXS J122758.8–485343 |
| 14239–3800           | 0.51 ± 0.21    | 1RXS J122758.8–485343 |
| 14353–3557           | 0.59 ± 0.33    | 1RXS J122758.8–485343 |
| 14495–4005           | 0.45 ± 0.15    | 1RXS J122758.8–485343 |
| 15360–4118           | 0.63 ± 0.29    | 1RXS J122758.8–485343 |
| 16049–7302           | 0.76 ± 0.32    | 1RXS J122758.8–485343 |
| 16537–1905           | 0.70 ± 0.24    | 1RXS J122758.8–485343 |
| 17223–7301           | 0.37 ± 0.27    | 1RXS J171850.0–732527\(^a\) |
| 17576–4534           | 0.63 ± 0.30    | 1RXS J171850.0–732527\(^a\) |
| 18486–2649           | 0.43 ± 0.24    | 1RXS J171850.0–732527\(^a\) |
| 19303–7950           | 0.49 ± 0.24    | 1RXS J194944.6–794519\(^a\) |

\(^a\) Possibly associated with star Tyc 9288-744-1 (V=9.8)
We expect our identified sample to be highly complete at $L_x \gtrsim 10^{30}$ erg s$^{-1}$ with respect to ABs and other types of coronal stars for the following reasons. First, it is very unlikely that more than \sim 1–2 of the 13 unidentified XSS sources (see Table 2) for which there is no obvious bright counterpart in the Rosat All-Sky Survey (RASS) are ABs or YSs, because coronal X-ray sources are relatively soft. To illustrate this point we plot in Fig. 3 the ratio of the ROSAT/PSPC count rate (0.1–2.4 keV) to the RXTE/PCA count rate (3–20 keV) as a function of the latter for our identified and unidentified sources. For the 13 XSS sources without a firm RASS counterpart an upper limit is shown that was derived from the ROSAT/PSPC count rate of the brightest RASS source within the XSS localization region (typically 0.5–1° in radius, R04). The unidentified XSS sources without a bright RASS counterpart are apparently hard X-ray sources compared to the identified ABs. It is important to note that the presented XSS source fluxes are averages over multiple RXTE/PCA observations separated by up to several years, hence it can be expected that these fluxes are not strongly biased by individual X-ray flares relative to the level of source persistent activity.

Secondly, for the 5 unidentified XSS sources reliably associated with a RASS source (see Table 2) we can search for a bright star inside the ROSAT localization region (typically less than 30 arcsec in radius). A source with a 3–20 keV luminosity of $10^{30}–10^{31.5}$ erg s$^{-1}$ (the higher value is quite extreme for coronal sources) would typically be detectable in the XSS out to \sim 20–100 pc. Stars exhibiting such high levels of coronal activity are rapidly rotating (usually in short-period binaries) main-sequence or evolved late-type stars, with $M_V \lesssim 6$ (see e.g. Singh et al. 1996; Makarov 2003). Therefore, if any of the unidentified XSS sources were a high-luminosity coronal source, we would expect to find a star brighter than $V \sim 11$ in the ROSAT localization region. Search of the Hipparcos and Tycho catalogs revealed only one such bright star, a possible counterpart to XSS J17223–7301/RXS J171850.0–732527 (see Table 2). Should this association be confirmed, it will not significantly change our estimate of the space density of ABs. Fig. 4 illustrates the above argument by showing the $R$-band visual magnitudes (or lower limits) vs. the RXTE/PCA count rate for identified XSS sources and for the 5 unidentified XSS sources with a RASS counterpart. One can see that the optical counterparts of the unidentified XSS sources (except for XSS J17223–7301 mentioned above) are much dimmer than expected for coronal sources.

