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XMM-Newton: the Next Decade

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# Investigating the galactic Supernova Remnant Kes 78 with *XMM-Newton*

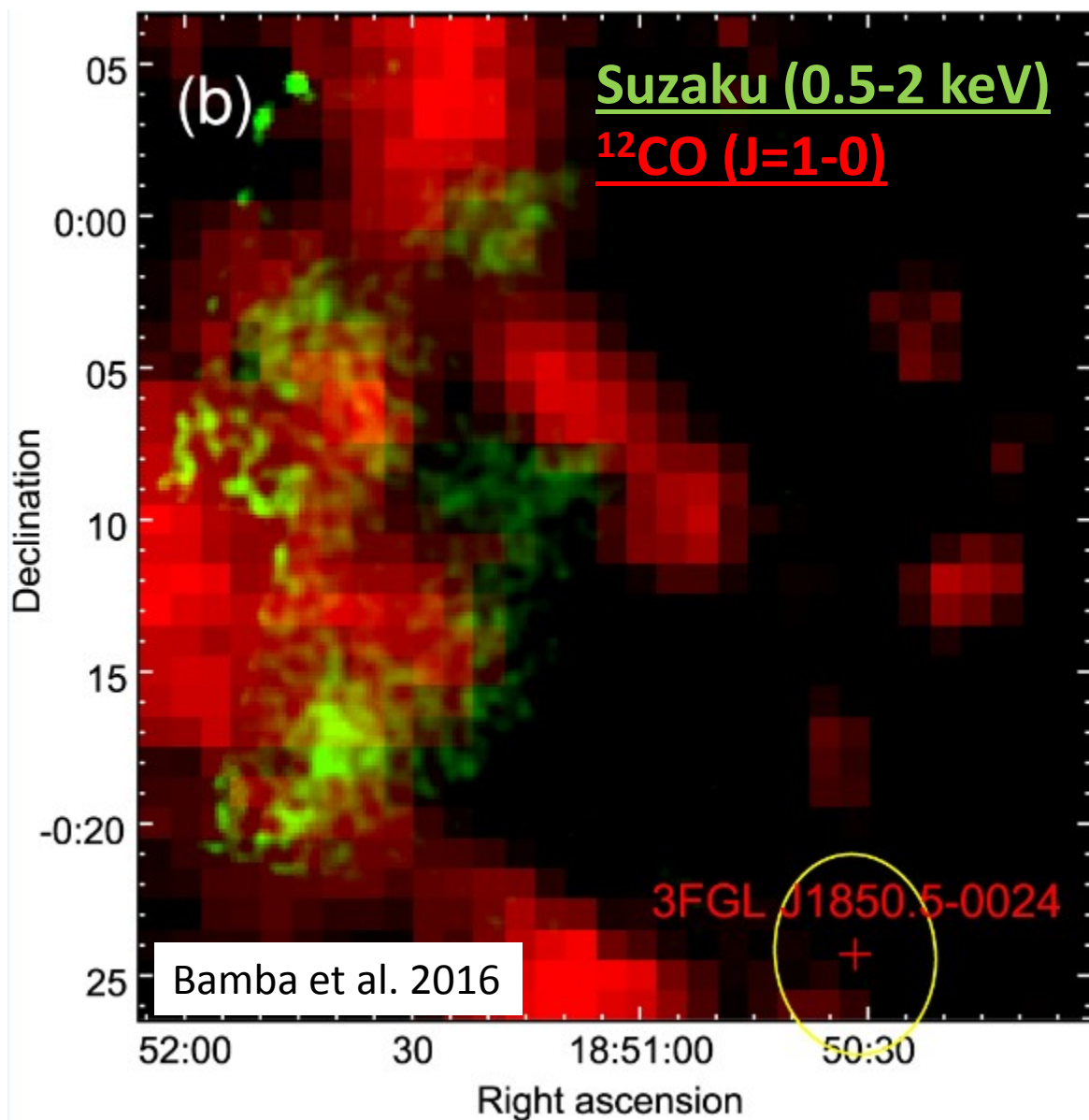
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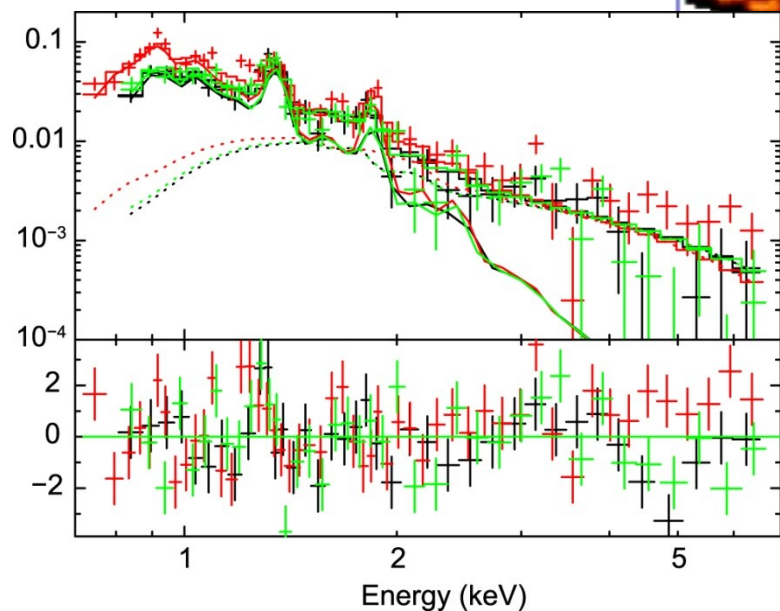
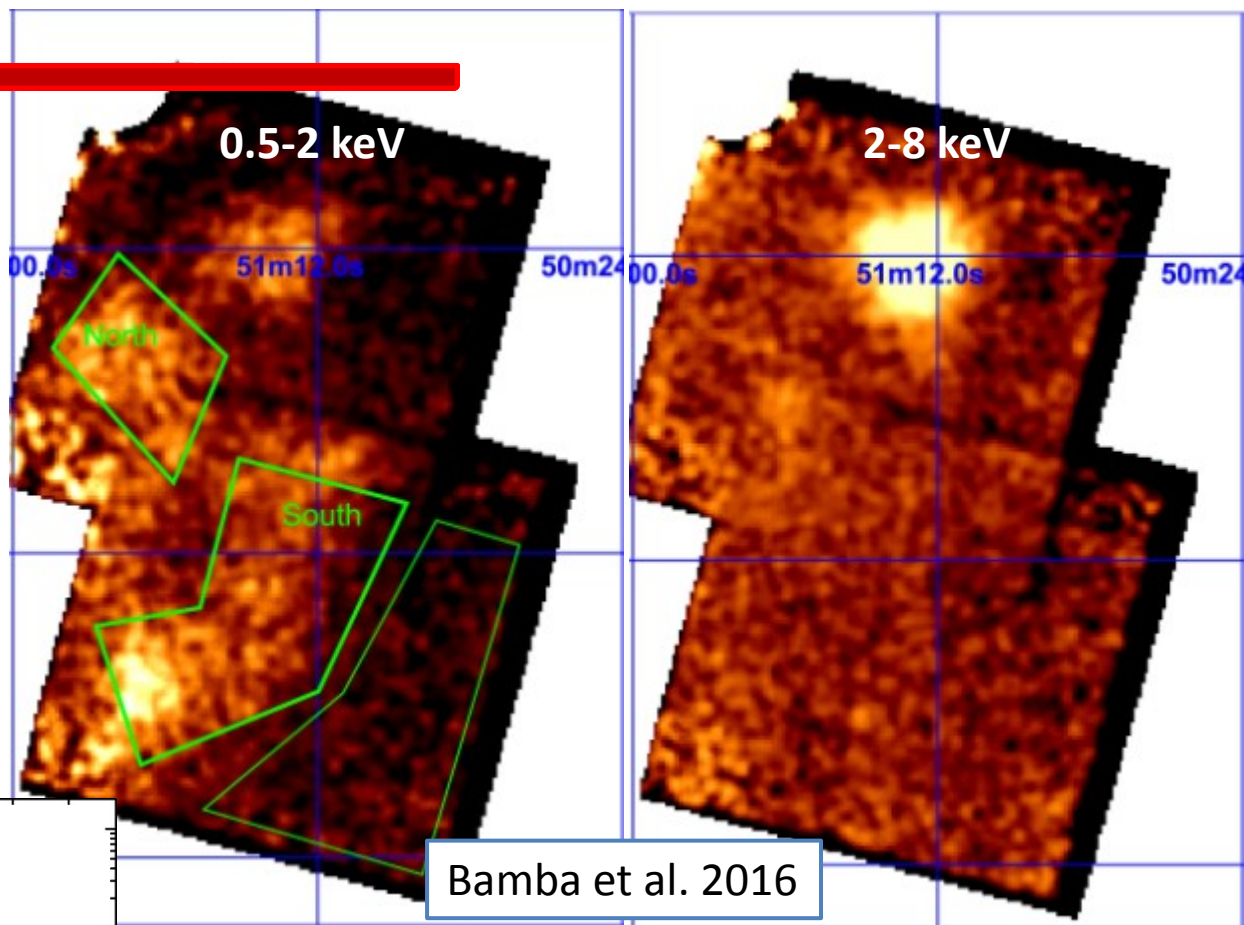
# The SNR Kes 78

