UNVEILING GALACTIC STELLAR POPULATIONS THROUGH XMM-NEWTON SURVEYS

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ABSTRACT

The wide field of view and sensitivity of the XMM-Newton satellite led to the serendipitous discovery of thousands of new X-ray sources during the last five years. This large collection of sources allows significant advances in many high-energy astrophysics fields. In this framework, XMM-Newton is also carrying out a deep survey of the Galaxy. EPIC cameras are able to probe X-ray active stars over larger distances than any previous survey. We present results of an ongoing program aiming at the identification of stellar coronae in the galactic plane. We compare observations with an age dependant X-ray stellar population model. At high galactic latitudes Log N-Log S curves are in very good agreement with the observations over six decades in flux. At low latitudes, however, we are confronted with patchy absorption which forces us to introduce this feature in the model. Comparison between models and observations (distributions in distances, colors, magnitudes and hardness ratios) allows to constrain young stellar population properties which are usually ill-defined from observations at other wavelengths.

Key words: Stars: population - Stars:X-rays.

1. INTRODUCTION

Because of the steep decay of X-ray luminosity with age, soft X-ray surveys highlight the young stellar population in the Milky Way. The distribution of young stars with galactic latitudes, spectral type and luminosity can be used to constrain the increase of scale height with age and the mean stellar formation rate history during the last 1-2 Gyr. This is achieved by comparing observationnal properties of X-ray emitting stars (number, distribution in distance, magnitude, colour, kinematic properties ...) with predictions of an *X-ray stellar population model* (Guillout et al., 1996). This model is based on the *Besançon synthesis model* (Robin et al., 2003) adjusted on optical and infrared counts. It provides an overall picture of the galactic stellar content in terms of spectral types, densities and ages in a given line of sight. Using a coronal X-ray spectral model and integrating age dependent X-ray luminosity functions over stellar densities, the model predicts the optical and X-ray statistical properties of the active stars detected by XMM-Newton. In an effort to update the *Besançon stellar X-ray population model* an extensive survey of coronal temperature has been carried out. These observations indicate that stellar X-ray sources serendipitously detected in XMM-Newton pointings at low galactic latitudes have a mean X-ray temperature similar to that of the *Pleiades population* (0.07 Gyr). At high galactic latitudes, the average coronal temperature is compatible with that of the *Hyades population* (0.7 Gyr) or older. Since stellar X-ray activity decreases with age we expect a dependency of the coronal temperature with galactic latitude as a result of the ”heating” mechanism of the galactic disc. In addition, observations reveal a clear variation of the coronal temperature with spectral type (see Guillout et al., 2005, for a full description). The model can now handle these new spectral features. Moreover it has the ability to take into account the bias introduced by the limiting magnitude at which optical counterparts are spectroscopically identified and can efficiently use different absorption laws.

2. COMPARISONS MODELS/OBSERVATIONS

2.1. High galactic latitudes

Different stellar populations are present at intermediate and high galactic latitudes; at high fluxes the youngest *Pleiades-like population* dominates number counts. As sensitivity increases, the contribution of the older population becomes prominent and the relative fraction of M stars rises. As shown in Fig.1 model predictions are in very good agreement with the observed number counts over six orders of magnitude. The observed distributions in distances and magnitudes match also very well model predictions. Typical XMM-Newton sensitivities are large enough to detect young stellar coronae up to 200 pc (10^{-2} cnt s^{-1} expected in the 0.5-2.0 keV band) and can thus easily reach the scale height of the youngest stars ($\sim$ 70 pc *Pleiades-like*; $\sim$ 200 pc *Hyades-like*).

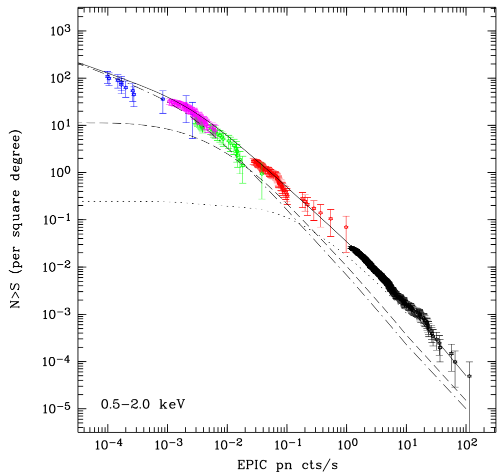

Figure 1. Log N-Log S curve for stellar identifications at high galactic latitudes. Bright sources (black) come from ROSAT survey (RBS, Schwope et al., 2002). XMM-Newton observations provide a large part of data: Bright XMM-Newton Serendipitous Survey (Della Ceca et al., 2004) (red), XMM-Newton SSC (Science Survey Center) medium sensitivity survey (Barcons et al., 2003) (green) and a faint XMM-Newton sample (Page, 2005)(magenta). The faintest sources are identifications from the Champ collaboration (Chandra; Green et al., 2003). The mean X-ray stellar population model fit very well the observations over 6 flux decades. Contributions of various populations are also shown (dotted line; <0.15 Gyr, dashed line;0.15-1 Gyr and dash-dotted line; >1 Gyr).

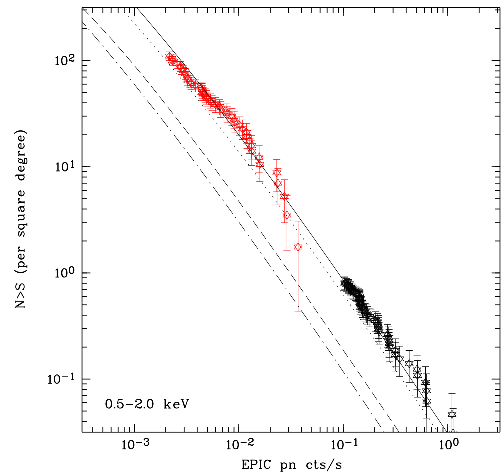

Figure 2. Log N- Log S curve for stellar identifications at low galactic latitudes. Black; the Rosat Galactic Plane Survey (Motch et al., 1997), red; identifications from the XMM-Newton SSC survey of the galactic plane (Motch et al., 2005). XMM-Newton data results from the merge of three b$\sim$ 0° fields. The X-ray model has the ability to take into account the bias introduced by the limiting optical magnitude and can handle different absorption laws. Here we use R lim of 17 to 21 depending on the field, and assume a mean absorption of about Av = 1.7 mag kpc^{-1} suitable for deep galactic plane regions..

2.2. Low galactic latitudes

At low galactic latitudes the stellar landscape drastically changes. The youngest stars now represent the overwhelming population, whatever the count rate is. Their fraction is typically around 60% while old stars contribute for 20% or less. In general the stellar population model is in relatively good agreement with the observations (Fig.2). The distribution in spectral types is not significantly different from that observed at high latitudes. The sensitivity of the EPIC cameras allows to reach 1 kpc in the galactic plane. However, the heterogeneous absorption is a key parameter that needs to be adjusted field by field (the case of absorbed regions is presented in Guillout et al., 2005).

3. PERSPECTIVES

Comparison of model predictions with observational data at high and low galactic latitudes reinforces the idea that the default scale heights of the young stars in the *Besançon synthesis model* are close to the actual values (scale heights are namely 70 pc for stars with age <0.15 Gyr and 190 pc for stars with age 0.15-1 Gyr). Our identification program carried out in the framework of the SSC galactic plane survey will allow to put strong constraints on this essential galactic parameter and on its variation with age.

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