On the other hand, since CVs can be undetectable in the RASS due to their hard spectra (see Fig. 3) and can also be inconspicuous optically (see Fig. 4), it is possible that some of the unidentified XSS sources belong to this class. There is an additional possibility to test the XLF obtained. Our identified sample is highly complete in the northern hemisphere: there are 16 identified and 2 unidentified sources at $\delta > 0$. This contrasts with the southern hemisphere, where there are 13 (excluding the high-luminosity XSS J17309–0552/RXS J173021.5–055933) identified vs. 16 unidentified sources. It is therefore worth comparing XLFs determined from the northern and southern subsamples. As shown in Fig. 2, the resulting XLFs agree with each other and with the all-sky XLF within the uncertainties, although there is a hint that the southern sample of CVs may be somewhat incomplete.

We conclude that we may somewhat underestimate the combined XLF of ABs and CVs at $L_x \gtrsim 10^{31}$ erg s$^{-1}$ since there may remain several unidentified CVs in the XSS catalog. The associated systematic uncertainty is unlikely to exceed 50% though.

\subsection*{3. Low luminosity range: Rosat All-Sky Survey}

The weakest X-ray source (a candidate AB) in the XSS sample has a luminosity $L_x \approx 10^{30}$ erg s$^{-1}$ in the 2–10 keV band. To extend our study to $L_x < 10^{30}$ erg s$^{-1}$ we need a large-area survey that would be more sensitive than the XSS and highly complete with respect to source identifi-
ABs of RS CVn, BY Dra, Algol, W Uma and other types (mostly of the first two types) make up 43% of the M03 sample. Another 42% consist mostly of pre-main-sequence and young main-sequence stars, while 15% of the stars are not classified. We may therefore determine the space density of all sources and separately that of ABs. Since the M03 is volume limited, the source space density can be found as

$$\rho = \frac{N}{(4\pi/3)D^3},$$

(2)

where $D = 50$ pc for the M03 sample. We ignore here the small effect of decreasing space density with height above the Galactic plane. The resulting space densities for 3 luminosity intervals are given in Table 3. Note that although we ignored the small number of unknown-type sources when estimating the space density of ABs, this cannot significantly affect the result.

The H99 catalog is expected to be highly complete within 25 pc of the Sun with respect to X-ray stars with $L_x > 1.5 \times 10^{28}$ erg s$^{-1}$. This follows from the fact that for 97% of the sky an exposure of 100 s or longer was achieved in the RASS (Voges et al. 1999), which for coronally active stars typically corresponds to a 0.1–2.4 keV flux limit of $\sim 2 \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$ (Hünsch et al. 1999). Given this flux limit one can readily find a distance $D$ within which the H99 catalog should be complete for a given limiting luminosity. One can then again apply equation (2) to estimate the space density of X-ray stars with luminosities exceeding this limit within distance $D$.

To separate ABs from other sources we need information about source classes, which is not provided by H99. We hence cross-correlated the H99 sample with published catalogs of chromospherically active binaries (Strassmeier et al. 1993, Karatas et al. 2004). A few additional RS CVn and W Uma systems were found by cross-correlating the H99 catalog with the General Catalog of Variable Stars (Samus et al. 2004). Since it is possible that these catalogs are not complete at low luminosities, we restricted our analysis to ABs with $L_x > 10^{28.5}$ erg s$^{-1}$. We additionally compared the space density of ABs within 25 pc with that within 15 pc. Table 3 provides space densities of X-ray sources in a number of luminosity intervals, as derived from the H99 sample.

Our analysis will be based on two published catalogs derived from the RASS: the catalog of 100 most luminous X-ray stars within 50 pc of the Sun (Makarov 2003, hereafter M03) and the RASS catalog of the nearby stars (Hünsch et al. 1999, hereafter H99). The first catalog includes all stars with $0.1–2.4$ keV luminosity ($L_x$) higher than $9.8 \times 10^{29}$ erg s$^{-1}$. The second catalog includes all objects from the Third Catalog of Nearby Stars (Gliese & Jahreiß 1991) that were detected in the RASS. Both catalogs are well suited for our statistical study since they are expected to be highly complete and since they provide accurate parallax distances for the sources.
The resulting values of $L_s/L_s$ are plotted as a function of

the most luminous coronal stars ($L_s \sim 10^{31.5}$ erg s$^{-1}$) down to Sun-like stars ($L_s \sim 10^{27}$ erg s$^{-1}$).

