X-ray spectroscopy of supernova remnants in the LMC

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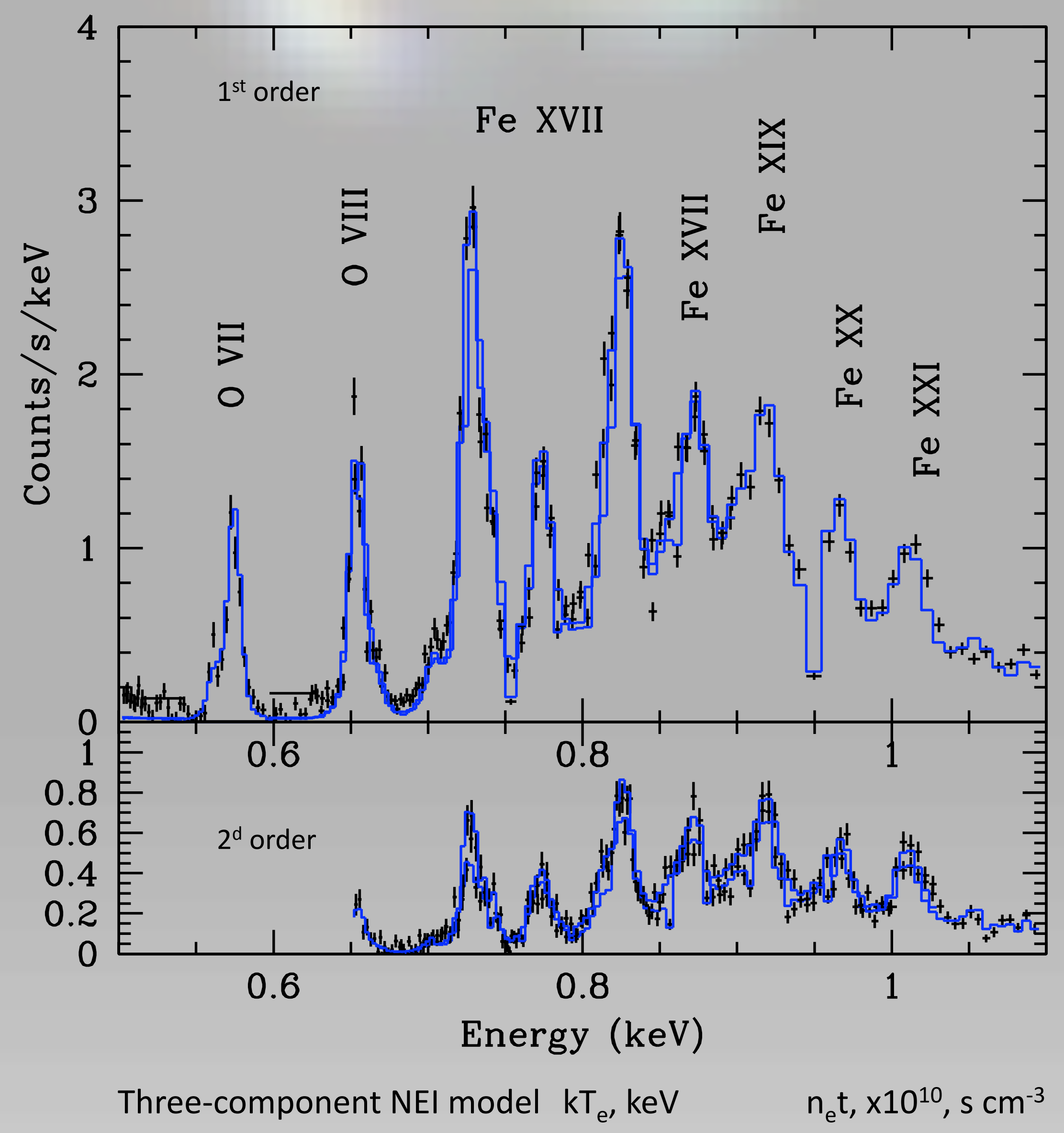
We discuss XMM-Newton and Chandra observations of supernova (type Ia) remnants in the Large Magellanic Cloud. The high resolution RGS spectra allow us to measure line velocity broadening and therewith to estimate the expansion rate of the remnants. Also the spectra provide information on the chemical composition of the supernova material. The XMM-Newton spectra combined with the Chandra images of the remnants reveal stratification of the elements in the supernova ejecta.

