Diffuse X-ray emission of the Galactic Centre

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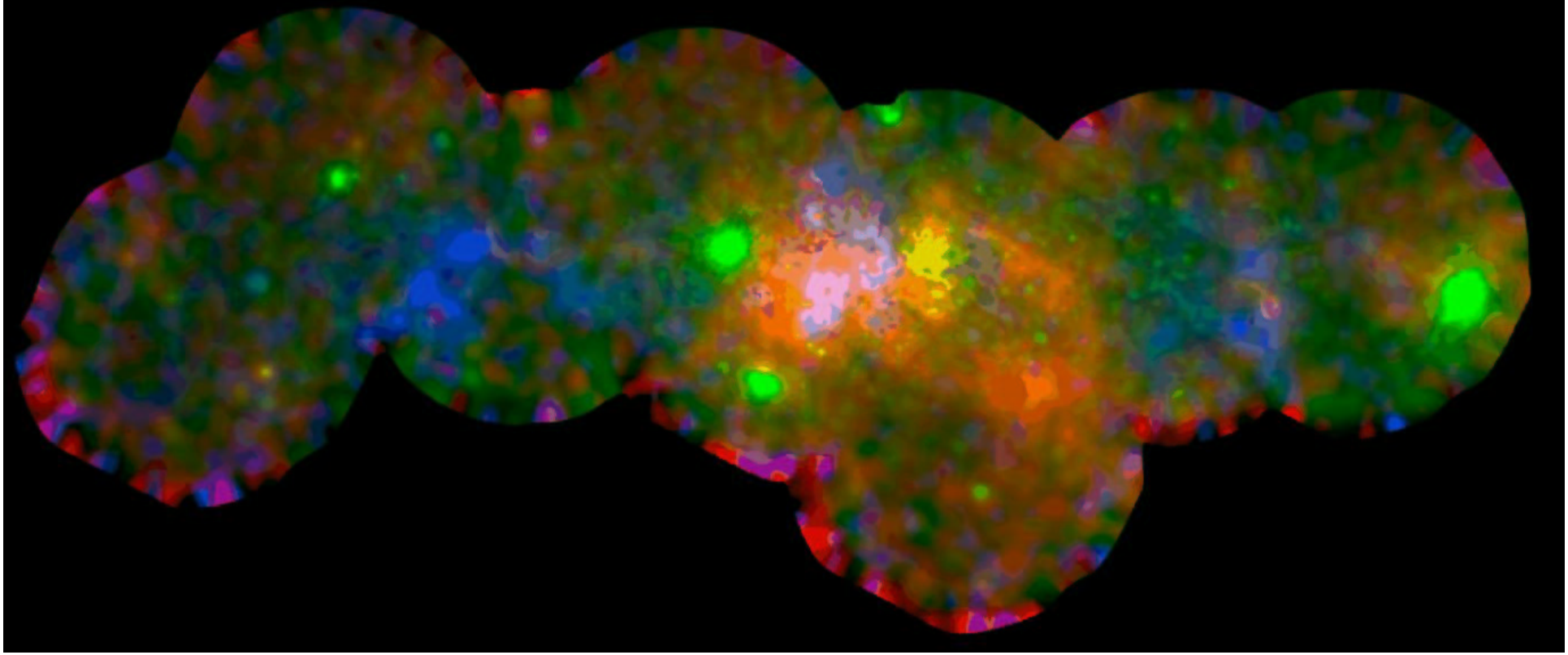


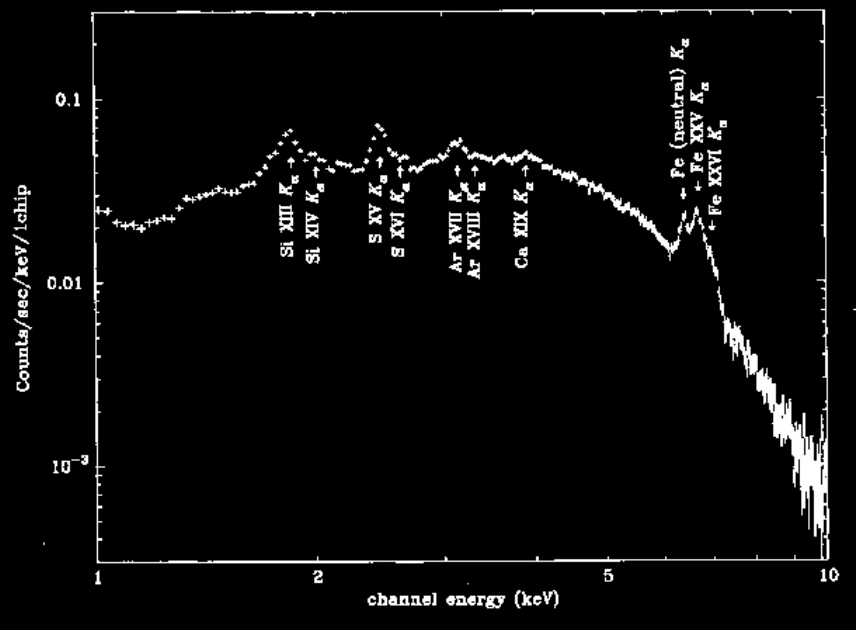
Before XMM-Newton and Chandra

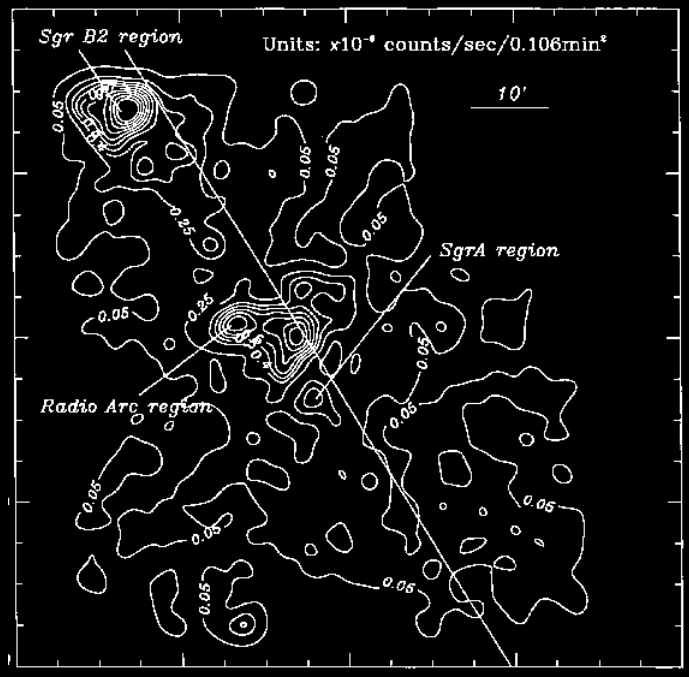
- Hard X-ray emission from the Galactic Ridge and particularly the Galactic Centre region (Worrall et al. 1982)

- ASCA: emission lines from highly ionised elements (Si, S, Ar, Ca, Fe)

-> ionization equilibrium multi-temperature hot diffuse gas with a component at 10 keV (Koyama et al. 1996)

-> Observed spectra identical in shape from place to place (except for the 6.4 keV iron K line)





Enigma of the hot diffuse X-ray emission

Confinement and production of a 10 keV plasma problematic !

- What is the heating source ? Young supernova remnants: kT ~ few keV
- Plasma not bound by the Galactic gravitational potential
- Constant replenishement required: What is the energy source ?

Entire kinetic energy of one supernova every 30 years required

Alternative explanations for the origin of the hard component ?