### 3.1. Conversion from the ROSAT energy band to the standard X-ray band

Conversion of the soft X-ray luminosity function obtained above to the 2–10 keV energy band requires knowledge of the source spectra. Since the majority of RASS sources used in our analysis have not been observed in the standard X-ray band, we are bound to rely on a representative set of sources for which broad-band spectra are available. To this end we selected from public archives X-ray observations, of sufficiently good quality for spectral analysis, for 22 sources from the M03 sample and 25 sources from the H99 sample. All observations were performed by ASCA, except for the star GJ 1245 observed by Chandra. ASCA and Chandra data were then processed by standard tasks of HEASOFT and CIAO packages according to recipes of the Guest Observer Facilities (http://legacy.gsfc.nasa.gov/docs/asca/ascagof.html and http://cxc.harvard.edu/ciaof).

In the 0.5–10 keV band the (moderate resolution) spectra of all selected sources are well fit by a broken power law with the break energy and lower-energy photon index fixed at 0.8 keV and 1.5, respectively. The high-energy photon index was a free parameter in our analysis and we found for it best-fit values in the range from $\sim 3$ to $\sim 5$ for different sources. This simple empirical model mimics reasonably well the actual multi-temperature emission spectrum (e.g. Schmitt et al. 1990, Dempsey et al. 1993, Giedel 2004) dominated by strong blended line emission below $\sim 0.8$ keV. From the best-fit model we can find for each source the ratio of its luminosity in the 2–10 keV band to that in the 0.5–2 keV band.

We then additionally convert $L$ (0.5–2 keV) to $L_s$, luminosity in the ROSAT (0.1–2.4 keV) band, assuming $L(0.5–2 \text{ keV})/L_s \sim 0.7$, a ratio typical for coronal stars observed by Einstein and ROSAT (Fleming et al. 1995). The resulting values of $L_s/L_s$ are plotted as a function of...
$$L_s$$ in Fig. 6 for our spectral sample of sources. In most cases the $$L_s$$ value determined from ASCA or Chandra observations differs by less than a factor of 2 from the soft X-ray luminosity directly measured by ROSAT at a different epoch.

Fig. 6 confirms the well-known trend of hardening of stellar coronal X-ray emission with increasing luminosity (e.g. Schmitt et al. 1990; G¨ udel 2004). It also demonstrates that ABs do not distinguish themselves spectrally from YSs with similar luminosities. Averaging the ratios $$L_x/L_s$$ for individual sources in a sliding window of width $$\Delta \log L_s = 0.5$$ leads to the result shown by the shaded region in Fig. 6 which reflects the uncertainty in $$\langle L_x/L_s \rangle$$ due to the scatter of individual $$L_x/L_s$$ values around this mean value. The sliding-window average can be approximated by the power law

$$\langle L_x/L_s \rangle = 0.045 \left( \frac{L_s}{10^{28.5}} \right)^{0.23},$$

shown by the solid line in Fig. 6.

The width of the shaded region in Fig. 6 indicates that the hardness-luminosity trend described by equation (3), which is based on a fairly small sample of sources, should enable ~50% accuracy of conversion of our soft X-ray luminosity function (Fig. 5), derived from a much larger sample of RASS sources, to the 2–10 keV energy band for $$L_s \gtrsim 10^{28.5}$$ erg s$$^{-1}$$. We will also need below a similarly determined approximate trend for the harder energy band 3–20 keV:

$$\langle L_x/L_s \rangle = 0.02 \left( \frac{L_s}{10^{28.5}} \right)^{0.31}.$$  

(4) 4. Combined X-ray luminosity function

We now proceed to convert to a common energy band the X-ray (3–20 keV) and soft X-ray (0.1–2.4 keV) luminosity functions derived from the XSS and RASS in Section 2 and Section 3 respectively. We first consider the 2–10 keV band. For the XSS sample we can readily recompute the XLF using the 2–10 keV source luminosities given in Table 1. We apply a more approximate procedure to the RASS sample, namely convert the measured soft X-ray luminosities to the 2–10 keV range using the approximate hardness-luminosity trend given by equation (3) and then recompute the XLF. The two recomputed XLFs make up a broad range XLF (from $$10^{27.5}$$ to $$10^{34}$$ erg s$$^{-1}$$) that is shown in Fig. 7. We can similarly construct an XLF in the 3–20 keV band (Fig. 8), in this case only the RASS XLF needed to be recomputed using equation (4). The 3–20 keV XLF is used by Revnivtsev et al. (2005) to assess the contribution of point sources to the Galactic ridge X-ray emission measured by RXTE in the same energy band.

