THERMAL AND NON-THERMAL X-RAYS FROM SN 1006 AND IC 443

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1. Introduction

From many Galactic supernova remnants (SNRs), X-ray emissions consisting of non-equilibrium ionization (NEI) plasma and additional hard component are detected. The hard emission have been usually interpreted as a high temperature plasma of $\geq$ 10 keV. However, the recent observation with ASCA made it clear that the hard components of some SNRs are of non-thermal origin. Here we report the ASCA results of SN 1006 and IC 443 observations as an example of such SNRs.

2. SN 1006

Koyama et al. (1995) found that SN 1006 has diffuse thermal component in its interior region in addition to the bright rims. Unfortunately, the region is strongly contaminated by the rim-emission leakage due to the loose XRT PSF: most of the photons above $\simeq$ 2.5 keV come from bright rims, and even below $\simeq$ 2.5 keV a significant fraction of the continuum is thought to be of rim origin. Fortunately, the leakage is mainly due to the distortion of the mirror surface so that we can expect that the leakage spectrum little changes position by position. Therefore, we used the off-source data as the background.

After being subtracted the Rim leakage, the resultant cannot be described by a single-component or two-component NEI plasma: they could

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not describe line profiles nor < 1 keV spectrum.

Nevertheless, strong Mg, Si and S lines implies that their abundances are much larger than the solar values. It suggests that SN 1006 is still in the free-expansion phase.

The bright rim spectrum can be described by the model of a power-law with an absorption which dominates above $\simeq$1 keV and the interior thermal component. The best-fit photon index and the absorption column are 2.86 ± 0.05 and $(2.4 \pm 0.1) \times 10^{21}$ cm^{-2}, respectively (with 90% errors). The 2-10 keV flux of NE and SW rims are 1.9 and 1.5×10^{-11} erg s^{-1}cm^{-2}, respectively.

3. IC 443

In contrast to SN 1006, we fitted the IC 443 GIS data region by region and found that their thermal components can be described by 1-NEI model and the abundances in all regions are about 1 solar or lower, which suggests that IC 443 is in the adiabatic expansion phase. While the Einstein (Petre et al. 1988) and ROSAT (Asaoka and Aschenbach 1994) data implied that the southern part of the remnant has larger absorption, we could not find such a tendency.

In addition, we found that the hard (>4 keV) component forms a shell-like structure similar to radio, IR and optical emissions. Since it lies along the edge of the PV FOV, we could not judge how large the component extends. Nevertheless, we can expect that it extends from the FOV because the hard-component flux ($\simeq 1 \times 10^{-4}$ photons s^{-1}keV^{-1}cm^{-2} at 7 keV) is only about a half of that suggested by the Ginga observation.

Due to the poor statistics, we carried out spectral fitting for only two bright regions. Each region could be described by the model of a power-law and the thermal component of the nearby region. The photon indices of the hard components of two positions are $2.48^{+0.31}_{-0.28}$ and $2.35^{+0.65}_{-0.53}$, respectively (with 90% errors).

References

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