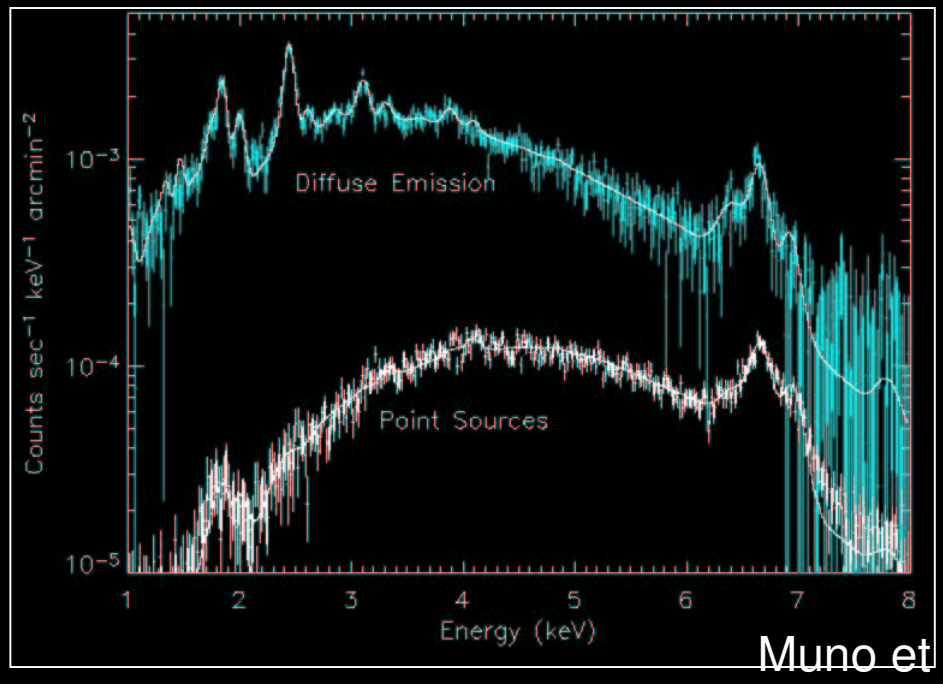
- discrete sources

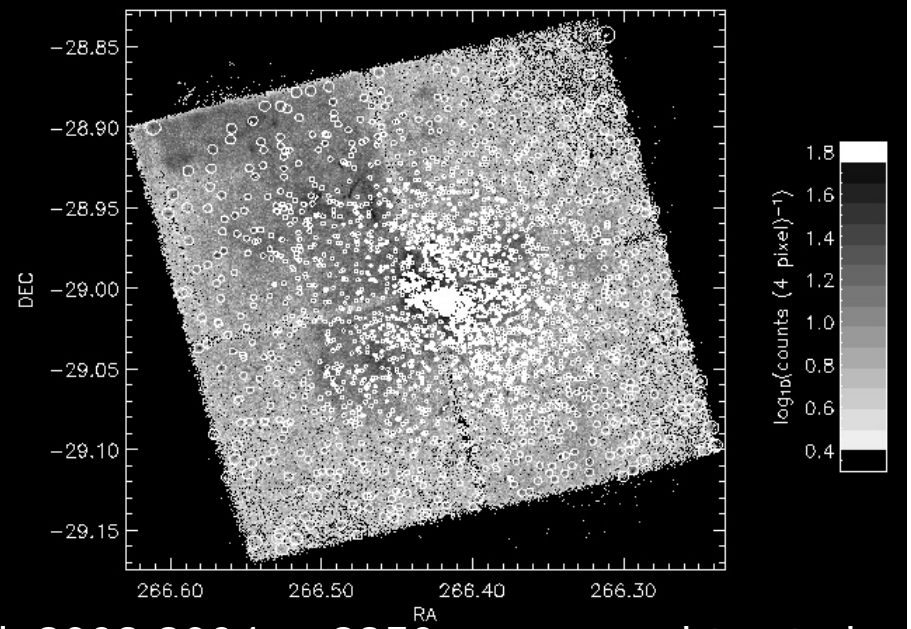
- diffuse non-thermal emission:

- bremsstrahlung from cosmic-rays interacting with neutral material (Valinia et al. 2000)
- charge-exchange interactions between CRs and ISM (Tanaka 2002)
- quasi-thermal emission from continuously accelerated particles (Dogiel et al. 2002, Masai et al. 2002) .

Discrete sources ? Results from Chandra

- Not enough discrete sources with $L_x > 10^{31}$ erg/s to account for more than 10 % of the diffuse emission (Ebisawa et al. 2001).
- Less than 10 % of the flux from point sources detected (Muno et al. 2003)
- Source spectrum at high energy similar to diffuse emission (Muno et al. 2004)
- Variation of the flux and line ratios incompatible with discrete sources





Muno et al. 2003,2004: ~ 2350 sources subtracted

XMM-Newton GT observations

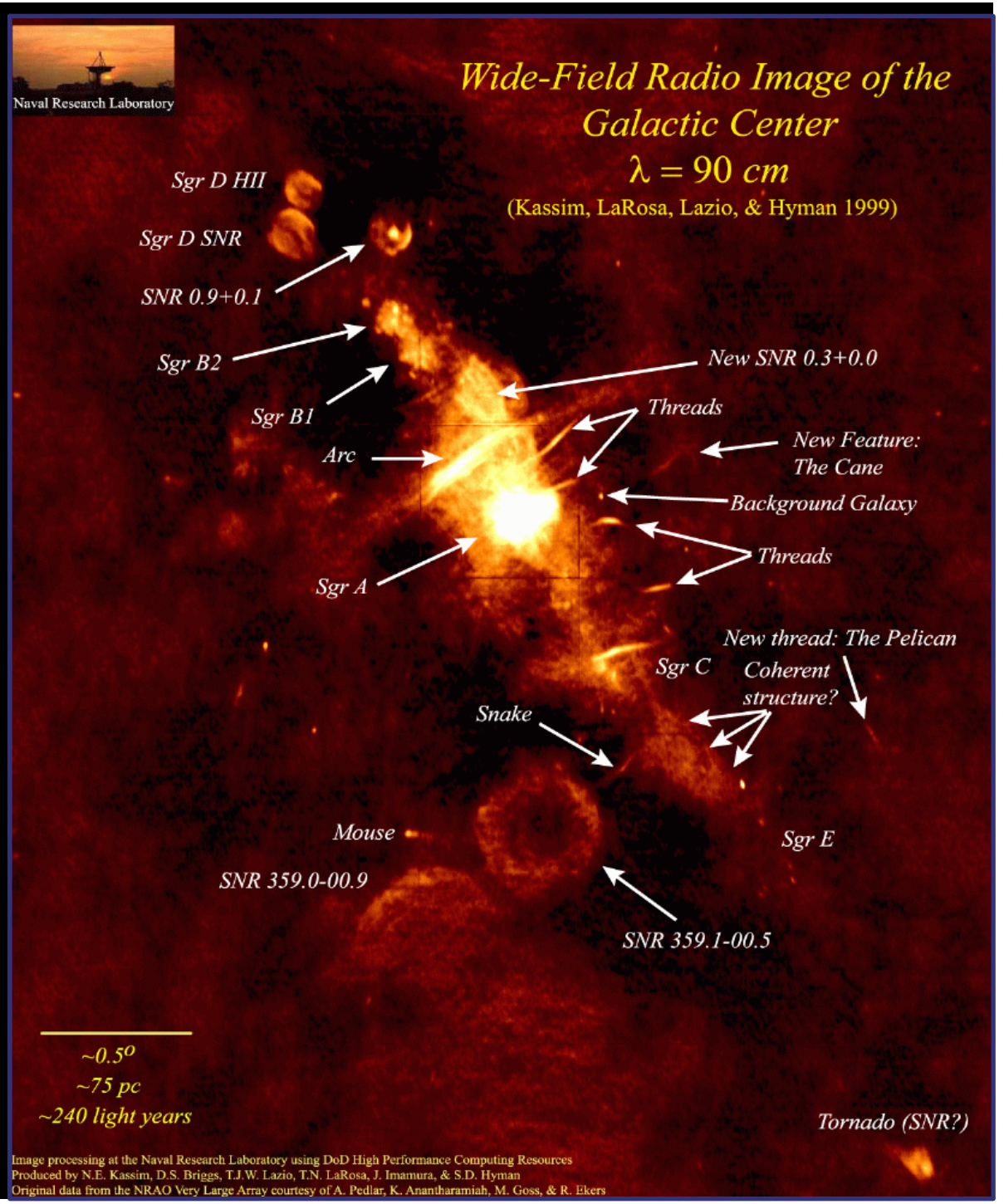
Saclay, Leicester, MPE
Total exp. time: 250 ks

