X-RAY STUDY ON PLASMA OUTFLOWS FROM THE GALACTIC CENTER

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Abstract

The center of our Galaxy (Galactic center; GC) has a lower activity than that of active galactic nuclei or starburst galaxies at present. The current luminosity of the central supermassive black hole, Sagittarius (Sgr) A*, is eight orders of magnitude lower than its Eddington luminosity of 10^{44} erg s^{-1}. Moreover, on-going explosive star formation is not found. However, signatures of past GC activities have been reported recently. For instance, X-ray observations have discovered fluorescent lines of neutral iron from dense molecular clouds in the GC. They are likely to be caused by reflections of past Sgr A* flares occurring 100–1000 yr ago. The luminosity of the flares are estimated as $\sim 10^{39}$ erg s^{-1}. Gamma-ray observations also revealed the giant bubbles, which suggest another Sgr A* flare or a nuclear starburst 10^6–10^7 yr ago. Such observational evidence of past GC activities is still limited, so that there is a large gap in the activity history between 10^3 and 10^6 yr ago. Our aim is to find other relics of GC activities and to clarify the history of them.

Previous X-ray observations have concentrated on the Galactic plane region. Contrastingly, we focused on the Galactic bulge region because it is less contaminated by the strong GC background emission and is more suitable to detect phenomena associated with the GC activities. We performed the survey of the off-plane region with *Suzaku*, and found the large diffuse plasma to the south and north of the GC, which are referred to as GC South and GC North, respectively.

From the spectral analysis of GC South, we discovered strong radiative recombination continua of highly ionized Si and S. They suggest that the plasma is in a recombining phase, which is not expected in the standard shock-heating scenario. Indeed, a recombining plasma (RP) model well represents the spectrum, and gave us the electron temperature of 0.5 keV, the initial ionization temperature of 1.6 keV. The recombination timescale of 10^5 yr indicates that GC South was generated $\sim 10^5$ yr ago. The spectrum

suffer from strong interstellar absorption with $N_{\rm H} \sim 1 \times 10^{22}$ H cm^{-2}, which is consistent with the GC distance. Then the mass and thermal energy of the plasma reaches 3000 $M_{\odot}$ and 8×10^{51} erg, respectively, which is two orders of magnitude higher than that of a typical Galactic supernova remnant. We also investigated the spatial variation of the plasma parameters, and found that the electron temperature and density decrease as the distance from the GC is larger in the range of 0.4–0.8 keV and 0.06–0.12 cm^{-3}, respectively. The plasma become a collisional ionization equilibrium (CIE) state near the GC.

The spectra of GC North is represented by a CIE plasma with the electron temperature of 0.7 keV. The absorption column densities of $N_{\rm H} \sim 3 \times 10^{22}$ H cm^{-2} indicates that GC South is also located at the GC distance. The mass and thermal energy are found to be 900 $\rm M_{\odot}$ and 3×10^{51} erg, respectively. The dynamical time scale of the plasma is estimated as $\sim 10^5$ yr. These parameters are comparable to those of GC South.

We consider that a past GC activity $\sim 10^5$ yr ago generated GC South/North on the basis of large thermal energies in both the plasma and the RP in GC South.