# The X-ray content of the XMM-Newton SSC survey of the Galactic Plane 

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## Abstract

The Survey Science Center of the XMM-Newton satellite has carried out optical follow-up observing campaigns with the aim to investigate the nature of the X-ray sources discovered in the Galactic plane. A group of 20 fields covering a total area of $\sim 3$ deg ${ }^{2}$ at low and intermediate Galactic latitudes (|b| < 20) has been studied. Spectroscopic observations helped by cross-correlations with large optical and infrared catalogues allowed us to positively identify around $30 \%$ of the X -ray sources. We find that the majority are $\mathrm{F}, \mathrm{G}, \mathrm{K}, \mathrm{M}$ stars, where coronal activity is responsible for the soft X -ray emission. We identified some other interesting objects: I CV, 2 T-Tauri and 3 Be stars, tentatively classified as $\gamma$-Cas like.At mid Galactic latitudes (|b| ~ 3-16 deg) $7 \%$ of the X-ray sources are spectroscopically classified as AGNs. X-ray stellar population models account partially for the observed $\log \mathrm{N}$ - $\log \mathrm{S}$ curves for identified active coronae in the soft band ( $0.5-2.0 \mathrm{keV}$ ). In the hard band ( $2.0-12 \mathrm{keV}$ ) we find a clear excess of sources above the expected extragalactic contribution, which is mostly apparent in the central parts of the Galaxy.

## The X-ray data

The 20 target fields presented here were selected early after the launch of the XMM-Newton satellite for studying the X-ray content of the Galaxy.We have crosscorrelated the original source lists with the 2XMMi-DR3 catalogue in order to have up-to-date X-ray parameters. Among a total of 1860 original sources we find 1103 entries within $20^{\prime \prime}$ from the original source positions. The distance between the original and the $2 \mathrm{XMMi}-\mathrm{DR} 3$ source positions and the total PN count rates are shown in the figures in the right. Sources without 2XMMi-DR3 entry tend to be fainter (black histogram) than those having a 2 XMMi-DR3 match (red histogram). It is likely that the fraction of spurious sources in thus higher in this faint sample than for the confirmed 2XMMi-DR3 matches.



## Optical spectra

Optical spectra taken at the William Herschel Telescope, the New Technology Telescope, the ESOUT4 (limiting magnitude R~2I) and the I.9m located at Observatoire de Haut Provence (limiting magnitude $R \sim 17$ ) lead to an identification success rate of $\sim 40 \%$ for the optically faint sample, and $\sim 30 \%$ for the bright sample. 273 sources were classified as active coronae. We also found some other interesting objects such as CVs, XRBs, $\gamma$-Cas like objects and $T$-Tauri stars (see figure below).


## Infrared and optical photometry

We cross-matched our sources with the 2MASS, USNOBI.0, and GSC2.3 catalogues making use of $X \mathrm{CatDB}^{\prime}$, which provided us with identification probabilities ${ }^{2}$. A total of 307 sources have counterparts in some of these catalogues with an associated identification probability $\geq 90 \%$, and 208 among them have been positively classified by their optical spectra as active coronae. In the bottom panels we show the distribution in the EPIC PN hardness ratios. Sources without optical or infrared counterpart are shown in gray. Sources with optical or infrared counterpart with matching probability higher than $90 \%$ are shown in red for stars, blue for AGNs, green for accreting systems and black for unidentified sources. Tracks for active coronae ( $\mathrm{kT}=0.2,0.5, \mathrm{I} .0 \mathrm{keV}$ ) and for AGNs (power law, $\Gamma=1.9$ ) for different $\mathrm{N}_{\mathrm{H}}$ are shown for comparison. A clear excess of stars with coronal temperatures above $I \mathrm{keV}$ is present in the hard band.


$\mathrm{kT}=0.2 \mathrm{keV}$ $\mathrm{kT}=0.5 \mathrm{keV}$
$\mathrm{kT}=1 \mathrm{keV}$ $\mathrm{kT}=1 \mathrm{keV}$
Power Law, $\Gamma=1.9$
Without counterpart

- Unidentified
- Stars
- Acc Candidates
- AGNs


## Hard Sources