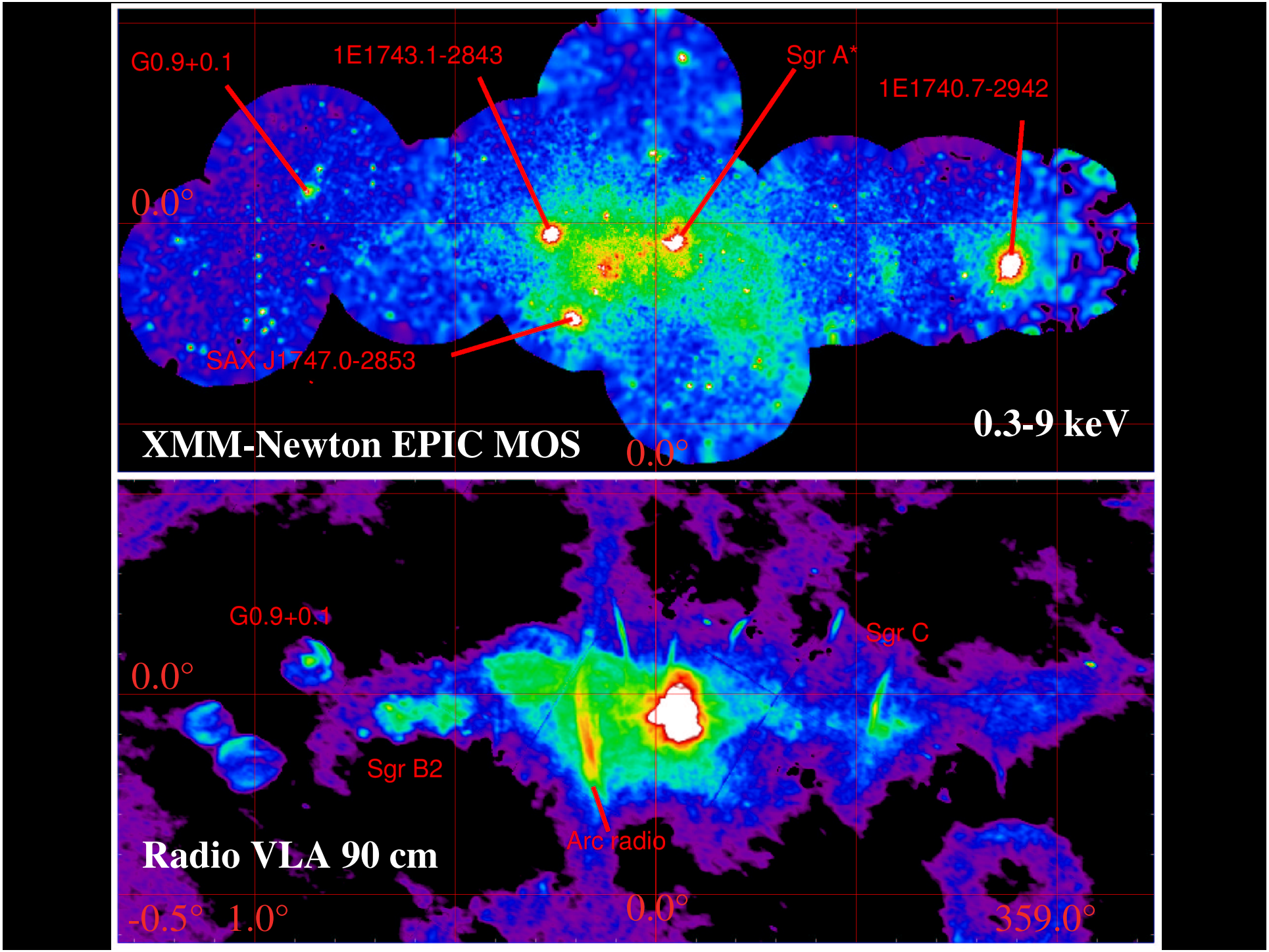
Goals:

- Diffuse emission of the center of the Galaxy
- Sgr A*

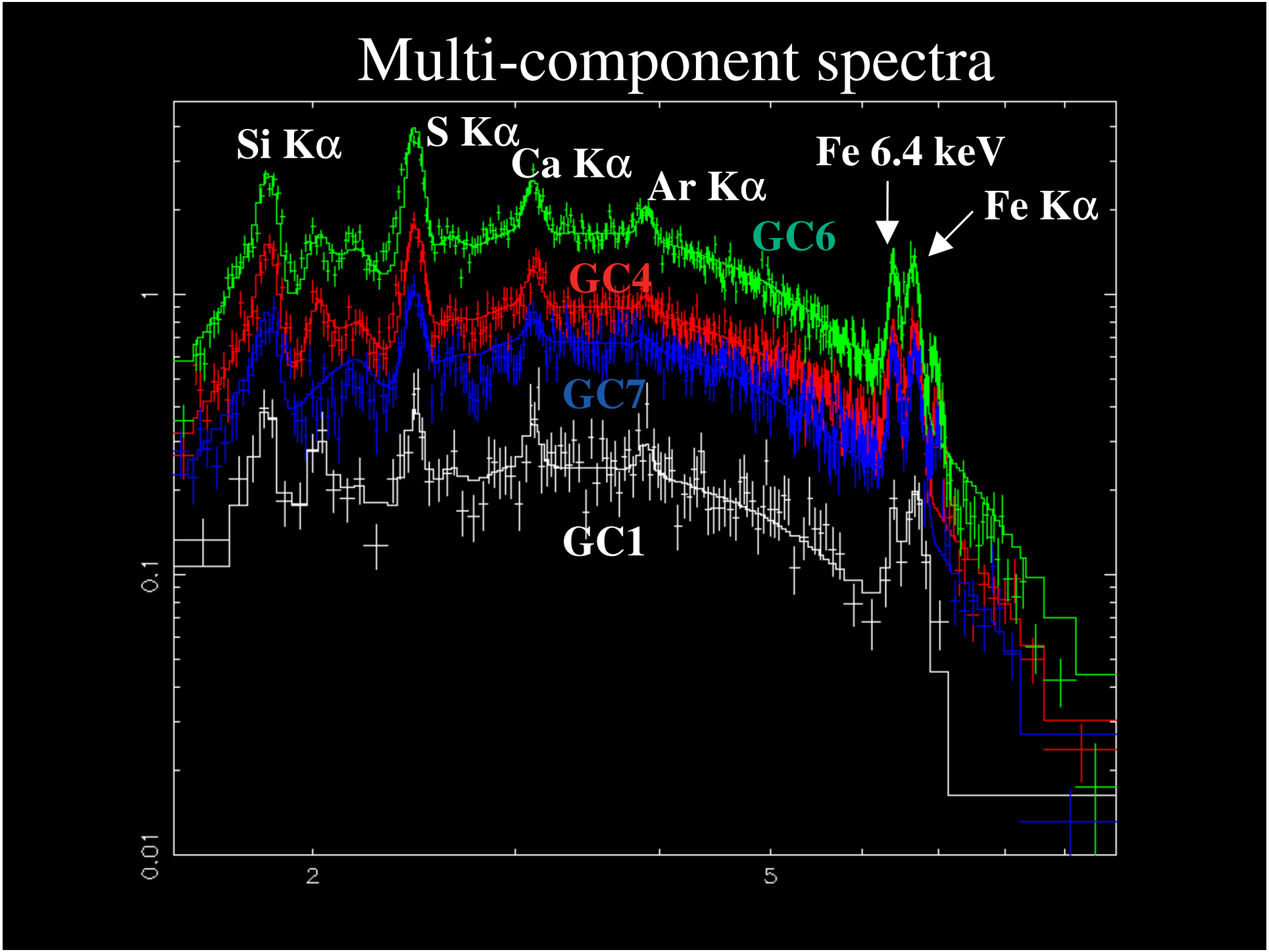
Collaborators :

- R. Warwick, M. Sakano (Leicester, UK)
- A. Goldwurm, P. Goldoni, J.L. Sauvageot (Saclay, F)
- D. Porquet , P. Predehl (MPE, Germany)