- 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)



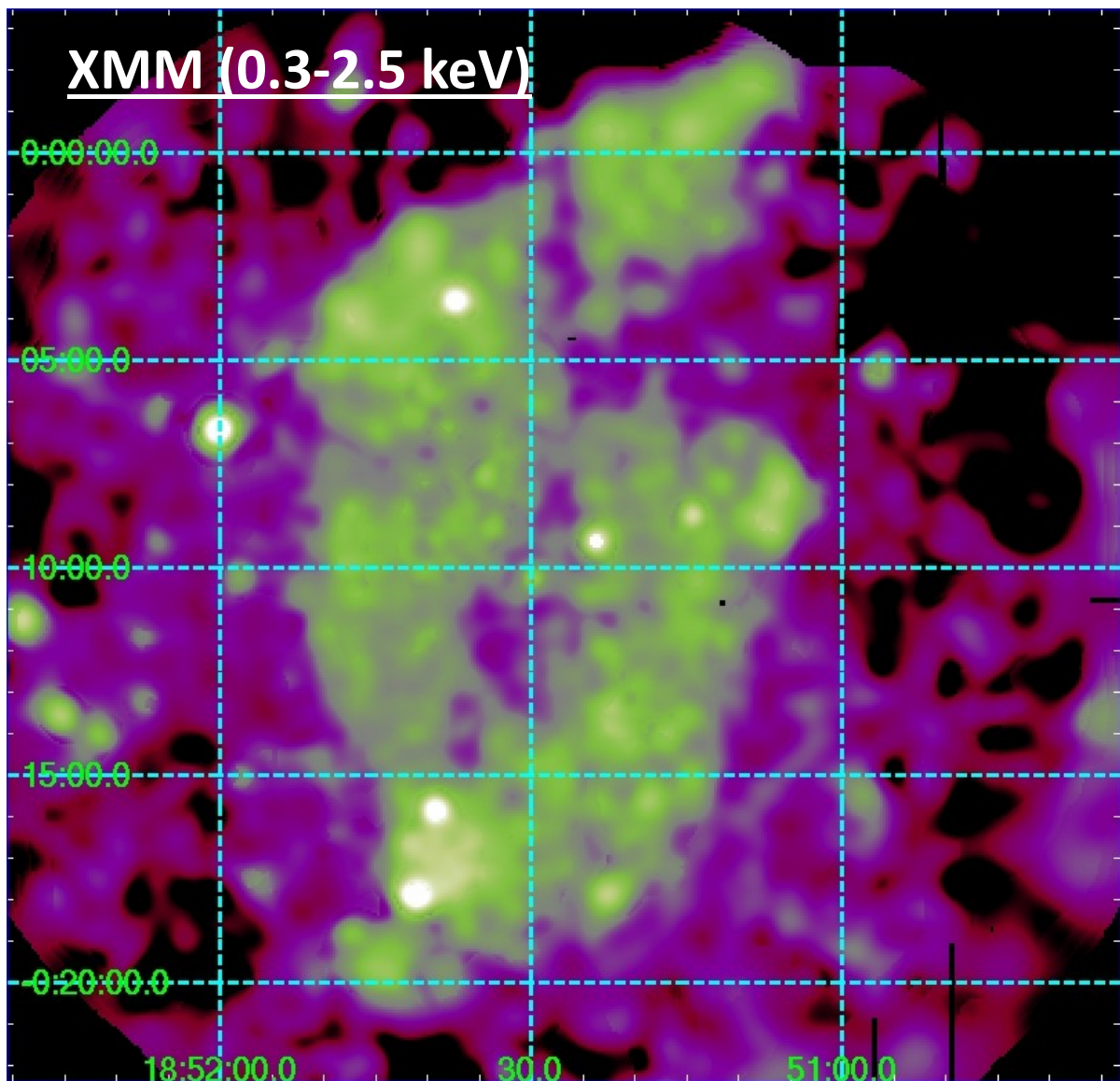
# The SNR Kes 78

- 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?)