RGS spectra

SNR 0519-69.0
age: 600 years

σ = 1900 ± 50 km/s ➔ v_S = 2800 ± 500 km/s



Three-component NEI model	kT_e, keV	n_et, x10^{10}, s cm^{-3}
O	0.8±0.2	2.3±0.7
Fe-low	1.2±0.3	3.0±0.2
Fe-high	2.5±1.0	5.2±1.4

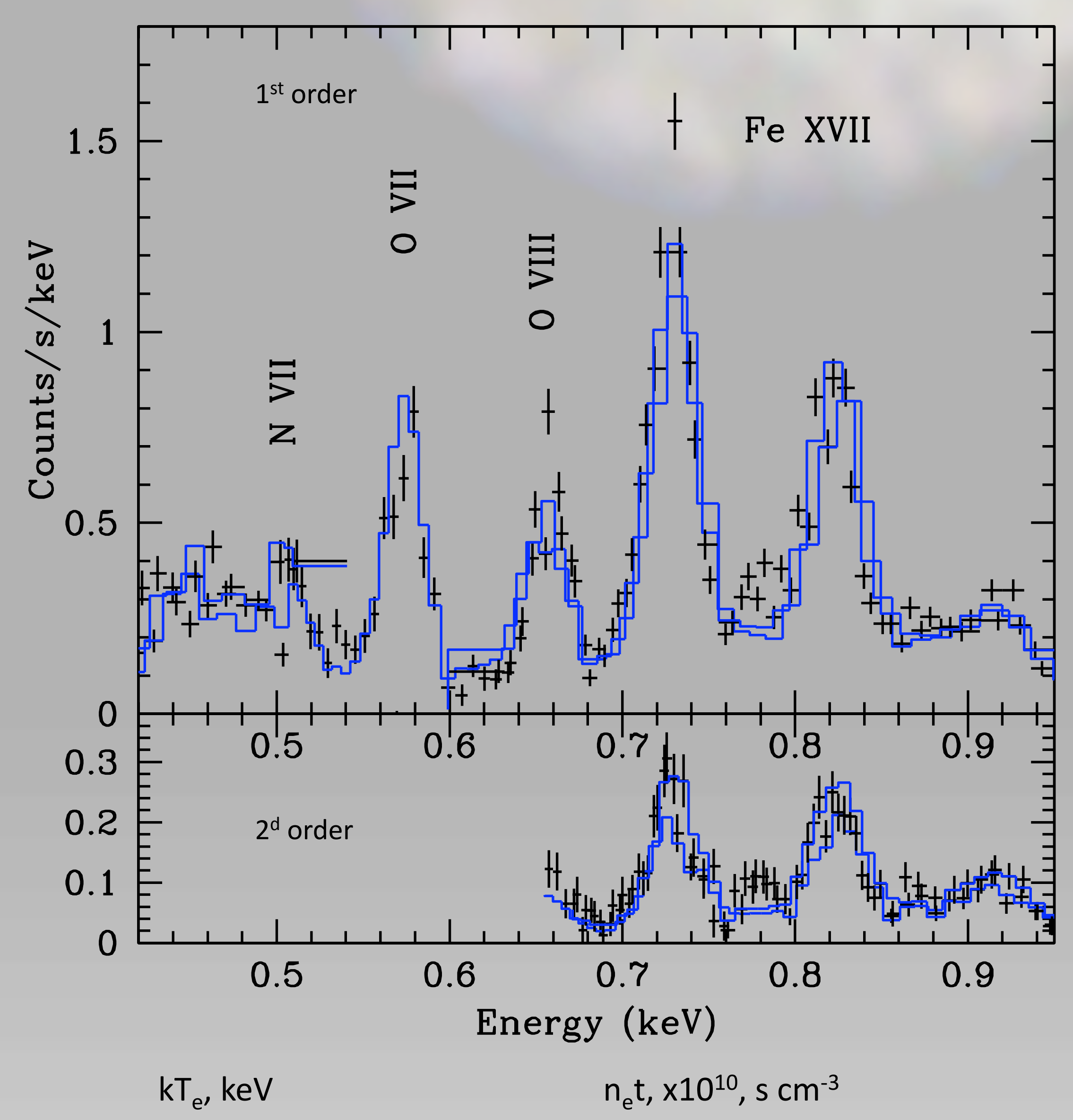
Fitting with **SPEX NEI** models, convolved with line velocity broadening profiles, allowed to measure σ and to estimate the velocity of the forward shocks v_S.

