G54.4−0.3 — MULTI-FREQUENCY INVESTIGATION OF AN SNR IN INTERACTION WITH THE ISM

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1. Introduction

G54.4−0.3 is an extended shell-type supernova remnant (SNR) in the Galactic plane. We selected this source as a candidate for the interaction of SNRs with the interstellar medium on the base of an investigation of cool IRAS point sources in the direction of SNRs. We found a statistical excess of IRAS sources with FIR spectra similar to young stellar objects ($T_d \approx 25 - 45$ K) in the vicinity of G54.4−0.3 and a number of other SNRs in the northern hemisphere (Junkes & Fürst 1992).

This prompted us to study G54.4−0.3 in the molecular line of CO. Medium-resolution CO observations, covering the whole area of the SNR, reveal a shell-type structure in nice correlation to the radio continuum structure (Junkes et al. 1992a).

In a further investigation (Junkes et al. 1992b) we extended this study to high-resolution CO observations of selected areas across the SNR centered on the positions of IRAS point sources, and found an association with condensations or small clouds in the CO shell. One of these clouds shows a bipolar structure and self-absorption at the central position in ^{12}CO, and is probably a young stellar object (YSO) still embedded in dust.

2. ROSAT X-ray Observations

In order to investigate the hot gas in connection with the SNR, we observed G54.4−0.3 with ROSAT in four separate exposures. The extended structure in the central part of the image can be associated with the SNR. In addition, the young compact SNR G54.1+0.3 (Reich et al. 1985) shows up as a bright X-ray source in the western half of the image.

L. Blitz and P. Teuben (eds.), Unsolved Problems of the Milky Way, 627–628.

There is a nice anti-correlation between the X-ray feature (hot thermal gas) seen in the ROSAT image and the molecular line emission in CO (cold molecular gas). The X-ray emission almost fills the gap in the CO shell. Spectral fitting of the soft X-ray emission towards G54.4−0.3 gives the following result: The best-fitting thermal plasma spectrum (Raymond & Smith 1977) shows almost complete absorption below 1.0 keV, indicating a high hydrogen column density in the direction of this SNR located directly in the Galactic plane. The results of the fit are $10^{22}\mathrm{cm}^{-2}$ for HI column density towards the source, with a plasma temperature of $\approx 2 \times 10^7$ K.

The spectral fit already indicates that the upper limit of the X-ray temperature of the SNR is too high to be reasonably determined by the ROSAT observations. In order to perform a detailed spectral analysis of the X-ray spectrum of G54.4−0.3, to investigate absorption and the hard X-ray morphology of the source, we successfully applied for observations with the Japanese ASCA satellite.

3. Final Remarks

We have investigated the SNR G54.4−0.3 and propose the following picture for this source: It is part of an extended complex of young population I objects (OB-association with associated HII-regions), the possible birthplace of the progenitor star of the supernova. An energetic stellar wind pushed molecular material ahead and condensed it to a shell. The supernova exploded inside the created cavity, and the debris expanded almost freely into the stellar wind bubble before it reached the edge of the molecular shell. Since the CO-shell was formed by the stellar wind 10^7 years ago, parts of it have been condensed and developed into protostellar or young stellar objects (YSOs). The X-ray observations trace the hot gas from inside the shell and provide another step towards the multi-frequency investigation of this SNR in interaction with the ISM.

The project is further supplemented by an investigation of the neutral gas surrounding the SNR (high-resolution HI observations) and the FIR energy distribution of the suspected YSOs (ISO proposal).

References

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