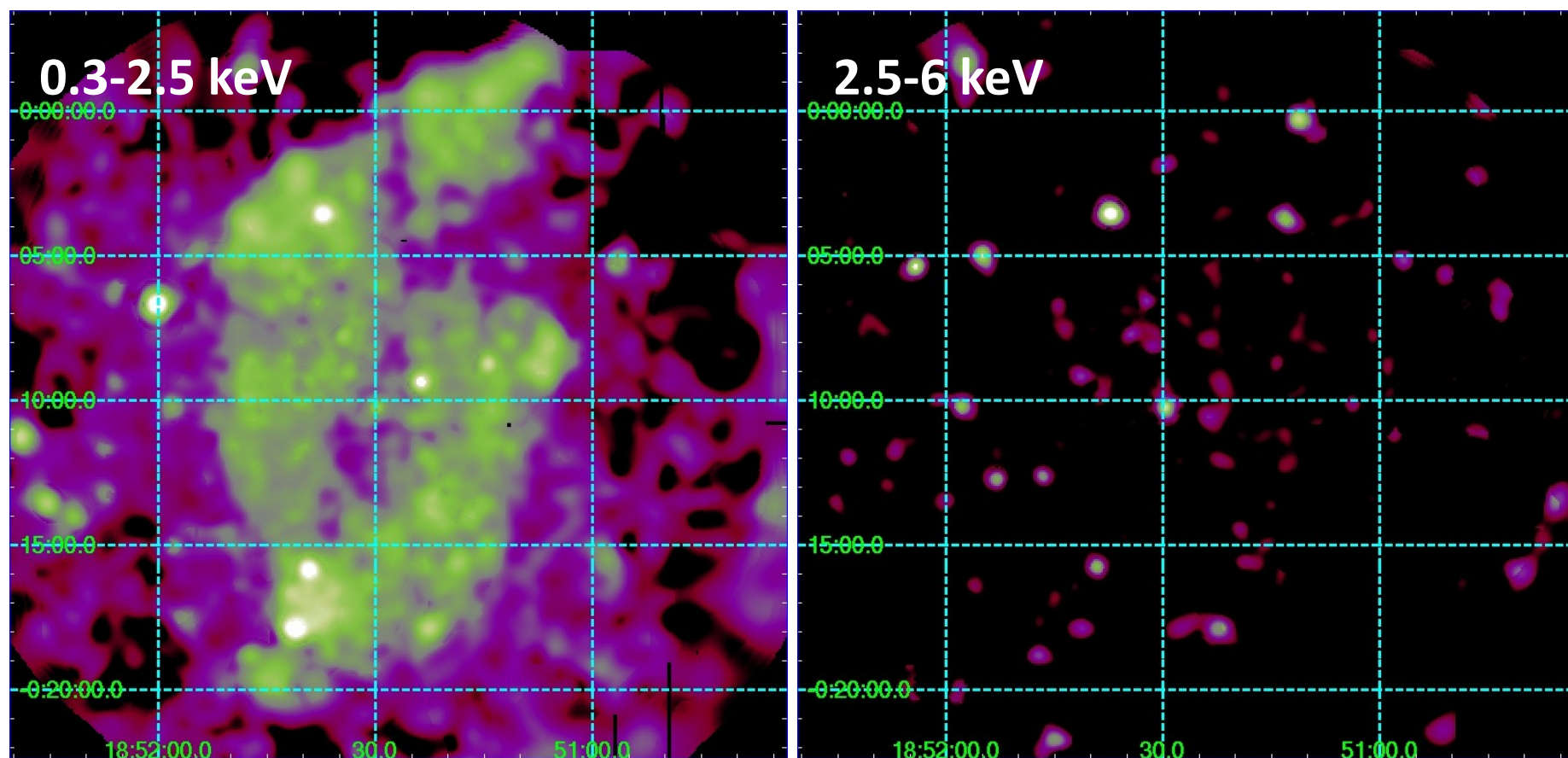
# The XMM-Newton data



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