RGS spectra of **SNR 0519-69.0** fitted with three-component NEI model, reveal stratification of O and Fe with different ionization states.

Nitrogen line, discovered in the RGS spectra of **SNR 0509-67.5** allowed to measure density behind the forward shock, and to estimate the circumstellar matter (CSM) density.

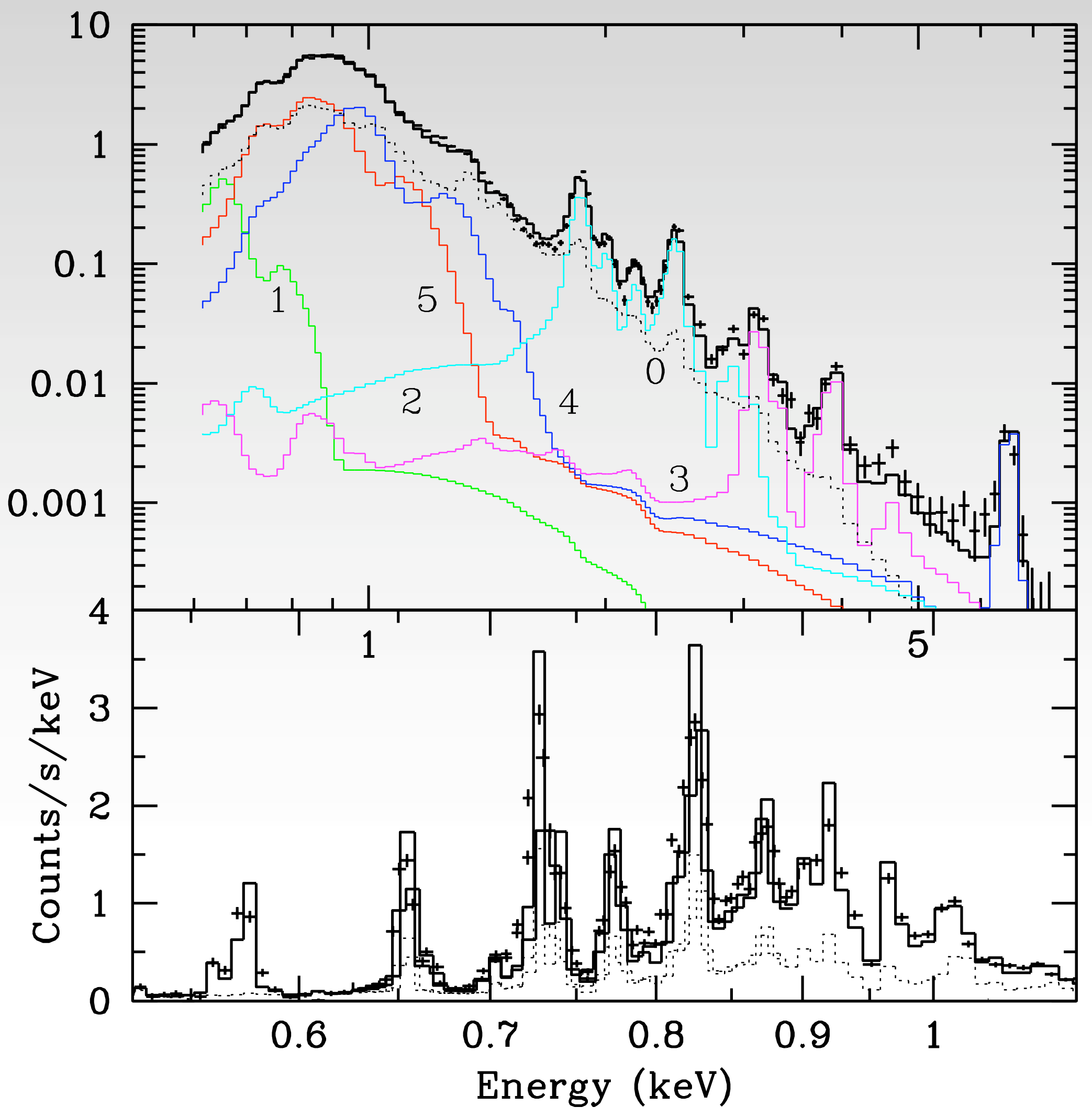
SNR 0509-67.5
age: 400 years

σ = 4900±420 km/s ➔ v_S =6900±500 km/s