The XLFs shown in Fig. 7 and Fig. 8 were multiplied by luminosity to expose the contribution of different luminosity intervals to the total X-ray emissivity per unit stellar mass. In the low-luminosity range covered by RASS data ($$L_X < 10^{30.5}$$ erg s$$^{-1}$$), both the total XLF including YSs and separately that of ABs are shown. To roughly allow for the uncertainty of conversion from the original soft X-ray band to the 2–10 keV and 3–20 keV bands we ascribed 50% errors to the RASS data points in addition to statistical uncertainties.

The medium-luminosity XLF derived from the XSS and the low-luminosity XLF derived from the RASS partially overlap near $$10^{30}$$ erg s$$^{-1}$$, in a region occupied predominantly by ABs, and do not contradict each other. For the subsequent analysis we will adopt the XSS estimates of differential source space densities in the ($$10^{30}, 10^{34}$$) luminosity range and the RASS estimates of space densities of lower-luminosity sources.

The combined 2–10 keV XLF of ABs and CVs can be approximated in the range $$10^{28}$$–$$10^{34}$$ erg s$$^{-1}$$ by a broken power law:

$$\frac{dN}{d \log L_x} = K \begin{cases} (L_b/L_x)^{\alpha_1}, & L_x < L_b, \\ (L_b/L_x)^{\alpha_2}, & L_x > L_b, \end{cases}$$

where $$K \approx 6.8 \times 10^{-4} M_{\odot}^{-1}$$, $$L_b \approx 1.9 \times 10^{30}$$ erg s$$^{-1}$$, $$\alpha_1 \approx 0.47$$ and $$\alpha_2 \approx 1.22$$. We note that incompleteness may significantly affect the XLF of ABs below $$L_x \approx 10^{28}$$ erg s$$^{-1}$$ (corresponding to $$L_s \approx 10^{29.5}$$ erg s$$^{-1}$$, see Section 3 and
Fig. 7. Differential luminosity distribution of 2–10 keV emissivity per unit stellar mass of coronally active stars and CVs. The XLF derived from the XSS is shown by filled circles, and the XLF derived from the RASS is shown by open squares for all stars and by filled squares for ABs only. The errors shown for the RASS data points take into account an assumed 50% uncertainty of conversion from the original 0.1–2.4 keV band in addition to statistical errors. The dashed line shows the broken power-law fit to the combined XLF of ABs and CVs, given by equation (5).

also somewhat the XLF of CVs above $L_x \sim 10^{31} \text{ erg s}^{-1}$ (see Section 2). Similarly the 3–20 keV XLF of ABs and CVs can be fitted in the range $10^{27.5} – 10^{34} \text{ erg s}^{-1}$ by

$$\frac{dN}{d\log L_h} = K \begin{cases} (L_h/L_b)^{\alpha_1}, & L_h < L_b, \\ (L_h/L_b)^{\alpha_2}, & L_h > L_b, \end{cases}$$

with $K \approx 4.9 \times 10^{-4} \ M_\odot^{-1}$, $L_b \approx 2.7 \times 10^{30} \text{ erg s}^{-1}$, $\alpha_1 \approx 0.45$ and $\alpha_2 \approx 1.12$. These analytical fits (multiplied by luminosity) are shown by dashed lines in Fig. 7 and Fig. 8.