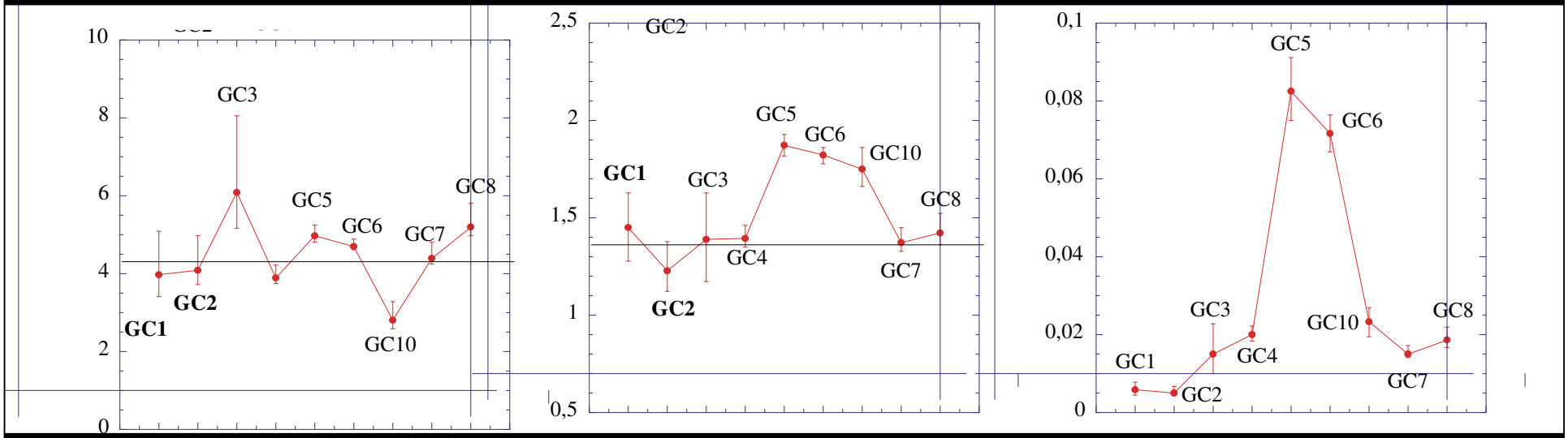



G0.9+0.1
1E1743.1-2843
Sgr A*
1E1740.7-2942
0.0°
SAX J1747.0-2853
XMM-Newton EPIC MOS
0.0°
0.3-9 keV
G0.9+0.1
0.0°
Sgr C
Sgr B2
Arc radio
Radio VLA 90 cm
-0.5°
1.0°
0.0°
359.0°

Multi-component spectra



Global properties of the X-ray emission

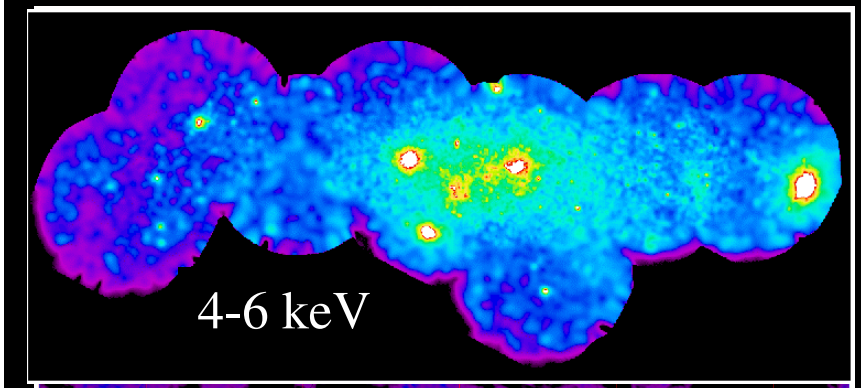


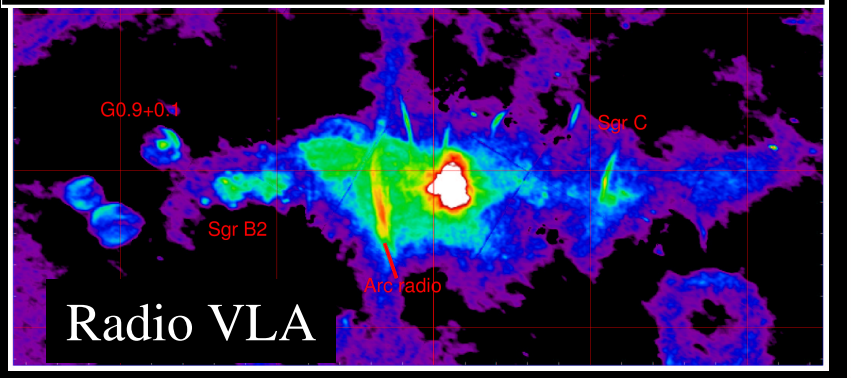
Interstellar absorption (10^{22} at/cm^2)