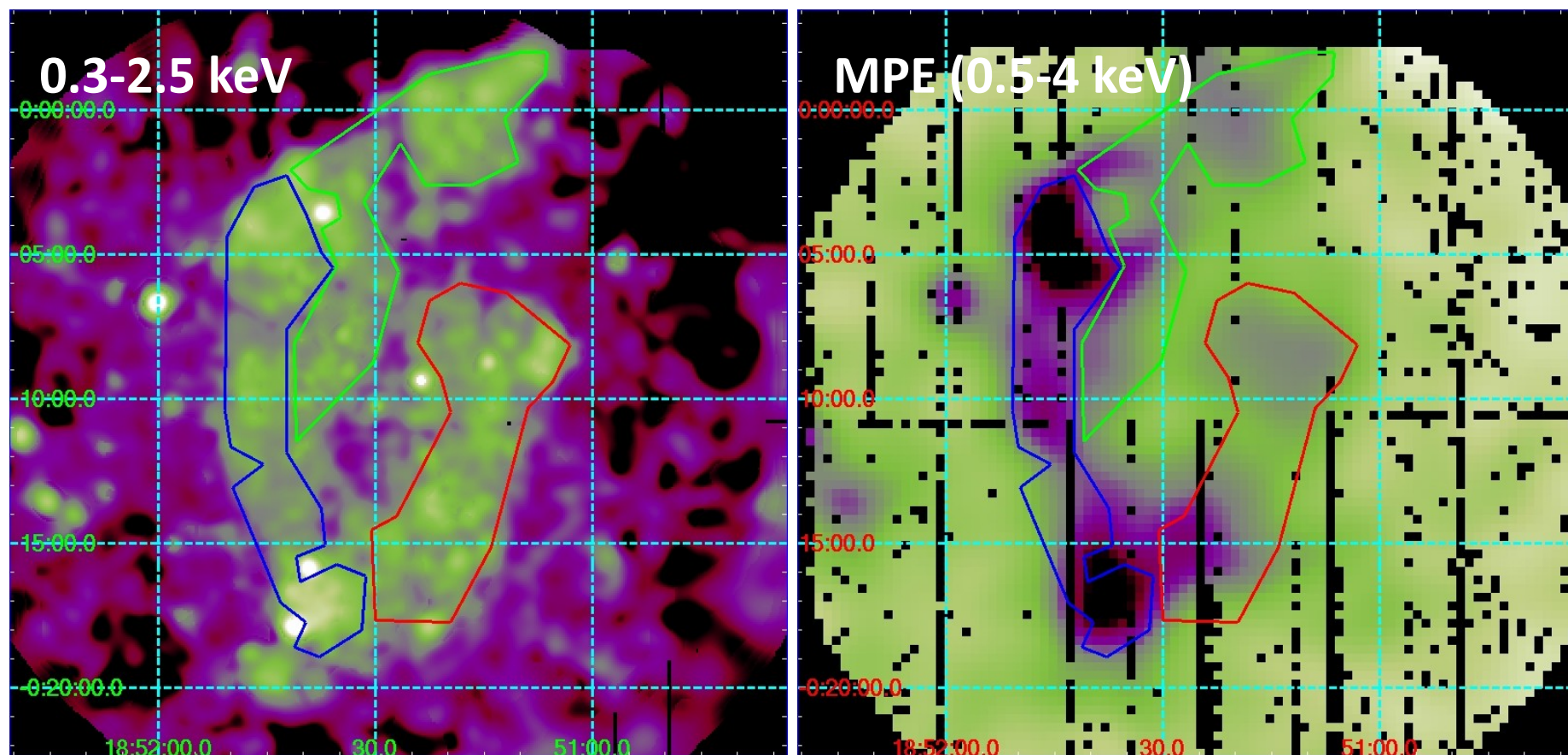
## Aims:

- Study the morphology of the soft/hard Xray 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**

