Magnetically Confined Interstellar Hot Plasma in the Nuclear Bulge of Our Galaxy

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The origin of the Galactic center diffuse X-ray emission (GCDX) is still under intense investigation. In particular, the interpretation of the hot ($kT \approx 7$ keV) component of the GCDX, characterised by the strong Fe 6.7 keV line emission, is problematic. Two main ideas have been suggested to account for it : a truly diffuse plasma that bathes the emitting region (e.g., [1]); and a superposition of a large number of unresolved point sources (e.g., [2]).

In Nishiyama et al. 2013 [3], we show that the spatial distribution of the GCDX does *not* correlate with the number density distribution of an old stellar population traced by near-infrared (NIR) light. The longitudinal and latitudinal profiles of the 6.7 keV line emission measured by *Suzaku* clearly show an excess over the stellar number density profiles, strongly suggesting a significant contribution of the diffuse interstellar plasma. Contributions of the old stellar population to the GCDX are estimated to be ~50 % and ~20 % in the nuclear stellar disk and nuclear star cluster, respectively.

The most puzzling aspects of the GCDX is its high temperature. Since the $kT \approx 7$ keV plasma is too hot to be gravitationally bound, it requires a huge energy source *without* a confinement mechanism of the plasma. One idea to address this energetics issue is the confinement of the plasma by magnetic fields [4].

We have carried out NIR polarimetric observations for the central $|l| < 1^{\circ}.5$ and $|b| < 1^{\circ}.0$ region, and we obtain polarization originating from magnetically aligned dust grains in the Galactic center (for more detail, see [5]). The polarized angle traces the Galactic center's MF direction projected onto the sky. The obtained polarization map (Fig. 1) suggests that the GCDX region is permeated by a large scale, *toroidal* magnetic field, indicating a magnetic confinement of the hot plasma.

If the plasma were not confined, it would be rushing out of the Galactic plane vertically as a galactic wind. Assuming the gas flows out from the X-ray emitting region at the sound speed, the escape timescale is $\sim 4 \times 10^4$ yr. This requires a huge energy input to sustain the hot plasma; e.g., an unreasonably high supernova rate of $\sim 5 \times 10^{-3}$ yr^{-1}. If the plasma is magnetically confined, and there is no other cooling mechanism, the hot plasma only cools by radiation with a timescale of 10^7–10^8 yr, several orders of magnitude longer than the escape timescale. This would reduce the required energy input by several orders of magnitude and thus relax the energetics problem.

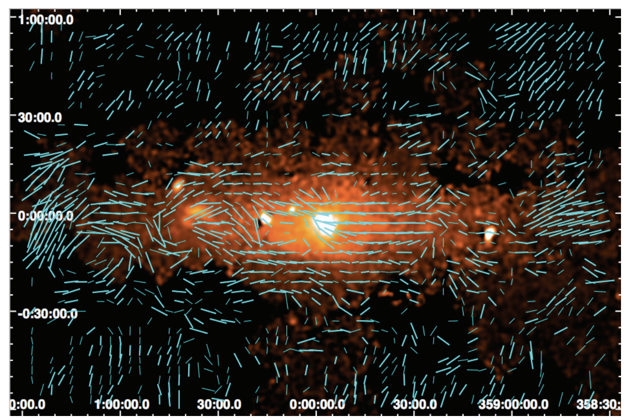

Figure 1: Polarimetry results covering $3^{\circ}.0 \times 2^{\circ}.0$ in the Galactic coordinate, together with an intensity map of 6.7 keV line emission [6]. The cyan vectors show the inferred magnetic field direction, and the lengths are proportional to polarization percentage.

References

[1] Koyama, K., et al.: 1989, *Nature*, **339**, 603.
[2] Wang, Q. D., et al.: 2002, *Nature*, **415**, 148.
[3] Nishiyama, S., et al.: 2013, *ApJ*, **769**, L28.
[4] Tanuma, S., et al.: 1999, *PASJ*, **51**, 161.
[5] Nishiyama, S., et al.: 2009, *ApJ*, **690**, 1648.
[6] Nobukawa, M., et al.: 2012, *AIP Conf. Proc.*, **1427**, 209.