kT_e, keV	n_et, x10^{10}, s cm^{-3}
0.8±0.2	1.3±0.3

Combined data:
EPIC MOS + RGS



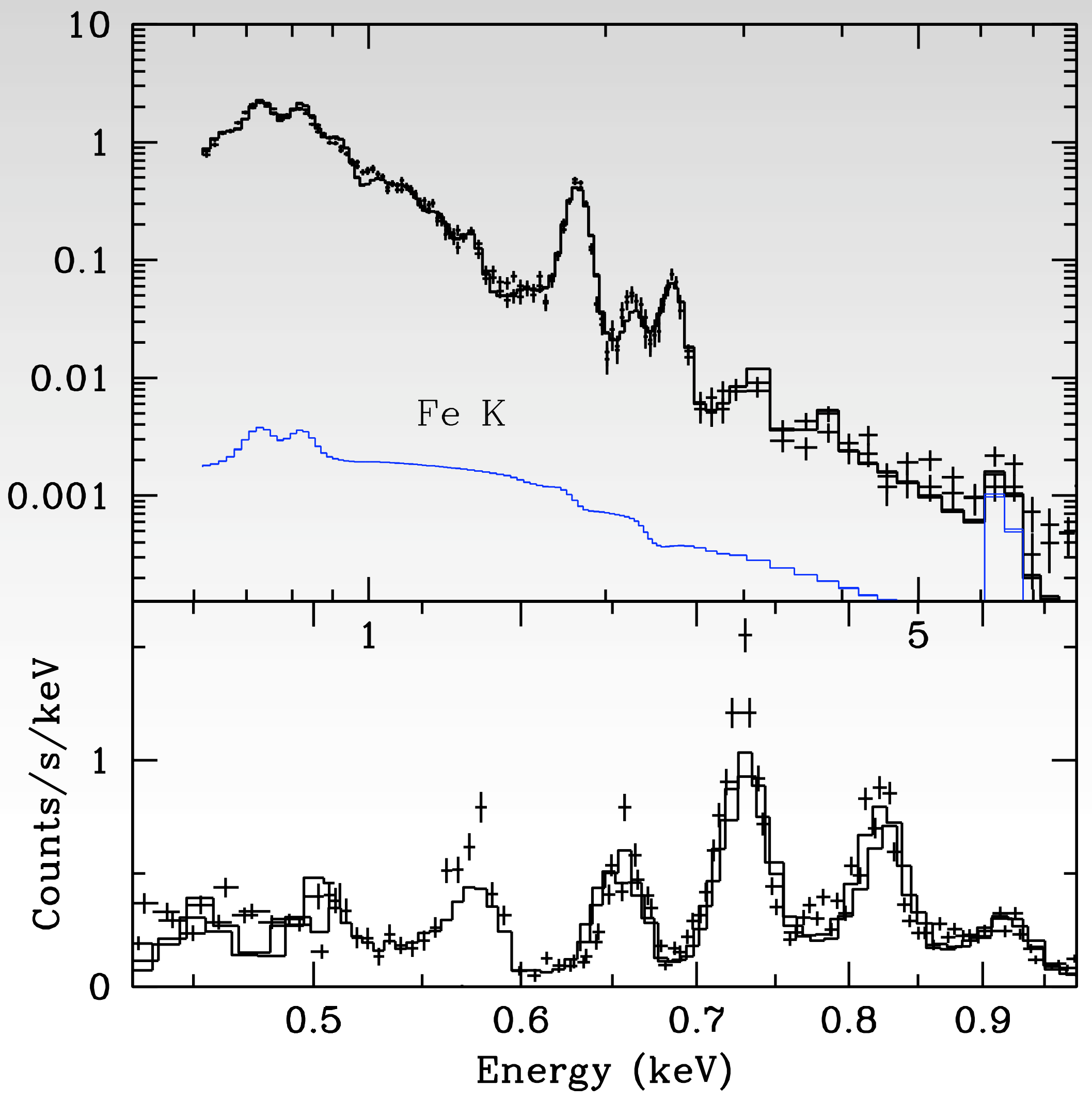
Component	1: 0xygen	2: Si/S	3: Ar/Ca	4: Fe-high	5: Fe-low	0: CSM
kT_e, keV	0.7±0.2	7.0±2.0	2.7±1.1	2.7±0.3	1.3±0.3	0.6±0.1
n_et, x10^{10}, s cm^{-3}	1.5±1.0	3.6±0.2	~30	3.8±0.3	2.6±0.4	~80

Fitting the data with multi-component NEI models helps us to measure metal abundances of the shocked supernova ejecta.