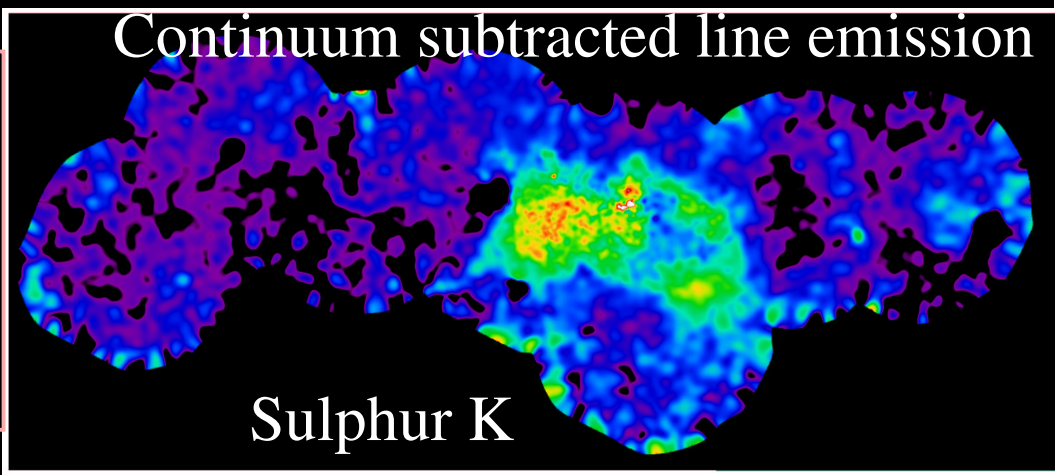
Spectral index

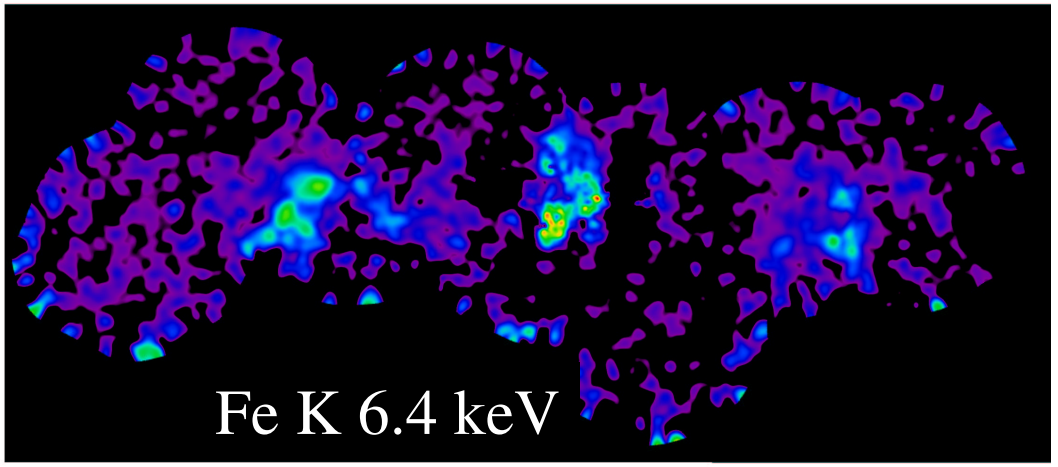
Emission measure

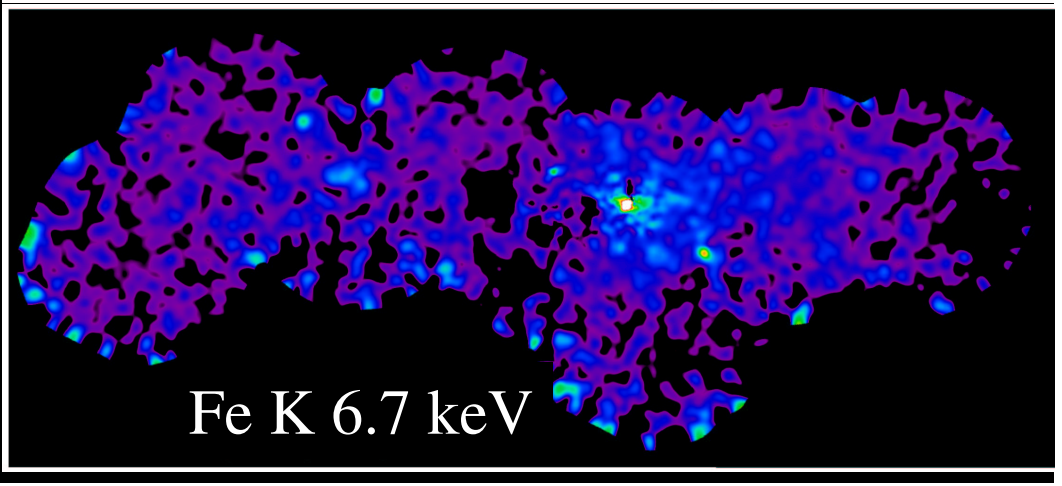
Morphology of the different components: XMM-Newton







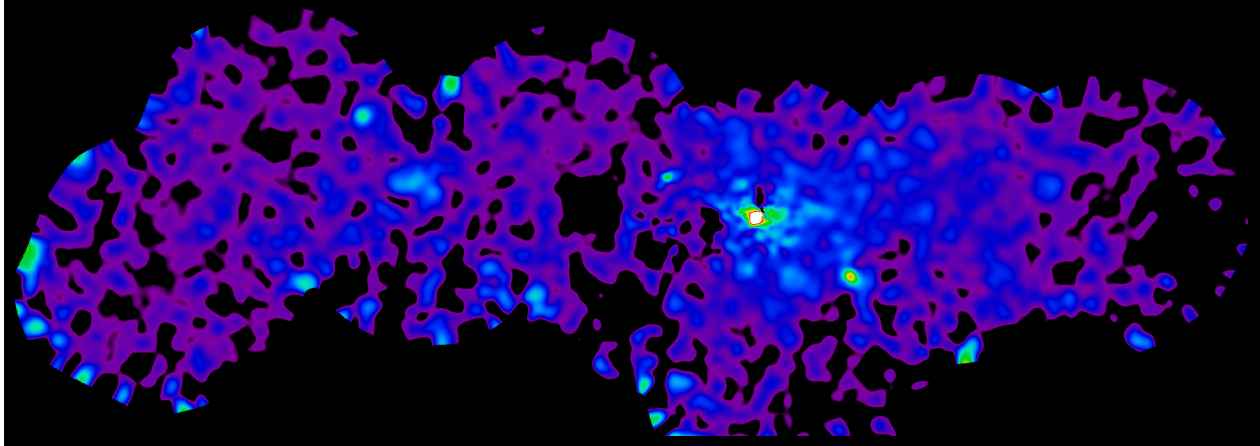




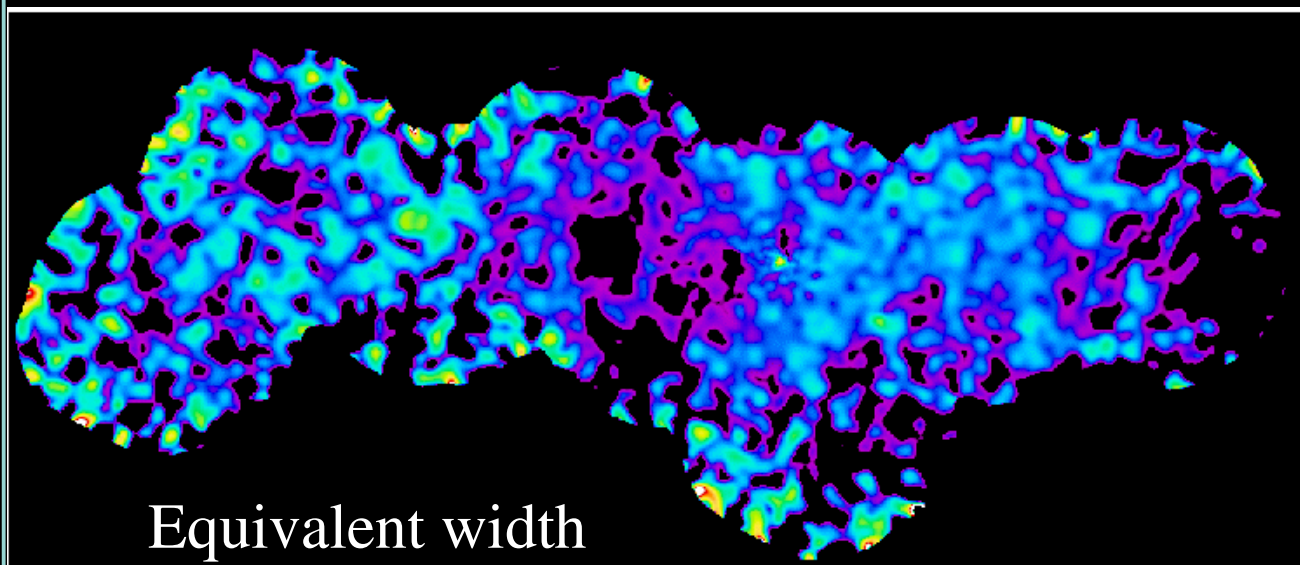
Density effects for the 6.7 keV component

Spatially uniform distribution of the hard component of the diffuse emission
-> not associated with Sgr A*
-> not correlated with emission at Si K and 6.4 Fe K

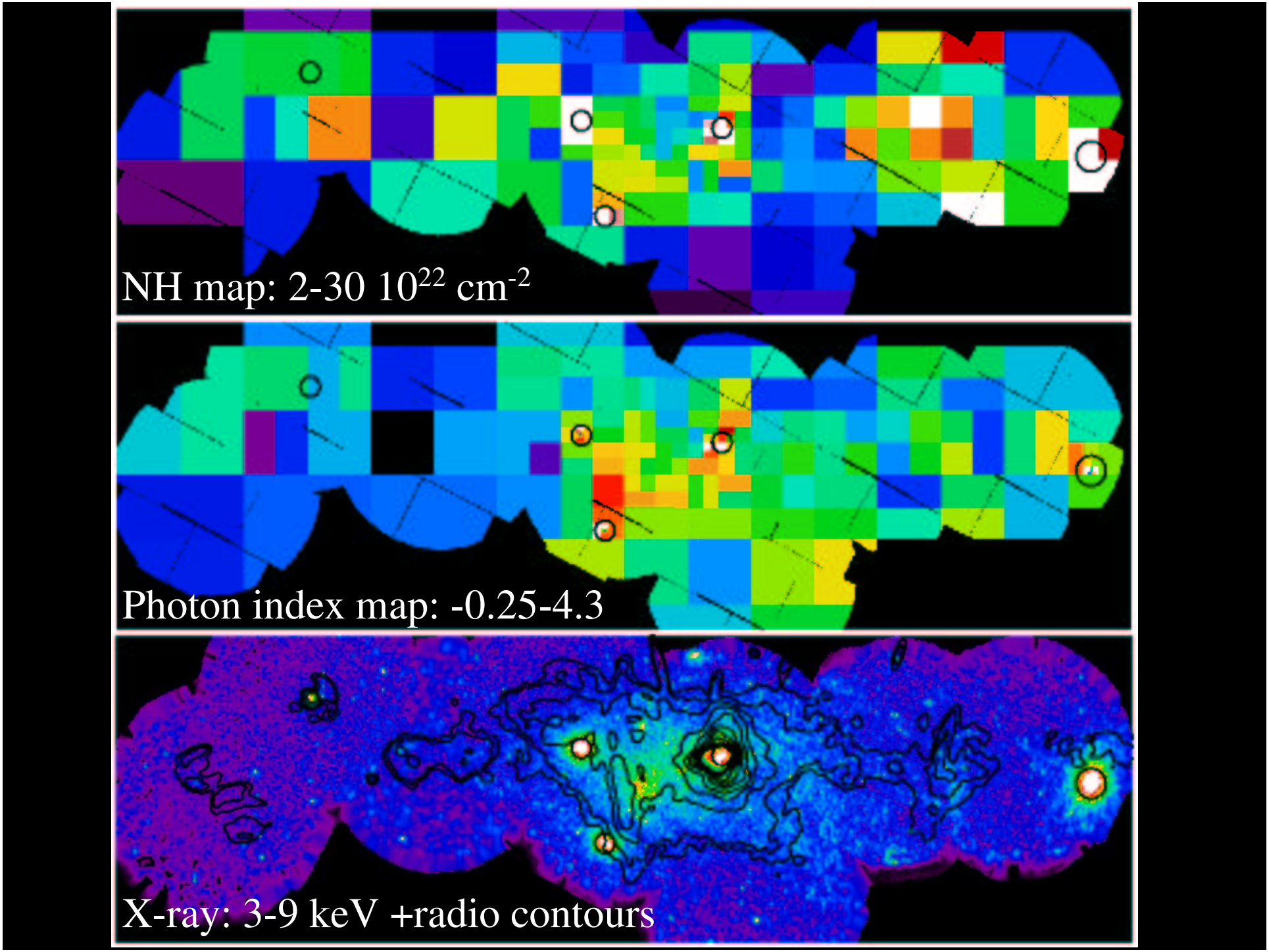
=> widespread Mechanism required
=> Not Sgr A*



