

# MAGNETIC RECONNECTION AS THE ORIGIN OF SUPERHOT PLASMAS IN THE GALACTIC CENTER

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Recent X-ray astronomy satellite (e.g., Ginga, ASCA) has revealed that the center of our Galaxy is filled with a large amount of very hot plasmas (a few - 10 keV) on a scale of 100 pc, which are referred to as superhot plasmas. These plasmas are similar to the Galactic Ridge X-ray Emission (GRXE; cf Tanuma et al. 1997), but with larger gas pressure, and their formation mechanism has been a big puzzle. Here we propose a new model, magnetic reconnection model (Fig. 1), to explain the heating as well as the confinement of the Galactic center superhot plasmas, by performing MHD numerical simulations of magnetic reconnection in the situation suitable for the Galactic center. In our model, the magnetic field is amplified by the rotation of the Galactic gas disk (Fig. 2), and inflate from the disk to outside by the Parker instability. The inflating magnetic loop collides with ambient field lines, thus inducing the magnetic reconnection (the same process applied to the solar corona is shown in Yokoyama and Shibata 1995). In this model, energy release per single reconnection event is  $\Delta E \approx e_m V_{\text{rec}} \approx 2 \times 10^{51}$  erg where  $e_m = P/\beta$  is the energy density of toroidal magnetic field,  $V_{\text{rec}} = \lambda^2 \delta$  is the volume of the event,  $\lambda \approx 60\text{pc}$  is the most unstable wavelength of the Parker instability, and  $\delta \approx 3\text{pc}$  is the thickness of the Galactic disk. The occurrence rate of this event is  $f \approx N/\Delta\tau_{\text{dep}} \approx (3 \times 10^4 \text{ yr})^{-1}$  where  $N = V_{\text{disk}}/V_{\text{rec}}$  is the number of current sheets in the disk,  $V_{\text{disk}}$  is the volume of the disk, and  $\Delta\tau_{\text{dep}}$  is the time scale of energy deposit which is comparable with the time scale of the Galactic rotation. Then, the heating rate is  $h = f\Delta E = 2 \times 10^{39} \text{ erg s}^{-1} = 100L_{2-10\text{keV}}$ .

## References

- Tanuma, S., Yokoyama, T., Kudoh, T., Matsumoto, R., Shibata, K., and Makishima, K. (1997) Magnetic Reconnection as the Origin of Galactic Ridge X-ray Emission, submitted to ApJ Letters.  
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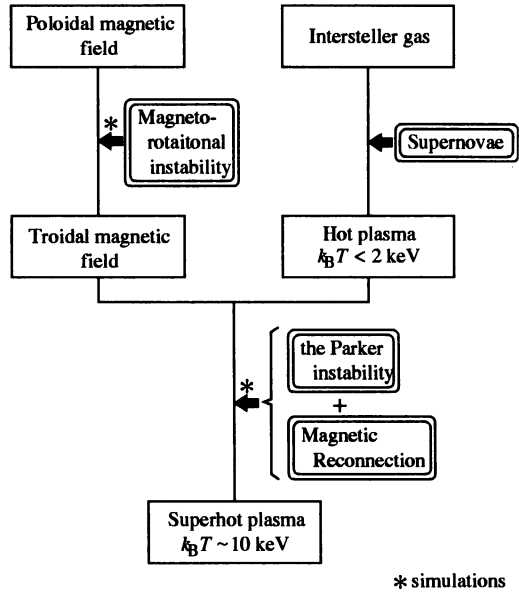


Figure 1.

Figure 1. Schematic diagram of our reconnection heating model for the superhot plasma in the Galactic Center

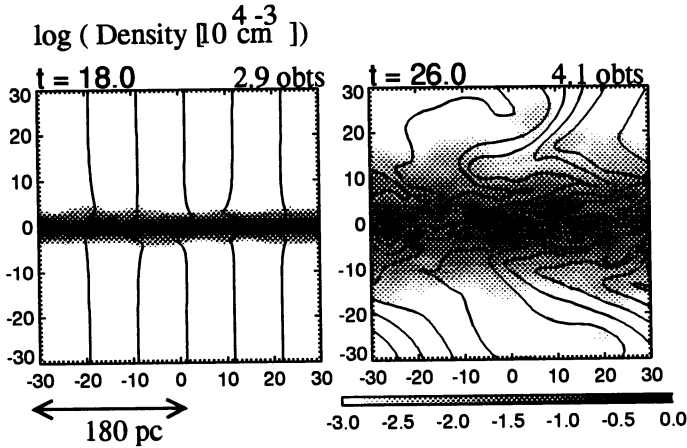


Figure 2.

Figure 2. Results of the two-dimensional MHD simulation of magneto-rotational instability in the Galactic center. A layered structure is formed in the plasma disk. It is divided into high- $\beta$  region (gas-pressure dominant) and low- $\beta$  region (magnetic-pressure dominant). Even though the averaged  $\beta$  is nearly unity, there could locally be a very low- $\beta$  ( $\approx 0.03$ ) region. Electric current density is large in the high- $\beta$  region in the disk. The shape of this region is sheet-like where magnetic reconnection may occur.