BEPPOSAX OBSERVATIONS OF THE GALACTIC CENTER REGION: SOFT X–RAYS FROM THE RADIO HALO OF SGRA EAST

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ABSTRACT The *Beppo*–SAX satellite performed a survey of the Galactic Center Region in the 1-10 keV energy band with its Narrow Field Instruments. Several bright X–ray sources containing neutron stars and black holes have been observed and studied, including the possible counterpart of SgrA*. Here we report the results on the diffuse emission coming from the SgrA Complex.

The emission from within 8′ from SgrA* has a double–temperature thermal spectrum ($kT_1 \sim$ 0.6 keV and $kT_2 \sim$8 keV) and an energy–dependent morphology: the hard emission (5–10 keV) is elongated along the galactic plane, while the soft one (2–5 keV) shows a triangular shape, very similar to the radio halo of SgrA East. This spatial correlation and the physical parameters of the lower temperature component support the interpretation of the radio halo of the Sgr A East shell as a SNR.

KEYWORDS: Galactic Center; X–rays; individual: SgrA East; supernova remnants.

1. INTRODUCTION

The BeppoSAX satellite performed a survey of the Galactic Center Region in the 1–10 keV energy band with its Narrow Field Instruments during 1997–1998.

A source positionally coincident with the Galactic Center (hereafter GC) was observed, together with strong diffuse emission and several point–like sources with luminosity $L_X \sim 10^{36}$ erg s^{-1}. The results on these sources, most of which are likely low mass X–ray binaries containing neutron stars and black holes, both with transient and persistent emission, are reported in detail by Sidoli et al. (1999). The spectral results for these sources are summarized in Fig. 1, where the photon index of the fits with a power law are plotted versus the hydrogen column density. An upper limit of $L_X \sim 10^{35}$ erg s^{-1} has also been placed to the 2–10 keV luminosity from the X–ray counterpart of SgrA* (see Sidoli et al. 1999 for details), confirming the underluminosity of this presumed supermassive black hole at high energies.

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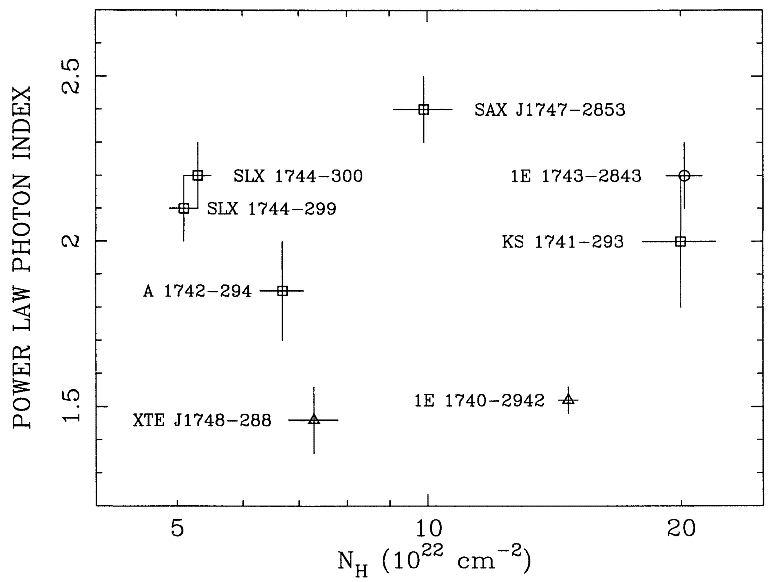

FIGURE 1. Spectral slope of the brightest sources observed in the GC region. Triangles mark the black hole candidates, the squares indicate LMXBs with neutron stars, while the circle marks a source the nature of which is still unknown.

Intense diffuse X–ray emission is also present in the GC region, the nature of which is still poorly known. Here we present the BeppoSAX results on the diffuse emission from the SgrA complex (Sidoli & Mereghetti 1999).

2. THE DIFFUSE EMISSION FROM THE SGRA COMPLEX

The Sgr A Region has been imaged with the MECS instruments (1.3–10 keV) with a spatial resolution of $\sim 1'$ (about 2.5 pc at the GC distance) in August 1997 (99.5 ksec net exposure time).

In order to study the spectral properties of the diffuse emission coming from the SgrA Complex, we extracted the MECS counts from four concentric annular regions ($0' - 2'$,$2' - 4'$,$4' - 6'$,$6' - 8'$) around SgrA*.

Several emission lines are present in all the spectra, with the K-lines from iron (E$\sim$ 6.7 keV) and sulfur (E$\sim$ 2.4 keV) particularly bright. The fit with a single temperature hot plasma model showed a nearly constant temperature ($\sim 7 - 8$ keV) at radii larger than $2'$, while in the innermost circle a softer spectrum (kT$\sim$ 4 keV) was found. This is probably due to the contribution from one (or more) point source(s) located close to SgrA* (Predehl & Trümper 1994, Maeda et al. 1996, Sidoli et al. 1999), that cannot be spatially resolved in our data. Since the temperature profile does not show spectral variations in the region from $2'$ to $8'$, we studied the overall spectrum from this entire corona. A single temperature plasma (MEKAL model) is not adequate to describe the spectrum, leaving positive residuals at low energy and especially around 6.4 keV. This can be due to the presence of fluorescent emission from neutral or weakly ionized iron in the nearby molecular