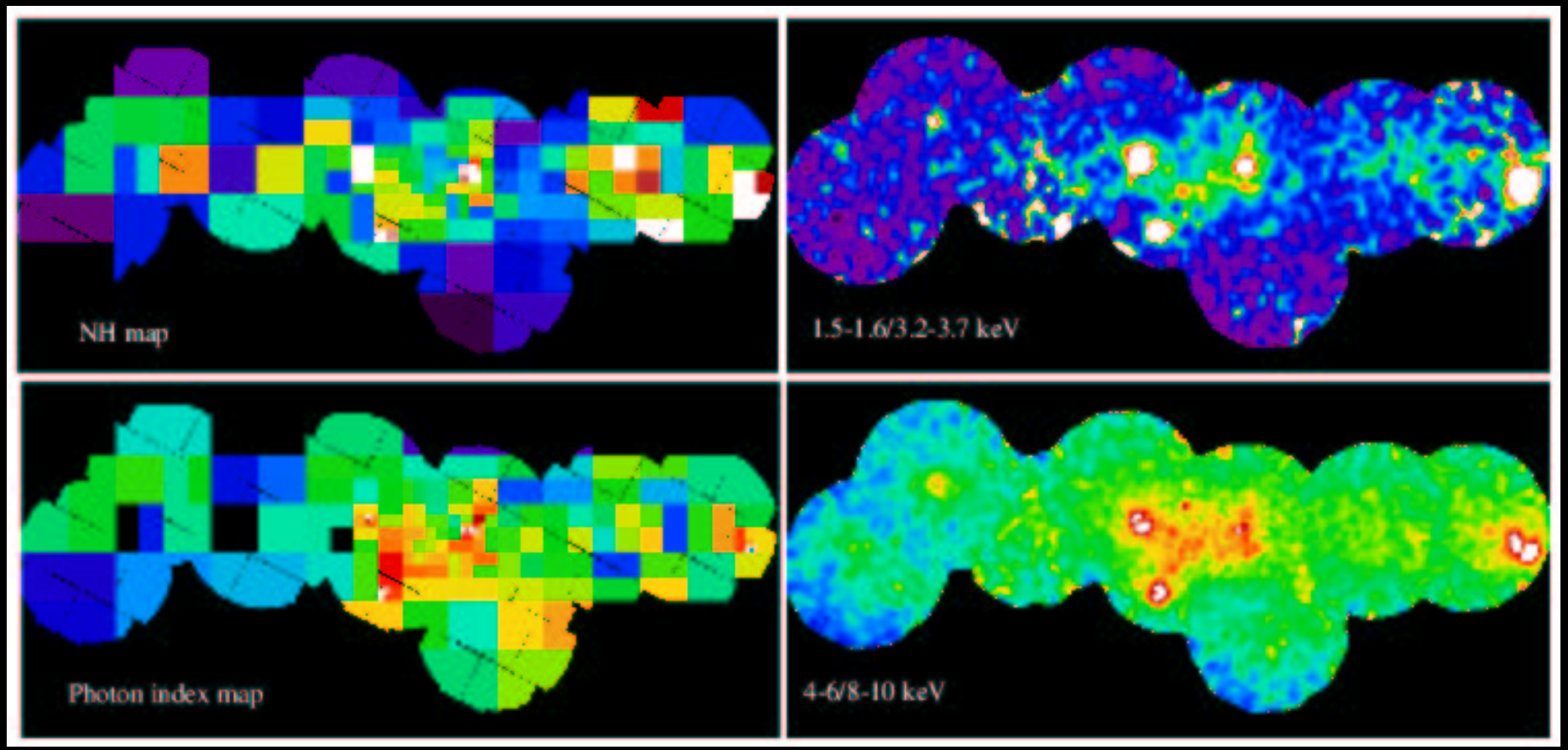
Continuum subtracted line emission



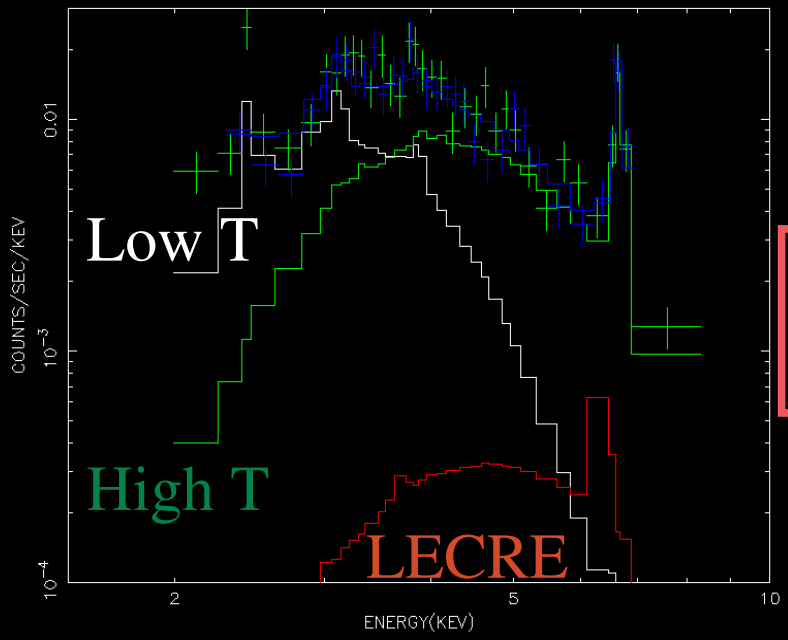
Equivalent width


NH map: 2-30 10^{22} cm^{-2}
Photon index map: -0.25-4.3
X-ray: 3-9 keV +radio contours