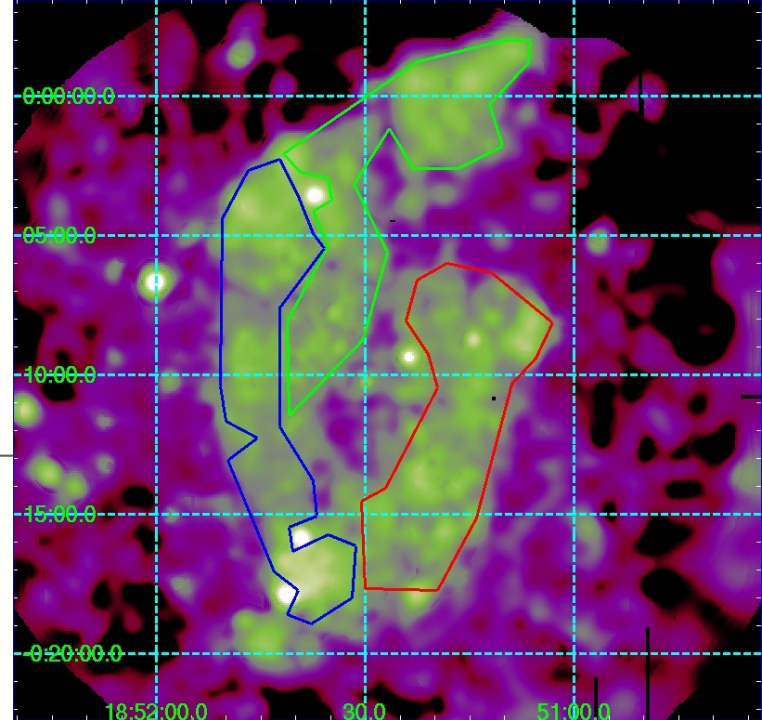
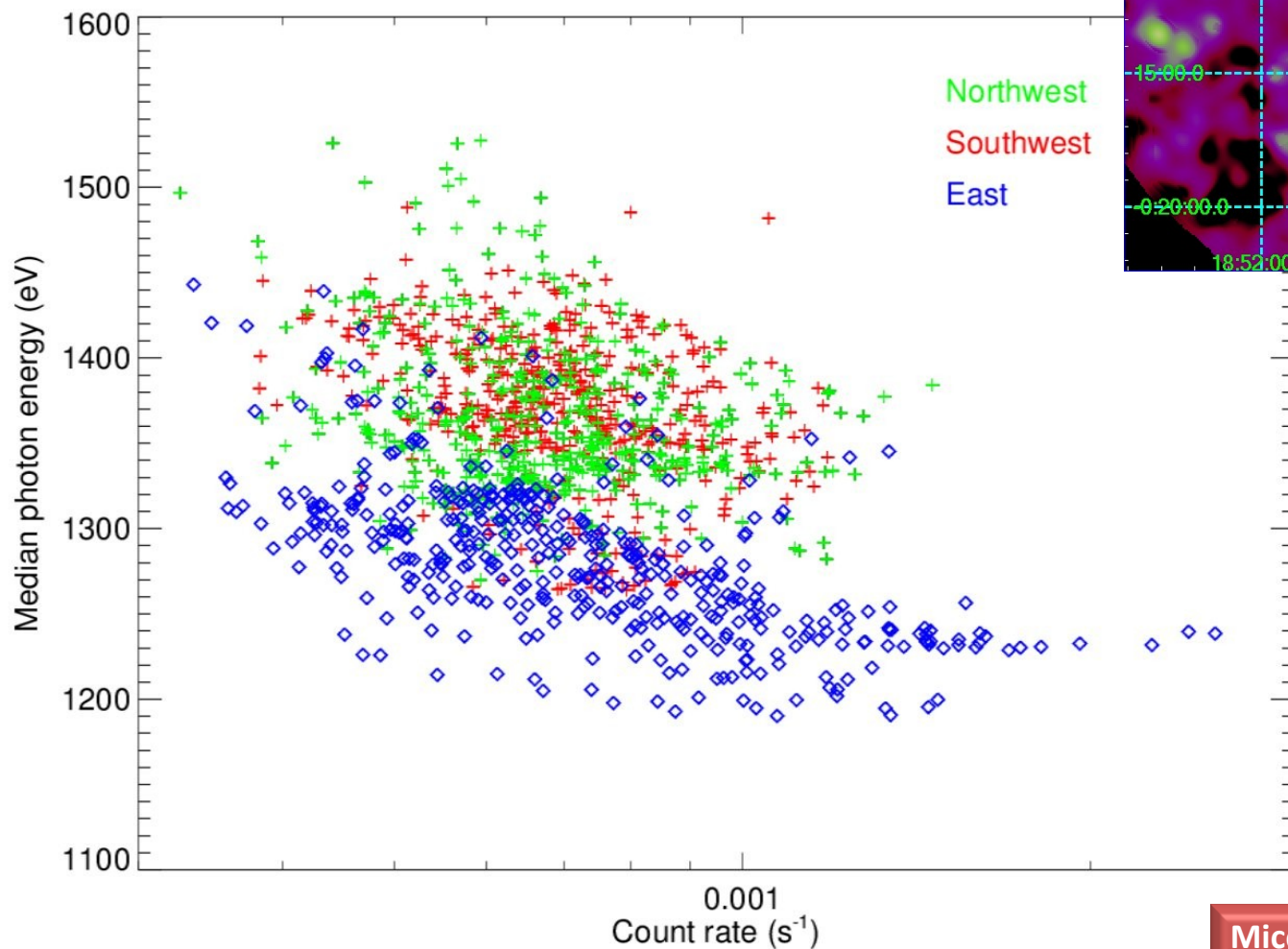
# Spatially resolved analysis