4.1. Cumulative emissivities

Using the differential XLFs obtained above we can assess the cumulative emissivity of local X-ray sources with luminosities below $10^{34} \text{ erg s}^{-1}$. We present in Fig. 8 and Fig. 9 the corresponding plots for the 2–10 keV and 3–20 keV bands. Table 4 summarizes our estimates of the cumulative local emissivities (per unit stellar mass) of ABs, CVs and YSs in the energy bands 0.1–2.4 keV, 2–10 keV and 3–20 keV, complemented by information about LMXBs (see Section 4.2 below).
Approximately 80% of the total X-ray (2–10 keV) luminosity of ABs and CVs is produced by sources with \( L_x > 10^{30} \text{ erg s}^{-1} \). In the solar neighborhood an additional significant contribution comes from YSs with \( L_x < 10^{30} \text{ erg s}^{-1} \), which make up \( \sim 30\% \) of the total luminosity at 2–10 keV. The fractional contribution of YSs decreases when going to a harder X-ray band because of their relatively soft spectra (compare Fig. 9 and Fig. 10). We note that the estimated (by integrating the soft X-ray luminosity function shown in Fig. 9 up to \( L_x = 10^{32} \text{ erg s}^{-1} \)) high soft X-ray emissivities of ABs and YSs compared to the harder X-ray bands reflect the fact that stellar coronae are much more efficient sources of soft X-rays than hard X-rays. We also point out that the lower luminosity end of the distributions shown in Fig. 9 and Fig. 10 corresponds to \( L_x \sim 10^{29} \text{ erg s}^{-1} \) and the contribution of less luminous X-ray stars (including normal stars like the Sun) to the total X-ray emissivity above 2 keV is expected to be negligible since they contribute less than 20% to the soft X-ray emissivity and are softer than the more luminous sources (see Section 3).

Our preceding analysis does not permit to estimate the soft X-ray emissivity of CVs. The XSS sample is not suitable for this purpose because the high-energy component (optically thin thermal emission with \( kT \lesssim 30 \text{ keV} \)) of CV spectra observed by RXTE or a similar X-ray instrument is often intrinsically absorbed below several keV (e.g. Cropper et al. 1998, Suleimanov et al. 2005), while another, much softer component (black-body emission with \( kT \sim 30 \text{ eV} \)) appears in the ROSAT energy range, with the relative amplitudes of the two components varying greatly from source to source (Cropper 1990, see also Fig. 4). Therefore, to obtain a reliable estimate of the CV soft X-ray emissivity one has to use a flux limited and optically identified soft X-ray survey such as the Rosat Bright Survey (RBS, Schweppe et al. 2001).

The RBS was already used by Schweppe et al. 2002 to estimate the space density of non-magnetic CVs. Using the same sample of 15 non-magnetic CVs with measured distances (Table 4 in Schweppe et al. 2002 which provides source luminosities and \( V_{\text{gen}} \) values) we can readily estimate the soft X-ray cumulative emissivity (per unit stellar mass) of non-magnetic CVs: \( \sim 7 \times 10^{28} \text{ erg s}^{-1} \).

Unfortunately, as noted by Schweppe et al. (2002), the RBS sample of magnetic CVs substantially suffers from incomplete distance information, which currently makes difficult its use for statistical studies. Using the published estimate of the space density of magnetic CVs of \( \sim 3 \times 10^{-7} \text{ pc}^{-3} \) (Patterson 1984, Warner 1995), which may be affected by different biases but nevertheless agrees with our XSS based estimate of space density of magnetic CVs with \( L_x > 10^{31} \text{ erg s}^{-1} \) of \( (4.8 \pm 1.6) \times 10^{-7} \text{ pc}^{-3} \), and assuming \( L_x \sim 5 \times 10^{31} \text{ erg s}^{-1} \) for the average source luminosity (e.g. Barrett et al. 1999), we can estimate the soft X-ray emissivity of magnetic CVs at \( \sim 4 \times 10^{26} \text{ erg s}^{-1} M_\odot^{-1} \). Considering that this estimate can be inaccurate by a factor of a few, we infer that the combined soft X-ray emissivity of non-magnetic and magnetic CVs is likely less than a few \( 10^{27} \text{ erg s}^{-1} M_\odot^{-1} \). This implies that the total local soft X-ray emissivity is strongly dominated by ABs and YSs (see Table 4).

