ASCA Observations of Supernova Remnant IC 443 and the First Detection of Over-ionized Plasma

Masahiro Kawasaki, Masanobu Ozaki, Fumiaki Nagase (*ISAS, Sagamihara, Kanagawa, Japan*)

Abstract

We present the results of ASCA observations of the supernova remnant (SNR) IC 443, focusing the detection of over-ionized plasma.

IC 443 is one of the "mixed-morphology" SNRs that have center-filled X-ray morphology contrary to the shell-like structure in optical and radio bands. From the ASCA data, we found that IC 443 has a plasma structure of an inner-hot (1.0 keV) and an outer-cool (0.2 keV) regions. In addition to this structure, we found that the Si and S H-like line emission is too strong considering the gas temperature $\simeq$1.0 keV suggested from the continuum shape of the spectrum. The intensity ratio of H-like Kα to He-like Kα requires a temperature $\simeq$1.5 keV, which is more highly ionized than would be expected if the plasma were in 1.0 keV collisional equilibrium. The existence of another higher temperature plasma component such as an ejecta is implausible because this component requires extraordinary large abundance (more than 10 times cosmic) and the image of Si and S H-like Kα bands is quite similar to those of other bands. Therefore, we conclude that the 1.0 keV plasma itself is over-ionized, which is the first detection in SNRs.

To make over-ionized plasma, the gas should cool faster than the ions could recombine to their equilibrium level. Thermal conduction from the hot interior to the outer shell cooled by the effective radiation could make the interior plasma be over-ionized, which suggests that IC 443 is in the radiative cooling phase.

CATEGORY: SUPERNOVAE, SUPERNOVA REMNANTS AND ISOLATED NEUTRON STARS