

A Detailed Observation of a LMC SNR, DEM L241, with *XMM-Newton*

Aya Bamba¹, Masaru Ueno², Hiroshi Nakajima³, Koji Mori⁴
and Katsuji Koyama³

¹RIKEN (The Institute of Physical and Chemical Research) 2-1, Hirosawa, Wako, Saitama
351-0198, Japan
email: bamba@crab.riken.jp

²Department of physics, Faculty of Science, Tokyo Institute of Technology 2-12-1,
Oo-okayama, Meguro-ku, Tokyo 152-8551, Japan
email: masaru@hp.phys.titech.ac.jp

³Department of Physics, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto
606-8502, Japan
email: nakajima@cr.scphys.kyoto-u.ac.jp, koyama@cr.scphys.kyoto-u.ac.jp

⁴Department of Applied Physics, Faculty of Engineering University of Miyazaki, 1-1 Gakuen
Kibana-dai Nishi Miyazaki, 889-2192, Japan
email: mori@astro.miyazaki-u.ac.jp

Abstract. We report on an *XMM-Newton* observation of the supernova remnant (SNR) DEM L241 in the Large Magellanic Cloud. In the soft band image, the emission shows an elongated structure, like a killifish (Head and Tail), with a central point source, named as XMMU J053559.3–673509 (Eye). The Eye’s spectrum is well reproduced with a power-law model. The source has neither significant coherent pulsations nor time variabilities. Its luminosity and spectrum remind us that the source might be a pulsar and/or pulsar wind nebula in DEM L241. The spectra of Head and Tail are well reproduced by a non-equilibrium ionization plasma model with over-abundant Ne and under-abundant Fe, suggesting that the progenitor of DEM L241 is a very massive star.

Keywords. supernova remnants, X-rays: individual (DEM L241), X-rays: individual (XMMU J053559.3–673509).

1. Introduction

Supernovae and supernova remnants (SNRs) shape and enrich the chemical and dynamical structure of the interstellar medium and clouds. The Large Magellanic Cloud (LMC) is the best galaxy for the systematic study of SNRs, thanks to the known distance (Feast 1999). In the LMC, we pointed out DEM L241 (0536–67.6), which was identified by Mathewson *et al.* (1985), and observed with *XMM-Newton*. The total exposure is 45 ks for MOS and 43 ks for pn, respectively. The details are in Bamba *et al.* (2005).

2. Results

Figure 1 shows the *XMM-Newton* MOS 1 + 2 images of DEM L241 in the (a) 0.5–2.0 keV and (b) 2.0–9.0 keV bands. In the soft band image, we can see a diffuse structure elongated from southeast to northwest with the size of $\sim 1.5' \times 3'$, corresponding to 22 pc \times 44 pc at 50 kpc. The shape is like a killifish, with double peaked feature on its “Head” and “Tail”. In addition to the body of the fish, there is a point source like an “Eye” of the fish. On the other hand, only Eye can be seen in the hard band image. We found no candidate of the counterpart of Eye in the SIMBAD database, and named it as XMMU J053559.3–673509.

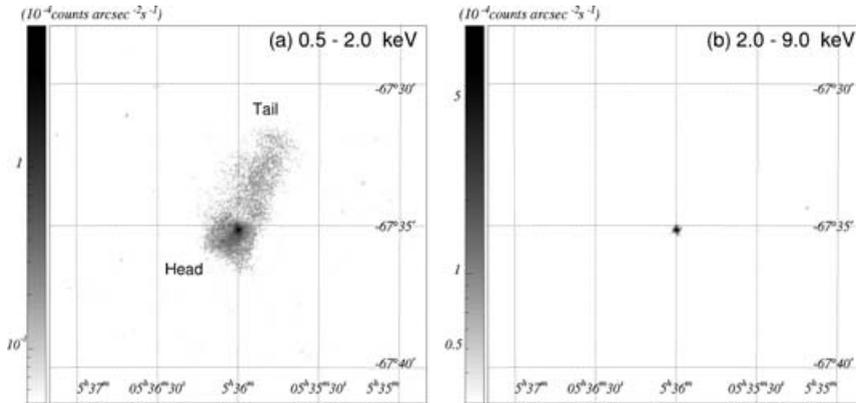


Figure 1. MOS 1 + 2 images in the (a) 0.5–2.0 keV and (b) 2.0–9.0 keV bands.

Table 1. Best-fit parameters for the Head, Tail, and Eye

Parameters	Head	Tail	Eye
kT_e/Γ [keV/—]	0.54 (0.46–0.57)	0.43 (0.38–0.50)	1.57 (1.51–1.62)
$n_e t_p$ [$10^{11} \text{cm}^{-3} \text{s}$]	2.4 (1.9–4.3)	3.4 (2.1–5.2)	—
[Ne/H]	0.64 (0.60–0.69)	0.58 (0.54–0.63)	—
[Si/H]	(<0.05)	(<0.07)	—
[Fe/H]	0.09 (0.08–0.10)	0.08 (0.07–0.09)	—
$E.M.$ [10^{58}cm^{-3}]	2.5 (2.2–3.0)	2.1 (1.4–2.8)	—
N_{H}^{LMC} [10^{21}cm^{-2}]	4.2 (3.3–5.2)	1.6 (0.6–2.3)	3.3 (2.7–4.0)
$\text{Flux}_{0.5-10\text{keV}}$ [$\text{ergs cm}^{-2} \text{s}^{-1}$]	3.2×10^{-13}	3.6×10^{-13}	6.4×10^{-13}

The spectrum of Eye is hard and has no line-like structure, and is well fitted with an absorbed power-law model (Table 1). The intrinsic luminosity is $2.2 \times 10^{35} \text{ ergs s}^{-1}$ in 0.5–10.0 keV. The central position and hard spectrum may indicate that Eye is a pulsar and/or pulsar wind nebula (PWN) of DEM L241. We searched for but could not find any coherent pulsations and time variabilities. If Eye is a pulsar and/or PWN, it belongs to the bright and hard class (Gotthelf & Olbert 2002).

The Head and Tail emission have, on the other hand, soft and line-rich spectra. Both are well fitted with a non-equilibrium ionization collisional plasma emission model (Borkowski *et al.* 2001) ver. 2.0 as seen in Table 1. The over-abundant Ne and less-abundant Fe relative to the average LMC value (0.3; Russel & Dopita 1992) indicate that the progenitor of DEM L241 is a very massive star. The estimated total plasma mass ($\sim 200 M_{\odot}$) and the thermal energy ($5 \times 10^{50} \text{ ergs}$) also suggest the massive star origin, together with the existence of the central point source, Eye, and the OB star association, LH 88 (Chu & Kennicutt 1988).

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