### 4.2. Addition of LMXBs

The XLF of Galactic LMXBs in the energy band 2–10 keV was constructed by Grimm et al. 2002, Gilfanov 2004 subsequently demonstrated that the LMXB XLFs for 11 nearby galaxies and the Milky Way have a universal shape and normalizations proportional to the stellar masses. We can now attach to the XLF of high luminosity LMXBs (\( \sim 10^{35} \sim 10^{39} \text{ erg s}^{-1} \)) averaged over nearby galaxies the XLF of ABs and CVs constructed here. The combined XLF (per unit stellar mass) multiplied by luminosity is shown in Fig. 11.

The only remaining poorly studied luminosity interval is \( 10^{34} \sim 10^{35} \text{ erg s}^{-1} \), but it is possible to place an upper limit on the space density of objects with such luminosities based on the ASCA Galactic Plane Survey (Sugizaki et al. 2001). This survey covered \( \approx 40 \text{ sq. deq} \) within the central region of the Galactic plane (\(|l| < 45^\circ\) and \(|b| < 0.4^\circ\)) with the flux limit in the 2–10 keV energy band varying between \( \sim 10^{-12.5} \) and \( \sim 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1} \).

It follows from the number-flux distribution obtained by Sugizaki et al. (2001) that there are on average \( \sim 4 \text{ deg}^{-2} \) Galactic sources with flux higher than \( 10^{-12.5} \text{ erg cm}^{-2} \text{ s}^{-1} \) within the region \(|l| < 45^\circ\), \(|b| < 0.4^\circ\). This implies that the total number of such sources in this region is \( \sim 290 \). Since the vast majority of weak
The quoted 2–10 keV emissivity for LMXBs represents an average over nearby galaxies (Gilfanov 2004).

\[ E_{\text{emissivity in the 0.5–2 keV band extrapolated from 2–10 keV assuming a power-law spectrum of photon index } \Gamma = 1} \]

We can conservatively assume that all detected sources (2004) are presented (dashed lines).

\[ \text{Total emissivity (10}^{37} \text{ erg s}^{-1} M_\odot^{-1}) \]

\[ \text{0.1–2.4 keV} \]

\[ \text{2–10 keV} \]

\[ \text{3–20 keV} \]

\[ \text{ABs} \sim 1.2 \times 10^{-3} \text{ (} L_x > 10^{47.5} \text{ erg s}^{-1}) \]

\[ (14 \pm 4) \quad 2.0 \pm 0.8 \quad 2.9 \pm 1.3 \]

\[ \text{CVs} \sim (1.2 \pm 0.3) \times 10^{-5} \text{ (} L_x > 10^{35} \text{ erg s}^{-1}) \]

\[ \lesssim \text{a few} \quad 1.1 \pm 0.3 \quad 2.4 \pm 0.6 \]

\[ \text{ABs+CVs} \sim 15 \quad 3.1 \pm 0.8 \quad 5.3 \pm 1.5 \]

\[ \text{YSs} \quad 24 \pm 3 \quad 1.5 \pm 0.4 \quad 1.0 \pm 0.2 \]

\[ \text{ABs+CVs+YSs} \sim 40 \quad 4.5 \pm 0.9 \quad 6.2 \pm 1.5 \]

\[ \text{LMXBs} \sim 3 \times 10^{-9} \text{ (} L_x > 10^{36} \text{ erg s}^{-1}) \]

\[ \sim 40^a \quad \sim 90^b \]

\[ a \] Emissivity in the 0.5–2 keV band extrapolated from 2–10 keV assuming a power-law spectrum of photon index \( \Gamma = 1 \).

\[ b \] The quoted 2–10 keV emissivity for LMXBs represents an average over nearby galaxies (Gilfanov 2004).


\[ \rho \propto \exp \left( - \frac{R_m}{R} - \frac{R}{R_{\text{scale}}} - \frac{z}{z_{\text{scale}}} \right), \]

we find that \( \approx 30\% \) of the total mass of the disk is contained within \( |l| < 45^\circ, |b| < 0.4^\circ \). Here we have assumed \( R_m = 3 \text{ kpc, } R_{\text{scale}} = 3 \text{ kpc, } R_{\text{max}} = 10 \text{ kpc} \) and \( z_{\text{scale}} = 150 \text{ pc} \) (Binnev, Gerhard & Spergel 1997; Freudenreich 1998), although the result is almost insensitive to the parameter values except for the scale height \( z_{\text{scale}} \).