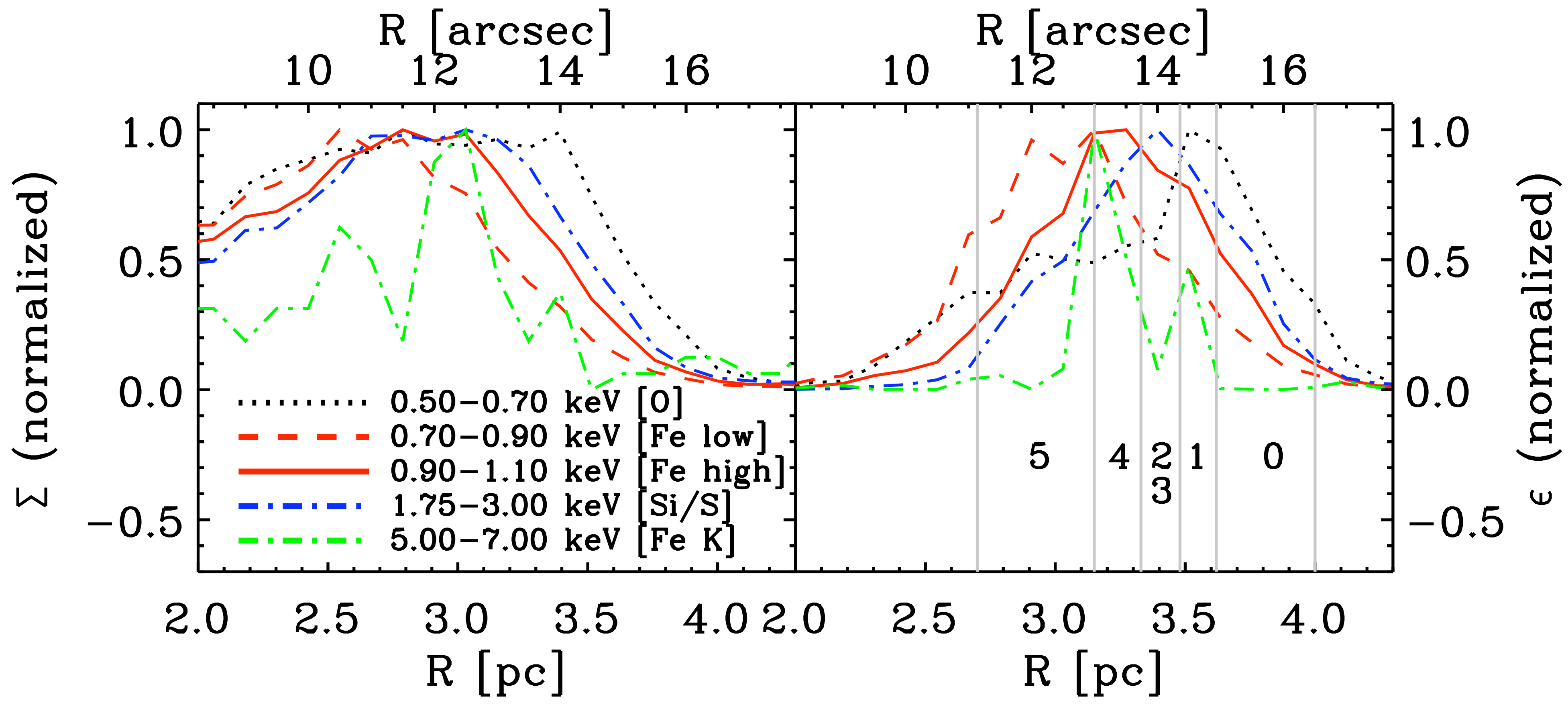
The data of **SNR 0519-69.0** reveal chemical stratification (linked to the different ionization timescales) of the elements in the shocked ejecta, which is confirmed by the Chandra radial profiles (shown below).

The data of **SNR 0509-67.5** show a layer of recently shocked Fe with very low ionization timescale, which produce most of the Fe K emission.