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)

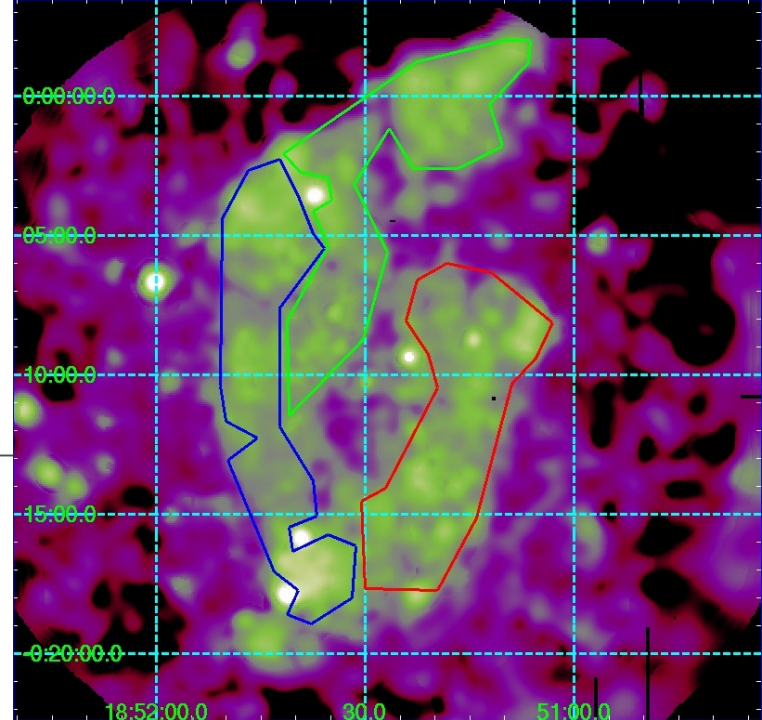
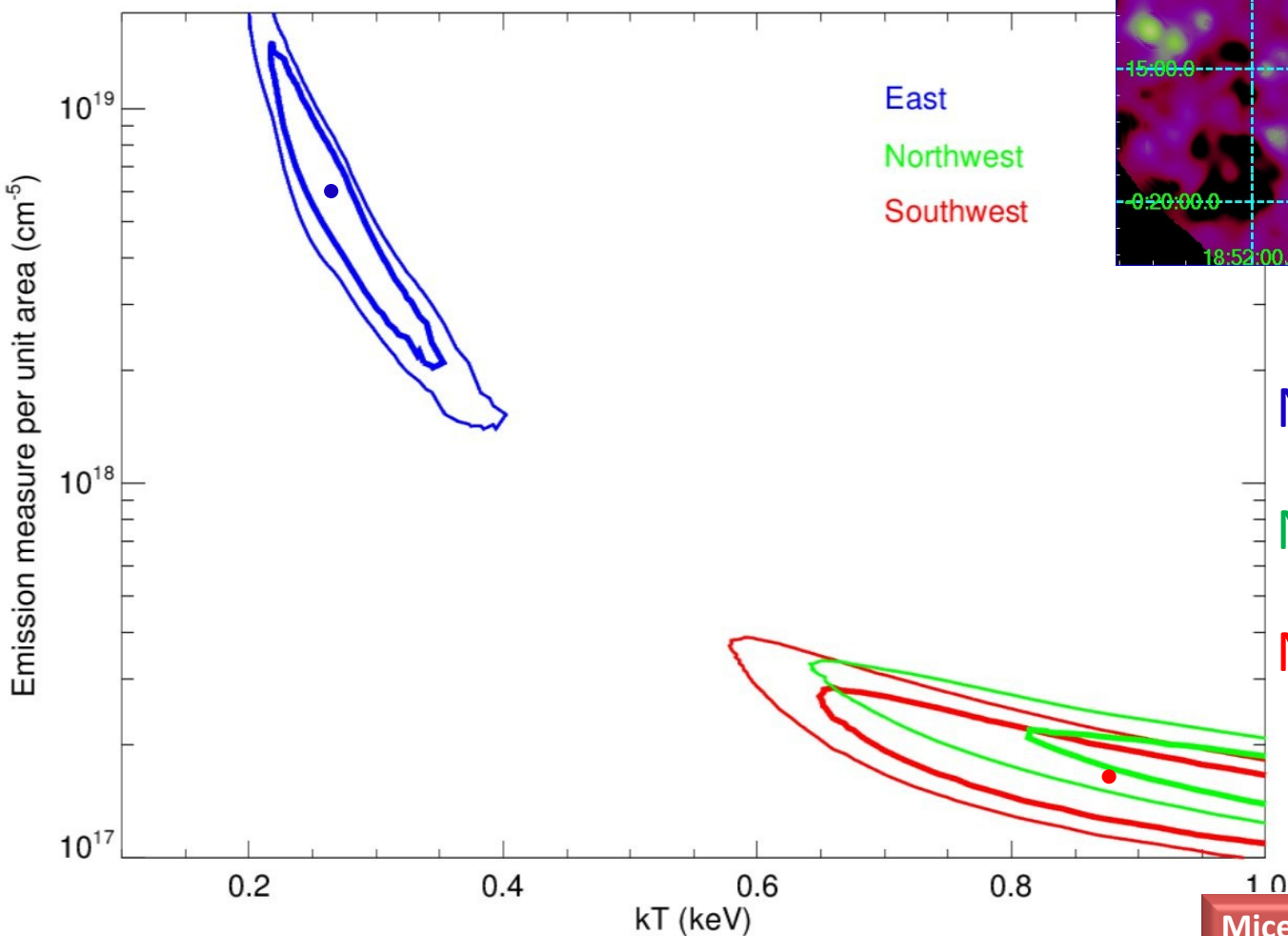
# Spatially resolved analysis