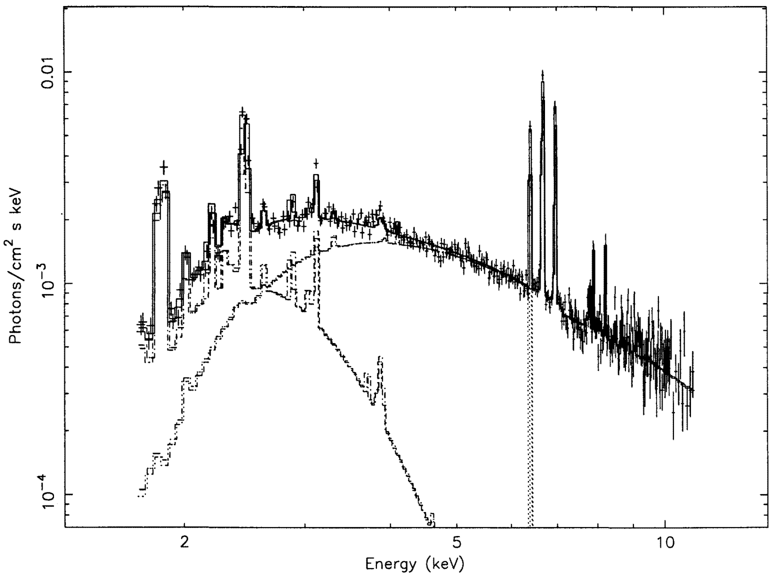

FIGURE 2. Best fit to the MECS spectrum ($2'-8'$ corona) from the Sgr A Complex.

clouds (Koyama et al. 1996). Thus we added a lower temperature plasma component plus a gaussian line at 6.4 keV. The resulting best fit is a double–temperature plasma, with $kT_1 \sim 0.6$ keV and $kT_2 \sim 8$ keV ($N_H = 8 \times 10^{22}$ cm^{-2}) and a gaussian line at 6.4 keV with an equivalent width of ~120 eV (see Fig. 2). The total flux corrected for the absorption is $F_X \sim 1.7 \times 10^{-10}$ erg cm^{-2} s^{-1} (2–10 keV), which translates into a luminosity of $L_X \sim 1.4 \times 10^{36}$ erg s^{-1}. About one third of the flux is contributed by the soft component.

2.1. Morphology of the Diffuse Emission

The spatial distribution of the diffuse emission was studied extracting two images in different energy ranges, below and above 5 keV (see Fig. 3). Both emissions are peaked at the GC position, but they have significantly different spatial distributions: the soft emission (2–5 keV) displays a triangular shape, while the hard one (5–10 keV) is elliptical and elongated in the direction of the galactic plane. While the hard emission can be simply part of the diffuse emission permeating the inner 60° of the galactic disk (e.g. Kaneda et al. 1997), the soft X–rays are spatially correlated with a structure observed in the radio band, known as the Sgr A East triangular halo (Pedlar et al. 1989). This is an extended non–thermal structure (probably a SNR) which surrounds in projection SgrA*. Since also our spectral data are well described by a two–temperature thermal model, it is tempting to give an interpretation in terms of two plasma components with different temperatures and spatial distributions. From the spectral analysis of the lower temperature plasma ($kT_1 \sim 0.6$ keV), we derive a luminosity $\sim 4.5 \times 10^{35}$ ergs s^{-1} (2–10 keV), an electron density $n_e \sim 3$ cm^{-3}, a total mass $M_g \sim 250\ M_\odot$ and an average thermal pressure

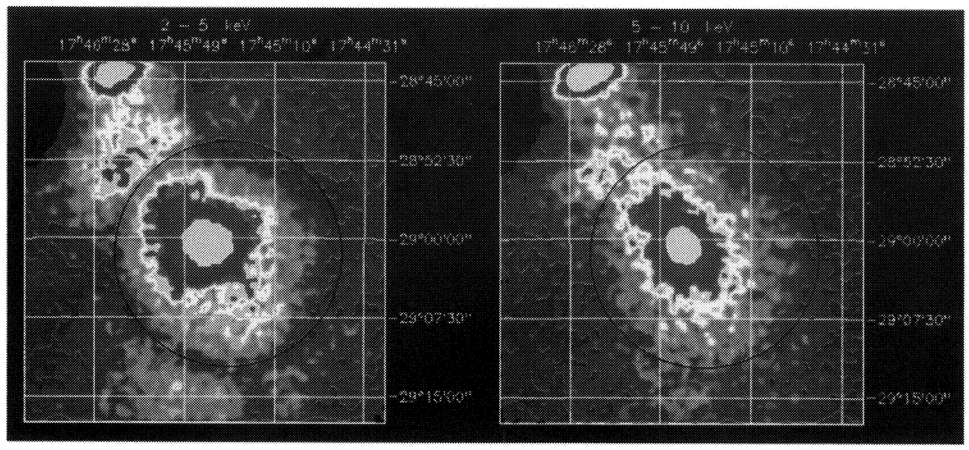

FIGURE 3. Spatial distribution of the diffuse emission from the Sgr A Complex below (left panel) and above (right panell) 5 keV. A smoothing with gaussian with FWHM=1′ has been applied. The black circle marks the position of the circular strongback structure of the MECS instrument (about 20′ diameter).

$P \sim 3 \times 10^{-9}$ ergs cm^{-3}, consistent with the pressure $P_{Sedov} \sim 4 \times 10^{-9}$ erg cm^{-3} derived for a SNR in a Sedov phase.

3. CONCLUSIONS

The BeppoSAX observation of the SgrA complex revealed the presence of at least two distinct components: a soft component with kT∼0.5–1 keV spatially correlated with the SgrA East 7′ triangular halo, and a hard one with kT∼7–9 keV elongated along the Galactic Plane and possibly associated with the harder component of the Galactic Ridge emission.

The soft component, which accounts for about one third of the 2-10 keV diffuse luminosity from the SgrA complex, can be well explained as thermal emission from the SNR responsible for the radio halo of the SgrA East shell.

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