Three-Dimensional Numerical Magnetohydrodynamic
Simulations of Magnetic Reconnection as the Origin of
X-ray Gas in the Galaxy

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Abstract. We suggested a magnetic reconnection model for the origin
of the X-ray gas in the Galaxy. In this paper, we examine this model
by performing the three-dimensional magnetohydrodynamic simulation
of the magnetic reconnection triggered by a supernova shock in the inter-
estellar medium. The magnetic reconnection heats the interstellar gas by
releasing the interstellar magnetic energy. The magnetic reconnection is
a possible mechanism to generate the X-ray gas in the Galaxy.

1. Introduction

Strong thermal X-ray emission, called Galactic Ridge X-ray Emission, is ob-

erved along the Galactic plane (Koyama et al. 1986). The origin of hot (\sim 7

keV) component of GRXE is not known, while cool (\sim 0.8 keV) one is associ-
ated with supernovae (Kaneda et al. 1997, Sugizaki et al. 2001). We propose
a possible mechanism to explain the origin; locally strong magnetic fields of
$B_{\text{local}} \sim 30 \mu \text{G}$ heat interstellar gas to \sim 7 keV via magnetic reconnection
(Tanuma et al. 1999). There will be the small-scale (< 10 pc) strong mag-
netic fields, which can be observed as $\langle B \rangle_{\text{obs}} \sim 3 \mu \text{G}$ by integration of Faraday
Rotation Measure, if it is localized by a volume filling factor of $f \sim 0.1$.

2. Numerical Simulations and Results

In order to examine this model, we solved three-dimensional (3D) resistive mag-
netohydrodynamic (MHD) equations numerically to examine the magnetic re-
connection triggered by a supernova shock (fig.1). We assume that the magnetic field is $B_x = 30 \tanh(y/20pc) \mu G$, $B_y = B_z = 0$, and the temperature is uniform, at the initial condition. We put a supernova explosion outside the current sheet. The supernova-shock, as a result, triggers the magnetic reconnection. The magnetic reconnection heats the interstellar gas to $\sim 7$ keV in the Galactic plane, if it occurs in the locally strong magnetic fields of $B_{\text{local}} \sim 30 \mu G$. The heated plasma is confined by the magnetic field for $\sim 10^{5.5}$ yr.

3. Discussion

The required interval of the magnetic reconnections (triggered by anything) is $\sim 1 - 10$ yr. The magnetic reconnection will explain the origin of X-rays from the Galactic ridge, furthermore the Galactic halo, and clusters of galaxies.

References

Koyama, K. et al. 1986, PASJ, 38, 121
Tanuma, S. et al. 1999, PASJ, 51, 161