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**



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

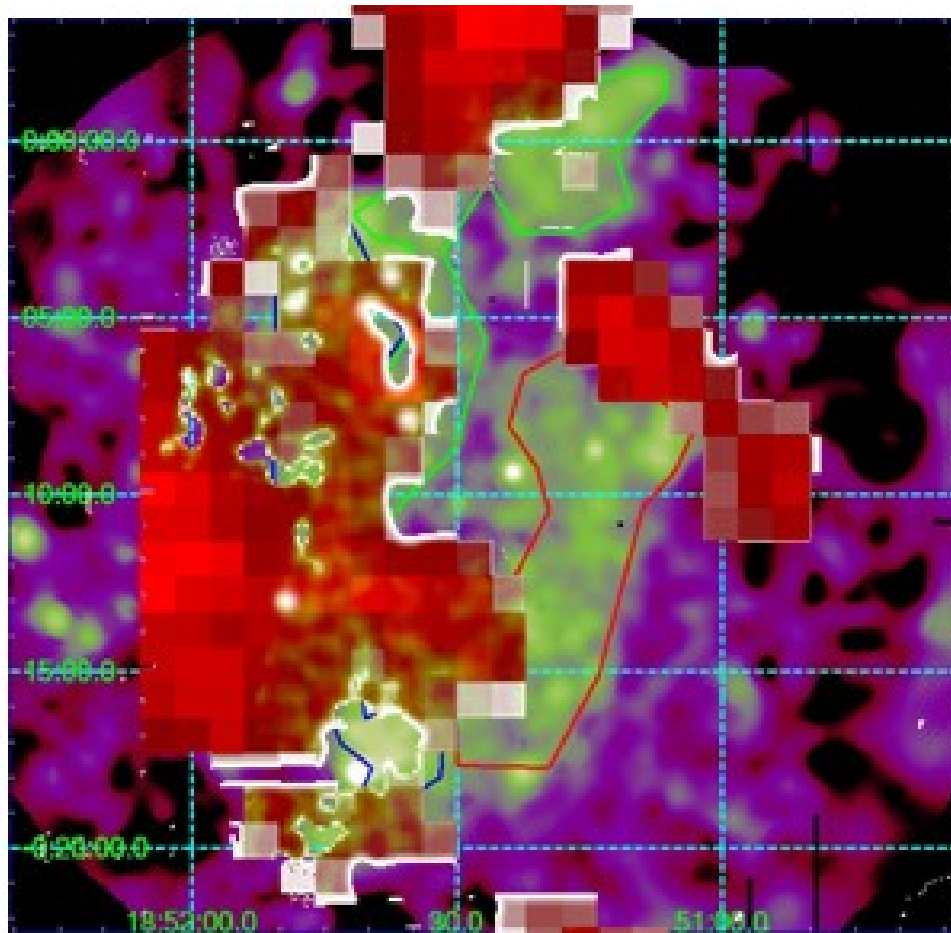
$$N_H = 0.8 \pm 0.1 \times 10^{22} \text{ cm}^{-2}$$

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



# Shock-cloud interaction

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



$^{12}\text{CO}$  (J=1-0)

# 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**

