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An XMM-Newton view of the Milky Way

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Abstract. We report on the results of a Galactic plane survey conducted by the XMM-Newton Survey Science Centre (SSC). We carried out optical spectroscopic observations and cross-correlated the serendipitously detected X-ray sources with large optical and infrared catalogues. The survey contains about 1300 X-ray sources, and we unambiguously classified ∼ 24% of them. Soft X-ray (< 2 keV) sources are dominated by stars, with spectral type in the range M to A, and with increasing surface density with decreasing Galactic latitude. Hard X-ray (> 2 keV) sources are dominated by the extragalactic background, with a small contribution of hard Galactic sources (CVs, γ-Cas, and stars). The surface density of hard X-ray sources at $b \sim 0°$ increases steeply from $l = 20°$ to 0.9°.

Key words. X-rays: binaries - X-rays: stars

1. Introduction

The XMM-Newton satellite, was launched at the end of year 1999. The Survey Science Centre of the XMM-Newton (Watson et al. 2001), processes the observations and constructs catalogues of the serendipitously discovered sources around the target of the observations. One of the aims of the SSC is the characterisation and classification of these X-ray sources in an statistical manner. With this goal, the SSC studied specific source samples: Barcons et al. (2002) and Della Ceca et al. (2004) concentrated on the medium and bright X-ray fluxes in high Galactic latitudes fields, Motch et al. (2010) studied a population of low latitude X-ray sources. In this work we focused on the Galactic population of low and intermediate Galactic latitudes ($b < 20°$).

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2. The data

The survey was based on the ∼ 1300 sources detected serendipitously in 26 XMM-Newton pointed observations, covering a total area of about 4°, and with limiting fluxes of 2×10^{-15} erg cm^{-2}s^{-1} in the soft (0.5 – 2 keV) band and 1×10^{14} erg cm^{-2}s^{-1} in the hard (2 – 12 keV) band. Dedicated spectroscopic and photometric follow-up observations and cross-correlation with multi-wavelength catalogues led to the identification of a total of 316 sources. We classified the majority as active corona, but we also found a few exotic objects, such as cataclysmic variables, γ-Cas analogues, T Tauri stars and Herbig-Ae stars. We classified a small number of extragalactic sources. For stars, we determined the spectral types by fitting their optical spectra to template spectra.

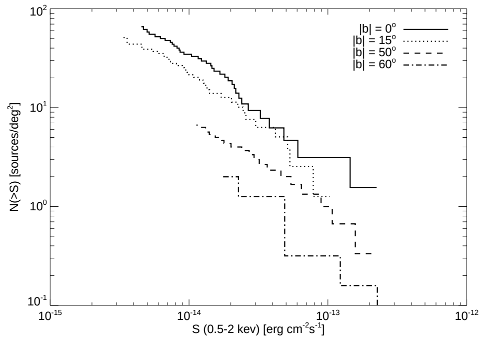

Fig. 1. Surface density of stars as a function of flux at different Galactic latitudes, at $b = 0°, 15°$ from this study, and at $b = 50°, 60°$ from Barcons et al. (2007) and López-Santiago et al. (2007) respectively.

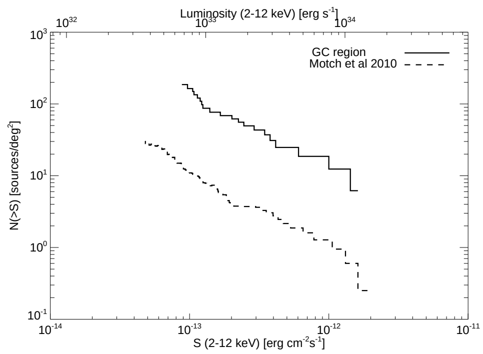

Fig. 2. Surface density of hard Galactic sources as a function of flux at $b \sim 0°$ for two different Galactic longitudes: $l = 0.9°$ from this study and $l = 20°$ from Motch et al. (2010). In the upper label we show the luminosity scale corresponding to a distance of 8 kpc.

3. Galactic soft sources: log N(>S) – log S variation with latitude

We computed log N(>S) – log S curves in the soft band (0.5 − 2 keV) for identified stars in four Galactic latitude bins: $b = 0°$ and $b = 15°$ from this study, and at $b = 50°$ and $b = 60°$ from Barcons et al. (2007) and López-Santiago et al. (2007) respectively. We found that the number of stars per square degree increases by about an order of magnitude from $b = 60°$ to $b = 0°$ at fluxes above $\sim 2 \times 10^{-13}$ erg cm^{-2}s^{-1}(see Figure 1). While at low Galactic latitudes X-ray surveys are dominated by young stars, at high Galactic latitudes the old stellar population start to dominate our high fluxes (Guillout et al. 1996). Therefore, the observed variations in the log N(>S) – log S curves with Galactic latitude reflect a dependence of the scale-height with age.

4. Galactic hard sources: log N(>S) – log S variation with longitude

We created log N(>S) – log S curves for hard sources (2 − 12 keV) in the Galactic Centre region covered by our survey ($l = 0.9°$, $b = 0°$) and subtracted from it the expected extragalactic contribution from Mateos et al. (2008). We compared the obtained residual log N(>S) – log S with that from Motch et al. (2010) ($l \sim 20°$, $b = 0°$). We found that the number of hard sources per square degree increases by about a factor of ten at a flux of about 10^{-13} erg cm^{-2}s^{-1}. If these hard sources are related to the Galactic Centre the luminosities are in the range 10^{33} – 10^{34} erg s^{-1} (at a distance of about 8 kpc). The nature of these sources is still unclear.

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