Suzaku identifies the true nature of an old friend in the Galactic center
— Sgr D —

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Abstract

Sagittarius D (Sgr D) is one of the oldest known objects from the dawn of the radio astronomy in the Galactic center (GC). It has been considered a complex of HII regions. However, recent radio-continuum and infrared studies indicate that several components at various distances are projected along the same line of sight. In this presentation, we report the Suzaku discovery of a supernova remnant in the Sgr D complex, overturning the long-standing view of the object for 30 years (Sawada et al. 2009, PASJ). Our work is a nice illustration of the Suzaku's superb sensitivity for faint diffuse sources, which continues to revise our view of the GC region.

Key words: ISM: HII regions — ISM: individual (Sgr D) — ISM: supernova remnants

1. Introduction

Sagittarius D (Sgr D; Downes et al. 1979) is a twin of an HII region (Sgr D HII region) and a supernova remnant (SNR; Sgr D SNR) in the Galactic center (GC). Interferometric radio images resolved the HII region into several substructures (figure 1a; Mehringer et al. 1998). This complex (Sgr D HII complex) had been considered to be a single HII region and its environment. However, the latest radio-continuum/infrared studies indicate that objects at various distances are projected along the same line of sight (Blum & Damineli 1999; Law et al. 2008).

In order to reveal the true nature of the complex, we conducted X-ray observations of the Sgr D HII complex using X-ray Imaging Spectrometer (XIS) on board Suzaku (Sawada et al. 2009). Here we report a significant detection of diffuse X-ray emission, which renews our understanding of the complex.

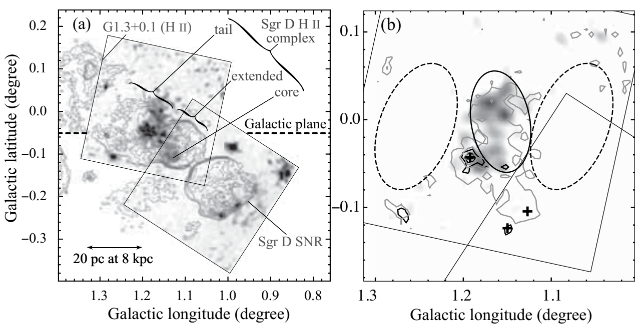

Fig. 1. XIS images of the Sgr D HII complex: (a) 0.7–5.5 keV with contours of an 18 cm radio map. (b) 2.4–2.5 keV with contours of 0.7–2.0 keV (black) and 2.0–5.5 keV (gray). Spectral source region and background region are shown with solid and dashed ellipses, respectively. Pluses indicate the positions of the point sources detected with XMM-Newton (Sidoli et al. 2006).

2. Results

2.1. Images

The Sgr D HII complex is accompanied by both diffuse and point-like X-ray emission (figure 1a). In the narrow-band (2.4–2.5 keV) image tracing the SXV Kα emission line (figure 1b), the diffuse emission emerges. Thus the diffuse X-ray emission is likely to be thermal emission of plasma with the temperature of $\sim$1 keV.

2.2. Spectrum

Figure 2 shows XIS spectrum of the diffuse X-ray emission. XIS spectrum was characterized by emission lines from highly ionized atoms. Observed spectrum was well reproduced by a thin-thermal plasma model attenuated by interstellar matter (table 1).

3. Discussion

3.1. Origin of the diffuse X-ray emission

No stellar distributions similar to the morphology of the diffuse X-ray emission nor bright X-ray point sources significantly contaminating to the diffuse emission were found. We therefore conclude that the X-ray emission is a new X-ray object and truly extended source in nature.

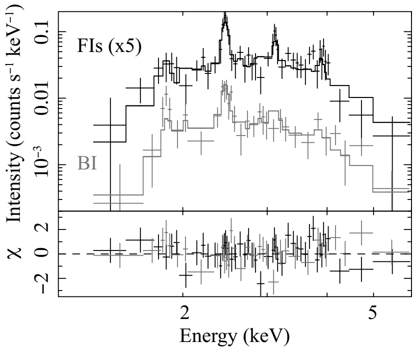

Fig. 2. XIS spectrum of the diffuse X-ray emission

Table 1. Best-fit parameters of the diffuse X-ray emission

Parameter	Value (90% error)
$N_{\rm H}$ (10^{22} cm^{-2})	8.5 (7.3–9.7)
kT (keV)	0.91 (0.74–1.08)
$Z_{\rm S}$ (solar)	1.6 (1.2–2.1)
$Z_{\rm Ar} = Z_{\rm Ca}$ (solar)	1.8 (0.9–2.9)
$L_{\rm X}$ (10^{35} erg s^{-1} at 8 kpc)*	1.4

*Absorption corrected value in 0.7–8.0 keV.