Interstellar absorption and hardness of the continuum



Sgr A* region: strong 6.7 keV line

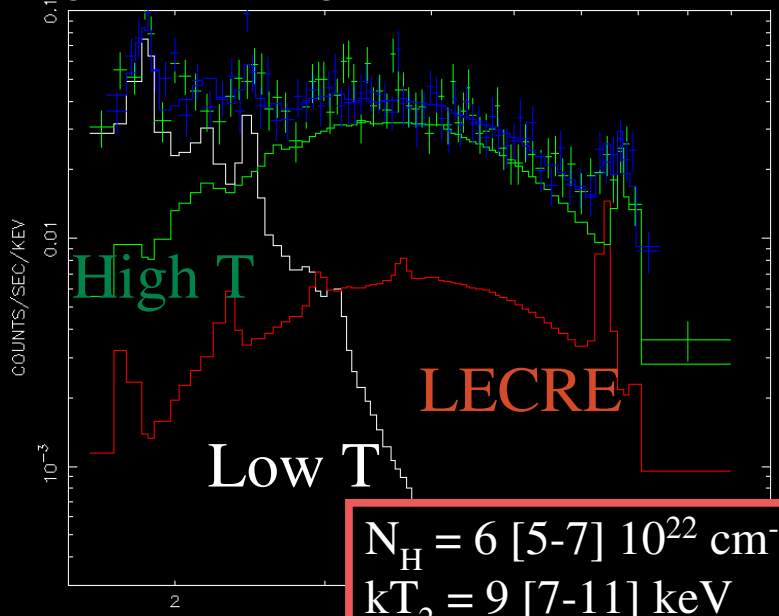


SPECTRAL MODELING

3 components:
2 mekal equilibrium models
+ LECRe (Valinia et al., 2000)

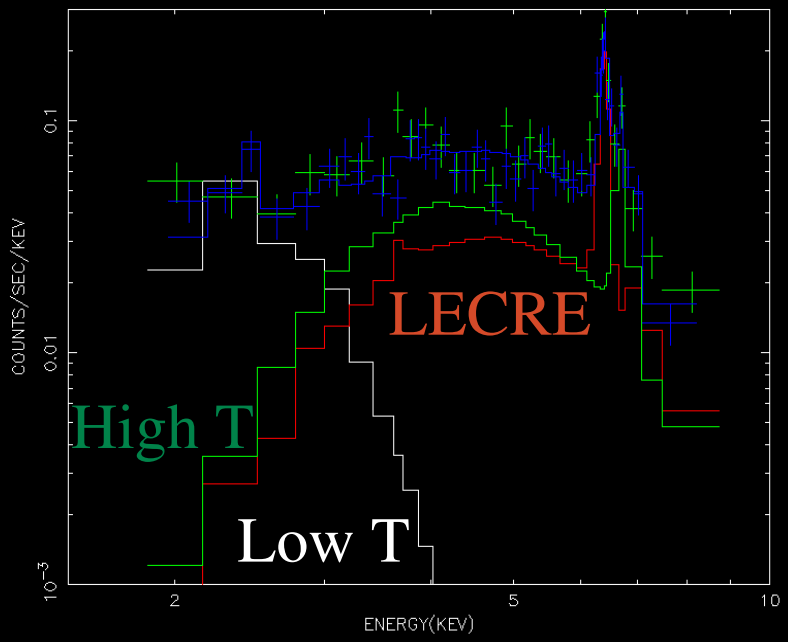
N_H = 17 [13-20] 10^{22} cm^{-2}
kT_2 = 3.5 [2-5] keV
Low energy CR e^- (LECRE) negligeable

High latitude region: hard continuum



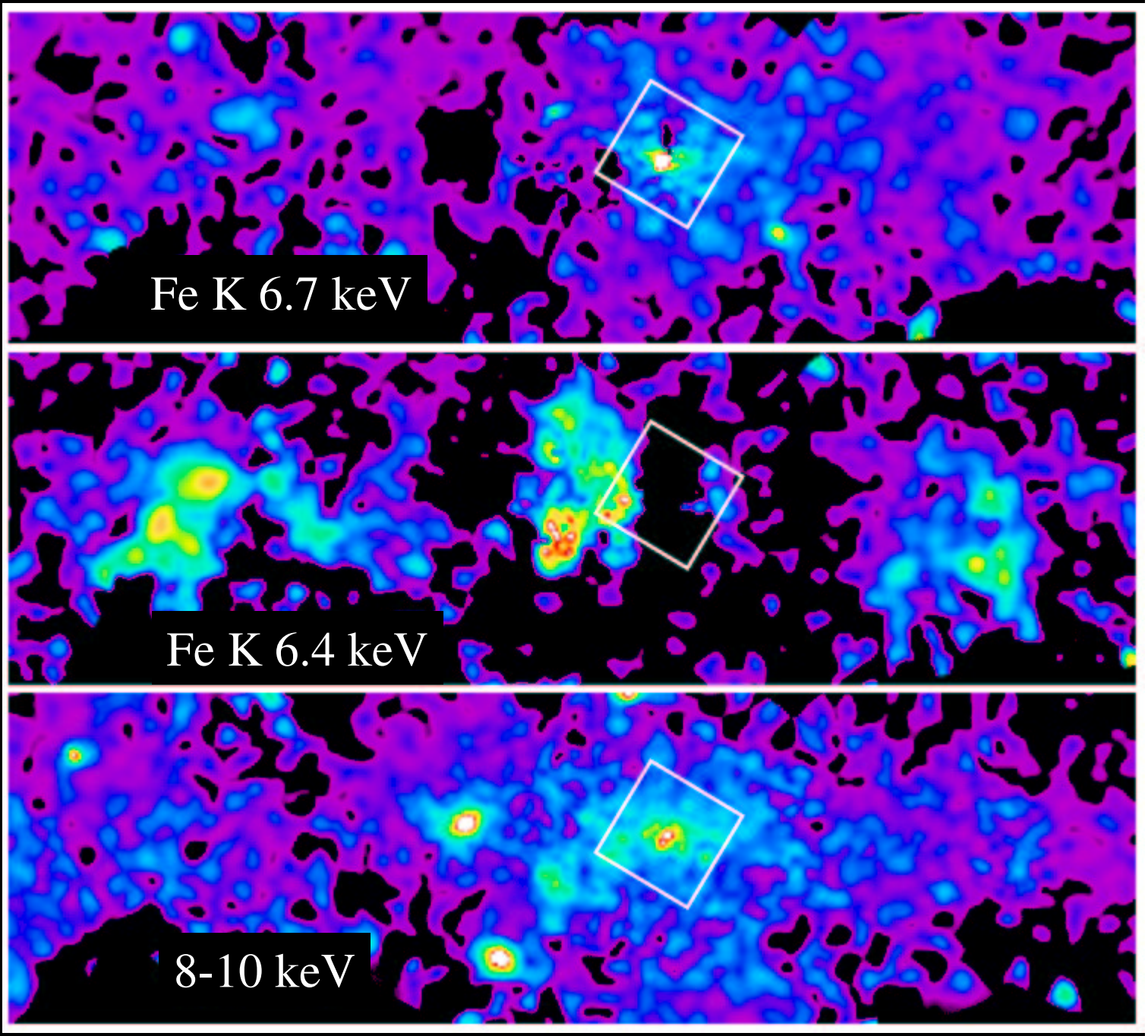
N_H = 6 [5-7] 10^{22} cm^{-2}
kT_2 = 9 [7-11] keV

Sgr B2 region: strong 6.4 keV line



N_H = 16 [14-18] 10^{22} cm^{-2}
kT_2 = 6 [5-7] keV
Important contribution from LECRe