Taking additionally into account that \( \sim 30\% \) of the Milky Way stellar mass is contained in the bulge and halo (Bahcall & Soneira 1980; Freudenreich 1998), which are virtually not covered by the ASCA Galactic Plane Survey, we may conservatively estimate that there are less than 290/0.3/(1 – 0.3) \( \approx 1400 \) sources with \( 10^{34} \text{ erg s}^{-1} < L_x < 10^{35} \text{ erg s}^{-1} \) in the Galaxy. Adopting the value \( 7 \times 10^{10} M_\odot \) for the mass of the Galaxy in stars (derived from the K-band luminosity measured by COBE, Malhotra et al. 1996; Gilfanov 2004), we finally obtain the upper limit shown in Fig. 11.

We can conservatively assume that all detected sources brighter than \( 10^{-12.5} \text{ erg cm}^{-2} \text{ s}^{-1} \) have luminosities exceeding \( 10^{34} \text{ erg s}^{-1} \). At the flux limit of the survey, a source with \( L_x > 10^{34} \text{ erg s}^{-1} \) is detectable out to a distance > 16 kpc, i.e. almost to the outer boundary of the Galactic disk. Using the model of stellar mass distribution in the Galactic disk

\[ \rho \propto \exp \left( \left( \frac{R_m}{R} \right)^3 - \frac{R}{R_{\text{scale}}} - \frac{z}{z_{\text{scale}}} \right), \]

we find that \( \approx 30\% \) of the total mass of the disk is contained within \( |l| < 45^\circ, |b| < 0.4^\circ \). Here we have assumed \( R_m = 3 \text{ kpc, } R_{\text{scale}} = 3 \text{ kpc, } R_{\text{max}} = 10 \text{ kpc} \) and \( z_{\text{scale}} = 150 \text{ pc} \) (Binnev, Gerhard & Spergel 1997; Freudenreich 1998), although the result is almost insensitive to the parameter values except for the scale height \( z_{\text{scale}} \).

Taking additionally into account that \( \sim 30\% \) of the Milky Way stellar mass is contained in the bulge and halo (Bahcall & Soneira 1980; Freudenreich 1998), which are virtually not covered by the ASCA Galactic Plane Survey, we may conservatively estimate that there are less than 290/0.3/(1 – 0.3) \( \approx 1400 \) sources with \( 10^{34} \text{ erg s}^{-1} < L_x < 10^{35} \text{ erg s}^{-1} \) in the Galaxy. Adopting the value \( 7 \times 10^{10} M_\odot \) for the mass of the Galaxy in stars (derived from the K-band luminosity measured by COBE, Malhotra et al. 1996; Gilfanov 2004), we finally obtain the upper limit shown in Fig. 11.

It can be seen from Fig. 11 that the differential luminosity distribution of X-ray emissivity of Galactic low-mass close binaries has two maxima. The primary peak at \( L_x \sim 10^{38} \text{ erg s}^{-1} \) is due to neutron-star LMXBs accreting at near the Eddington limit. The secondary peak, at \( \sim 10^{29}–10^{33} \text{ erg s}^{-1} \), is formed jointly by ABs and CVs. The XLF can be approximated by equation (5) in the range \( 10^{28}–10^{34} \text{ erg s}^{-1} \) and by the LMXB template given in Gilfanov (2004) (eqs. (8), (9) and Table (3)) in the range \( 10^{35}–10^{39} \text{ erg s}^{-1} \). Both analytical fits are shown by dashed lines in Fig. 11.

