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Origin of the Galactic Diffuse X-ray Emission: Iron K-Shell Line Diagnostics

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Abstract. An unresolved X-ray emission extends along the Galactic plane, so-called the Galactic diffuse X-ray emission (GDXE). The characteristic feature is three K-shell lines of Fe at 6.4, 6.7, and 6.9 keV. Recently, superposition of faint point sources, such as Cataclysmic variables (CVs) and Active binaries (ABs) is thought to be a major origin, although it is under debate which sub-class mostly contribute. We re-analyzed the Suzaku archive data and constructed spectral models of ABs, magnetic CVs (mCVs), and non-magnetic CVs (non-mCVs). The GBXE is explained by combination of those models; non-mCVs and ABs mainly contribute while mCVs account for $\sim$10% or less of the 5–10 keV flux. On the other hand, the GCXE and GRXE spectra cannot be represented by any combination of the point sources, indicating another origin would be required.

Keywords. Galaxy: center, Galaxy: bulge, Galaxy: disk, X-rays: diffuse background, X-ray: ISM, X-ray: stars

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1. Introduction

There is a diffuse X-ray emission along the Galactic plane (Galactic diffuse X-ray emission: GDXE), which is not resolved into bright X-ray binaries (e.g. Worral *et al.* 1982). Although many observational researches have been performed so far, the origin, superposition of faint point sources or truly diffuse, is still under discussion. The most characteristic feature of the GDXE is Fe-K line emissions at 6.4, 6.7, and 6.9 keV. Revnivtsev *et al.* (2009) carried out a deep observation at (l, b)=$(0°, -1.4°)$, and resolved $> 80\%$ of the Fe-K emission into point sources, such as active binaries (ABs) or cataclysmic variables (CVs). Hong (2012) confirmed a similar result using the same data set. Xu *et al.* (2016) analyzed the Suzaku archive data, and claimed that non-magnetic CVs (non-mCVs) mostly contribute to the GDXE.

Recently, Yamauchi *et al.* (2016) investigated the spacial distribution of the Fe-K lines, and found that the equivalent widths are different among the center ($|l| < 1°$, $|b| < 0.4°$, GCXE), ridge ($|l| > 1°$, GRXE), and bulge ($|b| > 0.4°$, GBXE). This fact may indicate that the same origin cannot explain whole of the three simultaneously. We will approach the origins from the point of view on Fe-K lines, in particular the equivalent widths (EWs) by comparing with those of ABs, magnetic CVs (mCVs), and non-mCVs. We used the Suzaku archive data according to Xu *et al.* (2016). The detailed analyses and results are written by Nobukawa *et al.* (2016).

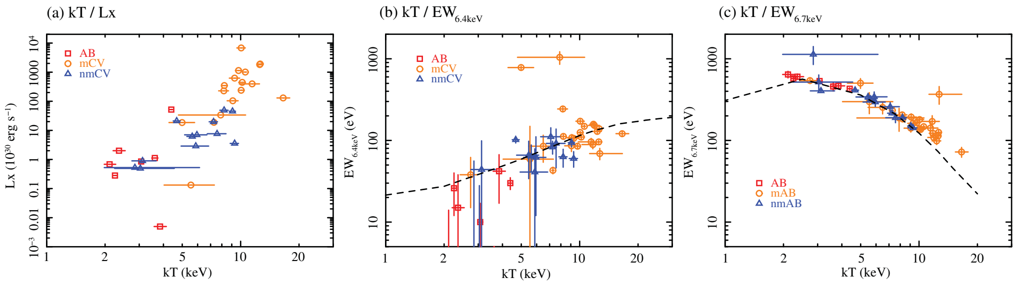

Figure 1. Parameters of ABs, mCVs, and non-mCVs (Nobukawa *et al.* 2016). (a) Plasma temperature (kT) and luminosity in 5–10 keV. (b) Plasma temperature (kT) and equivalent width of the 6.4 keV line ($EW_{6.4}$). A model curve is added with the dashed line, assuming that an X-ray emitting object is surrounded by a dense medium with $N_{\rm H} \sim 10^{23}$ cm^{-2}. (c) Plasma temperature (kT) and equivalent width of the 6.7 keV line ($EW_{6.7}$). The dashed curve shows the $EW_{6.7}$ of a plasma with a $Z_{\rm Fe} = 0.3$ solar abundance estimated by the APEC model.

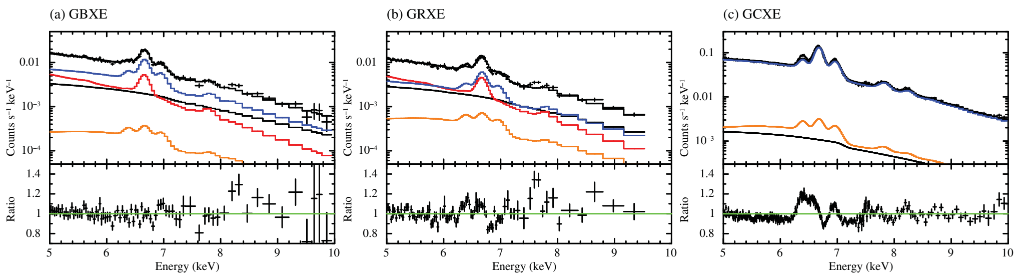

Figure 2. GDXE spectra fitted by combination of point source models: (a) GBXE, (b) GRXE, and (c) GCXE. The black curve in each top panel shows the cosmic X-ray background. The bottom panels show ratio between the data points and the models.

2. Result and Discussion

We selected 7 ABs, 18 mCVs, and 12 non-mCVs which have known distances. Figure 1a shows a positive correlation between the temperature kT and luminosity L_X. Except for two points, the $EW_{6.4\rm keV}$ is well represented by a model that a source with a given kT is surrounded by a dense medium (figure 1b). Also, the $EW_{6.7\rm keV}$ shown in figure 1c can be explained by a thin-thermal plasma (APEC).

We constructed spectral models by using the above results and an X-ray luminosity function reported by Warwick (2014). The GBXE spectrum is nicely fitted with the sum of AB:mCV:non-mCV$\sim 0.3 :< 0.1 : 0.6$ as is shown in figure 2a, which may support the point source scenario (e.g. Revnivtsev *et al.* 2009, Xu *et al.* 2016). However, the Fe-K lines of the GRXE and GCXE cannot be explained by any combination of the point source models (figure 2b, c). Another origin should be required for the GRXE and GCXE.

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