The large extinction ($N_{\rm H} \sim 8.5 \times 10^{22}$ cm^{-2}) indicates the X-ray object is located in or beyond the GC region. The apparent size of the object is about 9 pc × 16 pc at the GC distance of 8 kpc. The XIS spectrum is akin to those of SNRs discovered in the GC region (Mori et al. 2008). Thus we conclude that the origin of the diffuse X-ray emission is a new SNR in the GC region.

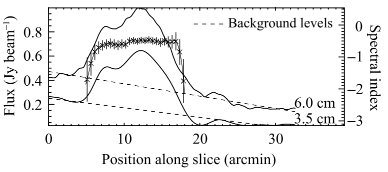

Fig. 3. Intensity maps of 3.5-cm and 6.0-cm bands and the spectral indices between the two bands along the slice (figure 4a).

In cm-band, spectra of SNRs are generally nonthermal synchrotron emission. We then studied the radio spectrum around the diffuse X-ray emission using the 100-m Green Bank Telescope (GBT) dataset. The spectral index was derived from background-subtracted intensity maps of 3.5-cm and 6.0-cm emission (figure 3) along the slice around the diffuse X-ray emission (figure 4a). We found the spectral index is consistently about -0.5. Therefore the radio emission across the diffuse X-ray emission is dominated by nonthermal synchrotron emission. This result provides another evidence of the diffuse X-ray emission being an SNR.

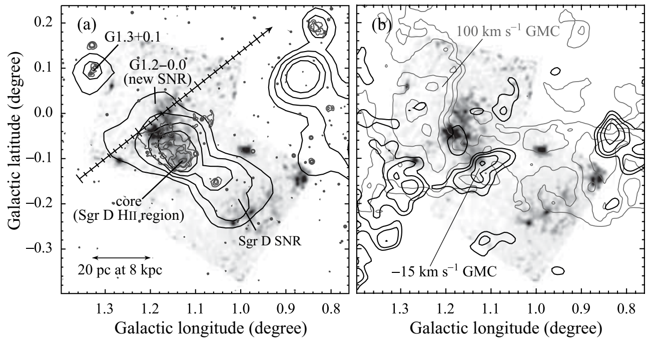

Fig. 4. Multiwavelength view of Sgr D: (a) GBT 6.0 cm with black contours and Spitzer 24 μm with gray ones. The slice for the radio spectral study is shown with a vector. (b) CO J=3–2 at 100±5 km s^{-1} with gray contours (Oka et al. 2007) and CS J=1–0 at -15 ± 5 km s^{-1} with black ones (Tsuboi et al. 1999).

3.2. Structure of the Sgr D HII complex

The "tail" is the new SNR and a part of it is bright in X-ray (figure 4a; G1.2−0.0). We found a 100 km s^{-1} giant molecular cloud (GMC) at the GC distance anti-correlates with the diffuse X-rays (figure 4b). This indicates that the lack of X-ray emission in other parts of the "tail" is due to the absorption by intervening GMC. Thus, the new SNR is behind the GC. The "core" is associated with a -15 km s^{-1} GMC on the near side of the GC (Blum & Damineli 1999). Therefore the new SNR is located behind the Sgr D HII region. It is now clear that an SNR and an HII region are projected along the same line of sight, not a HII region and its environment.

4. Summary

XIS detected diffuse X-ray emission toward the Sgr D HII complex for the first time. Spectral study of the emission in X-ray as well as cm-radio revealed its origin as a new SNR in the GC region. By assembling images across the wavelengths, we proposed a new view of the Sgr D HII complex: it is a projection of an SNR in or beyond the GC and an HII region in front of it. This revises a long-standing view of the object for 30 years.

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