Investigating the galactic Supernova Remnant Kes 78 with XMM-Newton

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The SNR Kes 78

- OH masers (Green et al. 1997), suggest interaction with an adjacent molecular cloud (see Koralesky et al. 1998, Zhou&Chen 2007, 2011)

- Close to the extended source HESS J1852–000 (Kosack et al. 2011)

- Close to a Fermi source (Acero et al. 2015)
The SNR Kes 78

- Bamba et al. 2016 detected the diffuse X-ray emission with Suzaku
- The Suzaku spectra show indications of hard (nonthermal?) X-rays

Is Kes 78 a cosmic ray accelerator? What is the origin of the $\gamma$-ray emission (hadronic or IC from hard X-rays?)
The XMM-Newton data

EPIC data: 35/24 ks of (screened) MOS/pn exp. time

Aims:
- Study the morphology of the soft/hard X-ray emission
- Spatially-resolved spectral analysis
- Studying the SNR-cloud interaction
- No diffuse X-ray emission above 2.5 keV
- Detection of a set of pt-like source whose cumulative spectrum is consistent with the hard X-ray emission detected with *Suzaku*
- The global spectrum shows no hard excess when pt-like sources are removed
Spatially resolved analysis

We selected a set of three regions (East, Northwest and Southwest, on the basis of the Median Photon Energy map (where each pixel hold the median energy of the photons detected therein)}
Spatially resolved analysis

The X-ray emission from the **East** region is softer than that from **NW** and **SW**.
Spatially resolved analysis

The X-ray emitting plasma in the **East** region has a lower temperature and a higher EM than that **NW** and **SW**.

$$N_H = 1.3 \pm 0.1 \times 10^{22} \text{ cm}^{-2}$$

$$N_H = 0.8 \pm 0.1 \times 10^{22} \text{ cm}^{-2}$$

$$N_H = 0.9 \pm 0.1 \times 10^{22} \text{ cm}^{-2}$$
Shock-cloud interaction

Low temperature, together with high EM and $N_H$ indicate shock-cloud interaction in the **East** region

Miceli, M. – XMM observation of Kes 78
Conclusions

The XMM-Newton observation allowed us to obtain new information on the physical properties of the plasma in Kes 78:

- High resolution maps of the soft X-ray emission
- No diffuse hard X-ray emission (no synchrotron emission)
- Two regimes in the X-ray emitting plasma
- Clear signatures of shock-cloud interaction

Possible hadron origin for the HESS $\gamma$-ray emission

Kosack et al. 2011