At the heart of the enigma with SIMBOL-X



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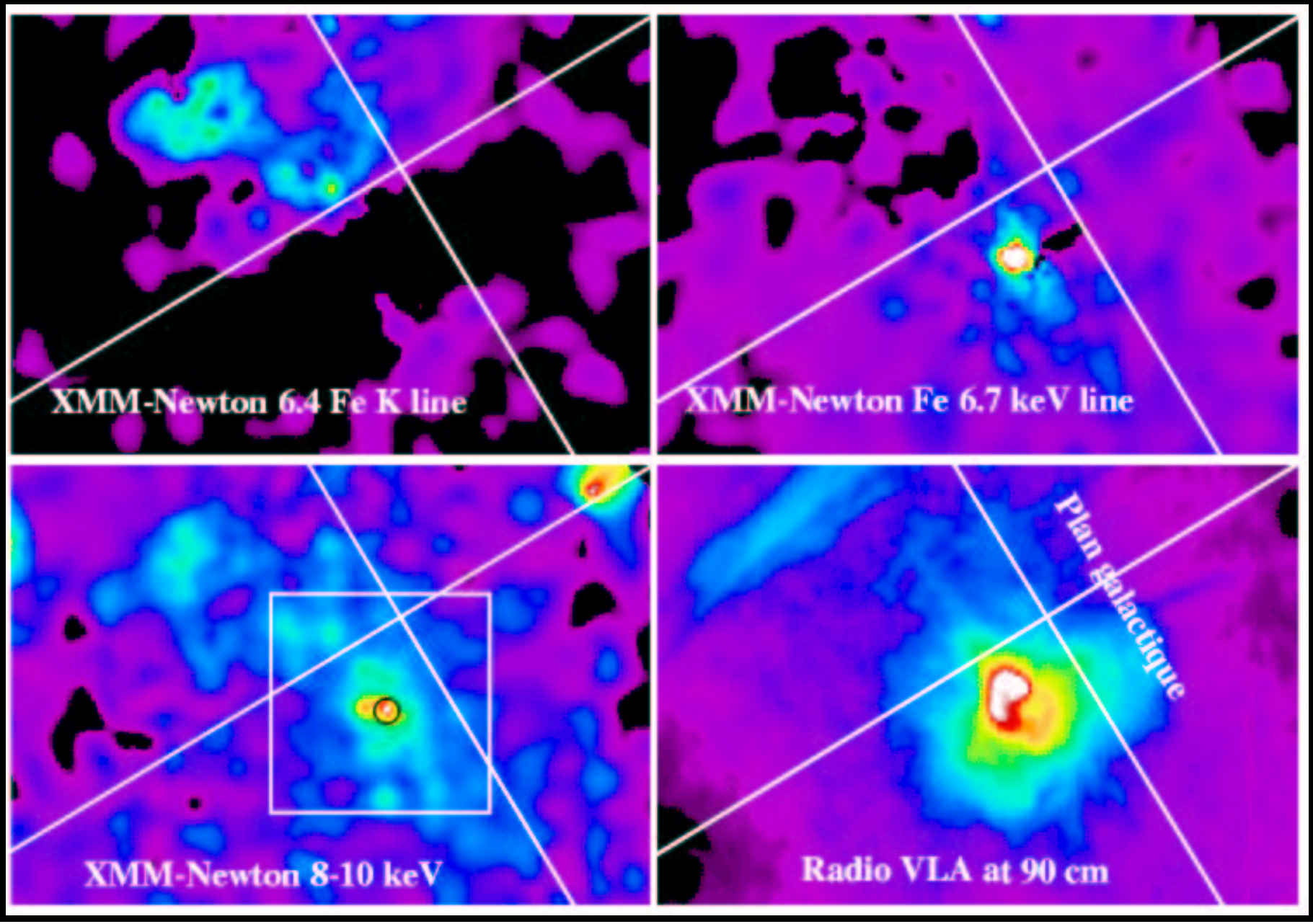

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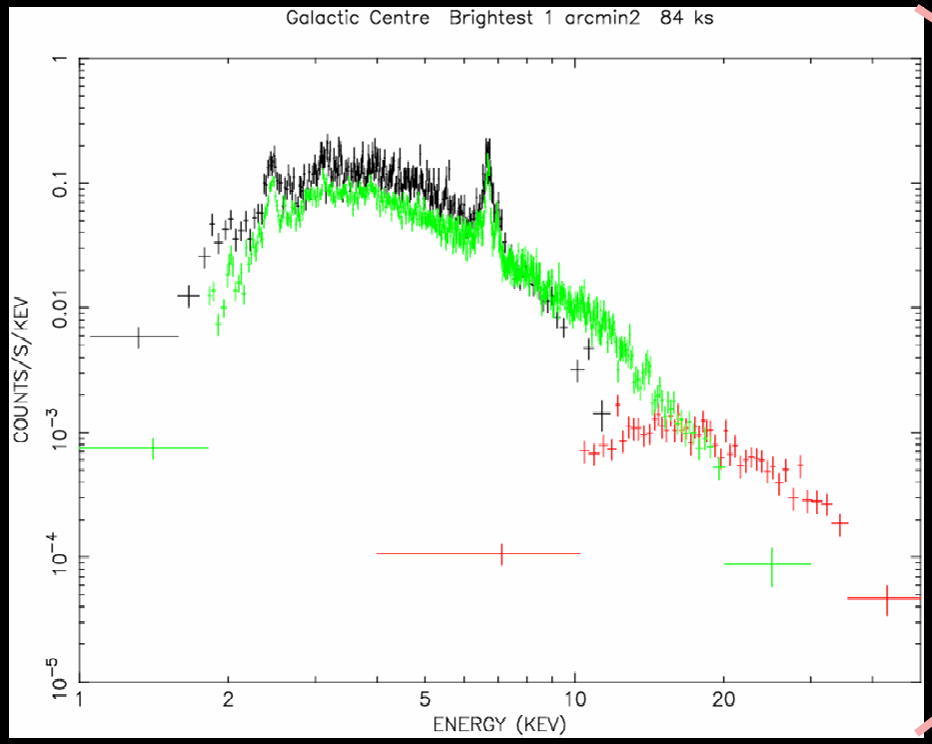

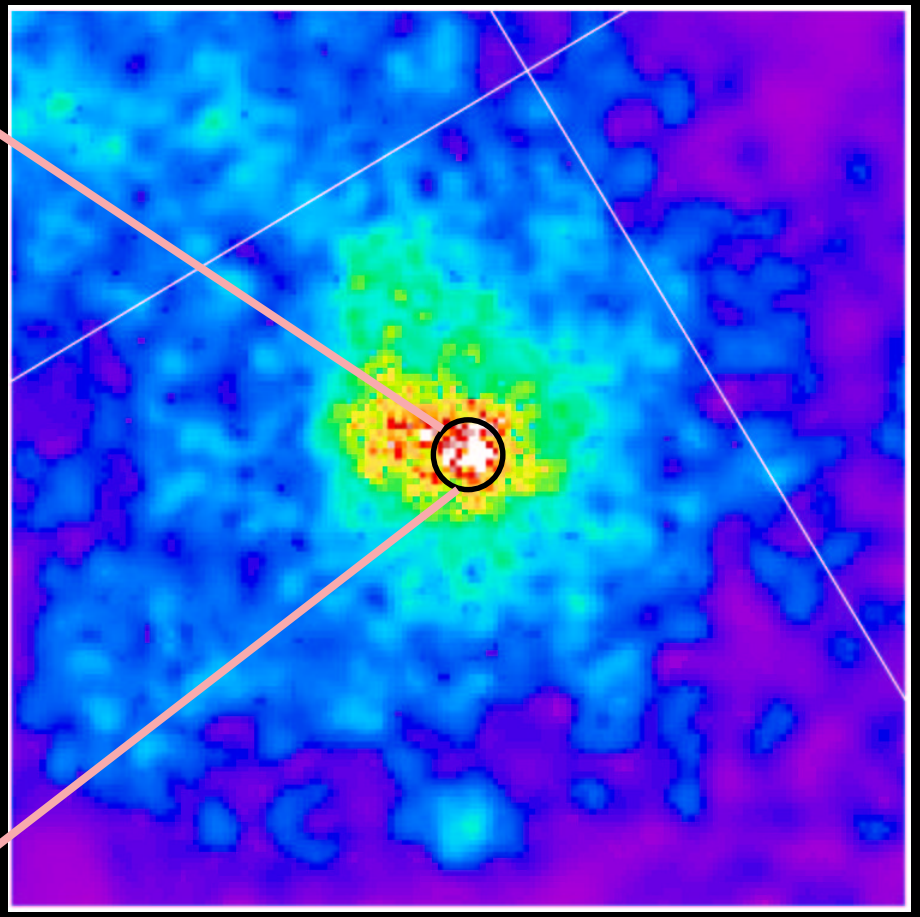

Simulation with SIMBOL–X
Bright and relatively steep region
of 1 arcmin2, Tsimul = 84 ks

Simulation > 10keV
Field of 10 x 10 arcmin2
Total exposure time = 300 ks

Conclusions

Hard X-ray continuum associated with two components:

- the 6.7 keV iron K line, most likely associated to a hot thermal gas
- the 6.4 keV line emission, associated with a non-thermal continuum

With XMM-Newton, morphology of these two components revealed

BUT their nature and origin still not understood

Requires spatially resolved spectroscopy and imaging above 10 keV

to determine the nature of the hard X-ray diffuse emission

with SIMBOL-X