X-ray and radio observations of a new SNR in the Large Magellanic Cloud

M.-H. Grondin[1,*], M. Sasaki[1], F. Haberl[2], W. Pietsch[2], M. Filipovic[3] & E. Crawford[3]

1. Institut für Astronomie und Astrophysik Tübingen, Universität Tübingen, Sand 1, 72076 Tübingen, Germany
2. Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse, 85748 Garching, Germany
3. University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW 1797, Australia

Abstract :

Because of their energy and hot gas inputs into the interstellar medium (ISM), the study of supernova remnants (SNRs) is crucial for a complete understanding of the chemical composition and evolution of the ISM in a galaxy. The Large Magellanic Cloud (LMC) is one of the closest satellite of the Milky Way. This irregular galaxy offers the opportunity for the study of a large sample of SNRs and candidates in great detail.

Discovered during the ROSAT PSPC survey, the source [HP99] 456 is one of the best SNR candidates classified in the ROSAT catalogue, which met the morphological and spectral criteria. Recent observations of this source with XMM-Newton have confirmed a structure like a SNR shell. In addition, a narrower and harder region can be observed, that may be a pulsar wind nebula candidate. Follow-up observations have been performed to search for radio counterparts. This poster presents results of radio and X-ray observations of this new composite SNR in the LMC.

Introduction :

Located at a distance of ~50 kpc (Macri et al, 2006), the Large Magellanic Cloud is the ideal laboratory to study a large sample of different types of galactic sources, such as supernova remnants (SNRs) in greater detail than in any other galaxy. Since its first detection in X-rays (Mark et al., 1969), it has been extensively observed but the major step forward came from the ROSAT survey of the LMC, which revealed 758 sources, among which 46 sources are SNRs and candidates (Haberl & Pietsch, 1999).

Among them, the source [HP99] 456 is one of the best SNR candidates classified in the ROSAT catalogue on morphological and spectral criteria. The high sensitivity of the XMM-Newton satellite and follow-up observations in the radio domain have enabled to investigate this source in more detail. Based on these observations, we attempted to identify the two components revealed in the X-ray domain (Grondin et al, 2011).

X-ray observations :

Observations :

- Obs. ID : 0651880101 (P.I. : M. Sasaki),
- 20 ks observations with XMM-Newton European Photon Imaging Cameras (EPIC: MOS1/2 & PN) in full frame mode.

Morphology :

The analysis of X-ray data reveals two components :

- a soft component, which dominates the emission below 0.9 keV. It has a shell-like morphology with a diameter of ~5.2' (i.e. ~76 pc assuming a distance of ~50 kpc),
- a harder component, which is clearly visible above 0.9 keV. It presents an elongated morphology of length ~0.8' (i.e. ~12 pc assuming a distance of ~50 kpc).

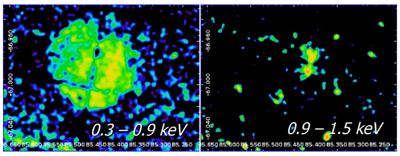

Figure 2 : X-ray exposure corrected images of [HP99] 456 in two energy ranges.

Spectral analysis :

- Soft shell-like component : well fitted with a thermal spectrum (NEI : non equilibrium collisional plasma) with a temperature of ~0.37 keV,
- Hard emission : well modeled with a non-thermal spectrum (power-law) with a spectral index of ~2.32.

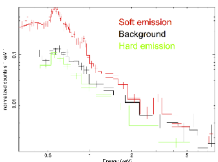

Figure 3 : Spectra of the soft (red) and hard (green) emitting regions

Assuming the identification of the soft shell-like emission as a SNR in the Sedov phase yields an electron temperature of ~0.25 keV, corresponding to a dynamic age of ~30 kyr.

References :

Grondin, M-H., Sasaki, M., Haberl, F. & Pietsch, W., Filipovic, M., A&A, in prep.
Haberl, F. & Pietsch, W., 1999, A&AS, 139, 277
Levenson, N. A. et al, 1995, AJ, 110, 739
Macri, L. M. et al., 2006, ApJ, 652, 1133
Mark, H. et al., 1969, ApJ, 155, L143
Meixner, M. et al., 2006, Astron. J, 132, 2268
Smith, R. C. et al., 2000, ASP Conference Proceedings, 221, 83
Williams, R. M. et al, 1999, ApJS, 123, 467
Williams, R. M. et al, 2004, ApJ, 614, 948

Radio follow-up observations :

Radio observations have been performed with the Australian Telescope Compact Array (ATCA) on the source [HP99] 456 to look for counterparts.

They reveal 3 point sources located within the hard X-ray emitting region. Among them, one presents a spectrum similar to that of the pulsar. Timing observations are required to confirm or invalidate this identification.

→ the hard emitting region may be a pulsar wind nebula.

Multi-wavelength observations :

- Near Infrared (IR) :

Near IR observations of the LMC by Spitzer (SAGE, Meixner et al., 2006) reveal a dust emission spatially coincident with the shell-like soft emitting region.

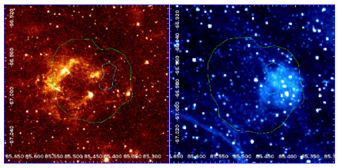

Figure 4 : Near infra-red (left) and Hα emission line in the surrounding of the source [HP99] 456. The green and blue contours represent the soft and hard X-ray emitting regions respectively.

- Optical :

The Magellanic Clound Emission Line Survey (MCELS, Smith et al., 2000) enables the study of emission lines from Hα, [SII] and [OIII]. No clear correlation can be observed between optical emission and the source [HP99] 456.

Conclusions :

Recent X-ray observations with *XMM-Newton* of the source [HP99] 456 previously discovered by *ROSAT* led to the identification of a new SNR in the LMC, which presents a shell-like morphology and a soft thermal spectrum.

Further analyses of the X-ray data have revealed a harder and narrower emitting region within the shell, that may be a pulsar wind nebula. This hypothesis is supported by multi-wavelength observations.

Follow-up observations with ATCA revealed radio point sources coincident with the hard emitting region. One of them could be a pulsar.

Near infrared data show a coincident feature, that may be related to the SNR shell, but no correlation can be found between the X-ray and optical emission.

The physical properties (temperature, size, etc.) of this new SNR are consistent with SNRs previously identified in the LMC by X-ray observations (Levenson et al, 1995, Willams et al, 1999, 2004).

The X-ray Universe 2011, 27 – 30 June 2011, Berlin, Germany

** Contact : grondin@astro.uni-tuebingen.de*