From this analysis, values for the CSM density derived.
SNR 0519-69.0: n_H = 2.4±0.2 cm^{-3}
SNR 0509-67.5: n_H = 0.8±0.4 cm^{-3}

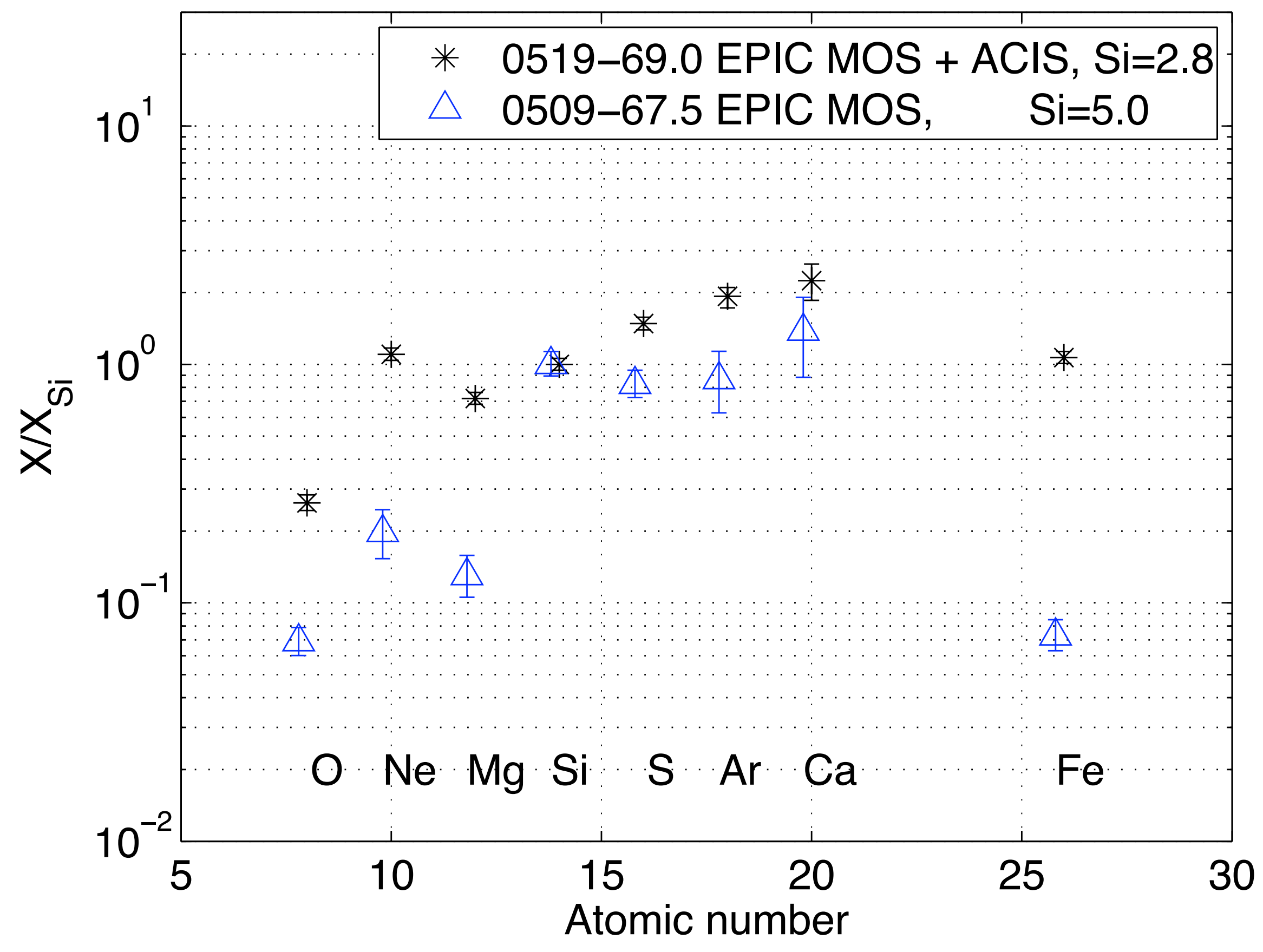


Component	Basic	Fe K
kT_e, keV	4.0±0.2	3.5
n_et, x10^{10}, s cm^{-3}	1.4±0.1	0.1



Azimuthally averaged radial profiles in different energy bands. Left panel: surface brightness radial profiles. Right panel: deprojected emissivity profiles. The vertical light grey lines outline the regions where the corresponding spectral components dominate.

Bibliography
Kosenko et al, arXiv:1001.0983 (2010)
Kosenko et al, A&A, 490, 223 (2008)
Helder et al, ApJ, 686, 1094 (2007)



Best-fit abundances of SNR 0519-69.0 and SNR 0509-67.5, derived from single-ionization timescale NEI fitting models. The data are in solar units (Anders & Grevesse, 1989), normalized by Si abundances.