

A Spatial Study of X-ray Properties in Superbubble 30 Dor C with XMM-Newton

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Abstract. The superbubble (SB) 30 Dor C with the strong non-thermal X-ray emission is one of the best targets for study of the cosmic-ray (CR) acceleration. We investigated X-ray spectral properties of the SB with a high spatial resolution of ~ 10 pc. Consequently, the spectra in the east regions can be described with a combination of absorbed thermal and non-thermal models while the spectra in the west regions can be fitted with an absorbed non-thermal model. We found that the observed photon index and intensity in 2-10 keV show variations of 2.0-3.5 and $(0.6-8.0) \times 10^{-7}$ erg s⁻¹ cm⁻² str⁻¹, respectively. The results are possibly caused by the spatial variation of the CR acceleration efficiency and/or the circumstellar environment.

Keywords. cosmic rays - ISM: supernova remnants - ISM: bubbles - X-rays: ISM

Sano *et al.* (2015) detected the sub-parsec spatial variations of the non-thermal X-ray properties in SNR RX J1713.7-3946 and a correlation between the X-ray intensity and the molecular mass interacting with the SNR. To explain the observational results, they suggested the shock-cloud interaction scenario (see the details [1]). Thus, in this work, we investigate X-ray properties of a superbubble (SB) which possesses a larger spatial extent created by successive supernova explosions and aim at constructing a CR acceleration mechanism also for SBs. 30 Dor C, located in Large Magellanic Cloud, is a young SB showing a shell structure with a diameter of ~ 80 pc ($\sim 6'$) in X-ray and bright non-thermal X-ray luminosity of $\sim 5 \times 10^{35}$ erg s⁻¹ [2]. Recently, TeV γ -ray emission associated with the SB was detected for the first time [3], meaning that CR protons/electrons are efficiently accelerated up to at least 10 TeV.

We used XMM-newton EPIC-pn datasets and divided the X-ray shell into 33 regions with $0.7' \times 0.7'$ grids corresponding to a physical scale of ~ 10 pc in order to examine the detailed X-ray properties in the SB. Consequently, the spectra in the east regions of 30 Dor C can be described with absorbed thermal and non-thermal models, while the spectra in the west regions can be fitted with an absorbed non-thermal model. The observed photon index and intensity in 2-10 keV show spatial variations of 2.0-3.5 and $(0.6-8.0) \times 10^{-7}$ erg/s/cm²/str, respectively.

When comparing the X-ray properties with the total integrated intensity in ¹²CO ($J=1-0$) observed by NANTENCO, we found a positive correlation between the X-ray intensity and ¹²CO intensity and the fact that the photon index tends to be less steep when the ¹²CO intensity increases. These trends suggest that an interaction between the ISM and shocks affects the process of the particle acceleration.

References

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