In Fig. 12 we show the cumulative 2–10 keV emissivity of ABs, CVs and LMXBs as a function of luminosity. LMXBs provide by far the dominant contribution \( (\sim 10^{29} \text{ erg s}^{-1} M_\odot^{-1}) \) to the total emissivity, whereas ABs and CVs together contribute \( \sim 3\% \). Fig. 12 also demonstrates the effect of cutting out the bright end of the combined XLF: the cumulative emissivity of LMXBs with \( L_x < 10^{36} \text{ (} L_x < 10^{36.5} \text{) erg s}^{-1} \) is \( \sim 50\% \) \( (\sim 100\%) \) of the total emissivity of ABs and CVs.

Finally Fig. 13 shows the predicted XLF and the luminosity distribution of X-ray energy output of ABs, CVs and LMXBs for the entire Galaxy. The predicted contribution from ABs and CVs to the 2–10 keV luminosity of the Milky Way is \( \sim 2 \times 10^{38} \text{ erg s}^{-1} \), which agrees within the measurement uncertainties with the total X-ray luminosity of the Galactic ridge X-ray emission (see a detailed discussion in Revnivtsev et al. 2005).
Fig. 12. Cumulative 2–10 keV emissivity (computed from low luminosities upward) of ABs, CVs and LMXBs as a function of luminosity. The dashed lines show the levels of 100%, 150% and 200% of the total emissivity of ABs and CVs.

5. Conclusions

In this paper we have constructed the X-ray (above 2 keV) luminosity function of coronally active binaries, CVs and LMXBs, covering ∼12 orders of magnitude in luminosity.

We find that the differential luminosity distribution of X-ray emissivity (per unit stellar mass) of low-mass close binaries has a broad secondary peak at $L_x \sim 10^{29}$–$10^{33}$ erg s$^{-1}$ composed of ABs and CVs, in addition to the previously well studied primary maximum at ∼$10^{38}$ erg s$^{-1}$ made up by neutron-star LMXBs accreting at near the Eddington limit. The combined emissivity of ABs and CVs in the 2–10 keV band is $(3.1 \pm 0.8) \times 10^{27}$ erg s$^{-1}$ $M_\odot^{-1}$, or ∼3% of the emissivity of LMXBs (averaged over nearby galaxies). About 65% of this total emissivity is due to ABs. The estimated combined contribution of ABs and CVs to the 2–10 keV luminosity of the Milky Way is ∼$2 \times 10^{38}$ erg s$^{-1}$.

Young coronal stars with luminosities $L_x \lesssim 10^{30}$ erg s$^{-1}$ provide an additional significant contribution of $(1.5 \pm 0.4) \times 10^{27}$ erg s$^{-1}$ $M_\odot^{-1}$ to the cumulative 2–10 keV emissivity in the solar neighborhood (within ∼50 pc). However, the fractional contribution of YSs to the X-ray emissivity is expected to vary substantially across the Galaxy, reflecting local star formation history. In contrast, the cumulative X-ray emission of ABs and CVs is expected to approximately follow the distribution of stellar mass, as is known to be the case for LMXBs.

The results of this work find immediate application to the problem of the origin of Galactic ridge X-ray emission. Revnivtsev et al. (2005) use the XLF constructed here in combination with the X-ray surface brightness distribution of the ridge emission, which is shown to follow the stellar mass, to demonstrate that ABs and CVs (with a possible contribution from YSs) likely produce the bulk of the ridge emission.

The results of this work also indicate that in order to assess contribution of low-luminosity point X-ray sources (ABs and CVs) to the apparently diffuse X-ray emission of gas poor elliptical galaxies, it is necessary to resolve out the brightest LMXBs with $L_x \gtrsim 10^{36}$ erg s$^{-1}$ (see Fig. 12). This can already be achieved with Chandra for nearby galaxies. It should be taken into account however that in elliptical galaxies a significant fraction of low-mass close binaries reside in globular clusters where their numbers are expected to be affected by dynamical processes in combination with aging (e.g. Verbunt & Lewin 2005).

It will be important to compare in future work the XLF derived here for the solar neighborhood with that determined for Galactic globular clusters from deep Chandra observations (e.g. Heinke et al. 2005).

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