

Separating the spectral counterparts in NGC 1275/Perseus cluster in X-rays

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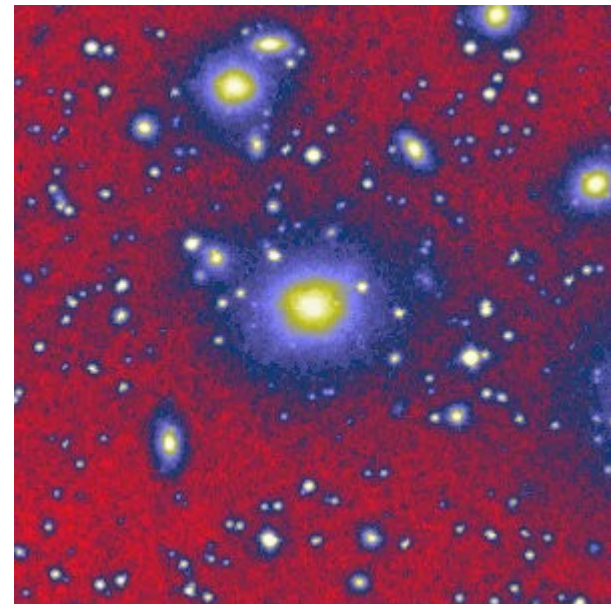
Outline of this work:

- Input: the data of the X-ray observations of an object (AGN) with X-ray bright surroundings (cluster);
- Goal: To develop the model-independent recipe to separate the spectra of the source (i.e. an AGN) and the surrounding (cluster)
- Output: the cleaned spectra of the source for further scientific analysis, fitting, etc.



Object of the investigation: NGC 1275

- NGC1275 is the central galaxy of the Perseus cluster;
- The redshift $z = 0.0175$ [1];
- The cluster surrounding is 8-9 times brighter than the AGN in the range of 0.1-8 keV, the AGN emission dominates above 12-15 keV [2];
- X-ray observational data available:
Suzaku (37 obs.), XMM-Newton (3 obs.), Swift (115 obs.), covering the period: 2001, 2006-2019



Sky Image view

Here we analyze the available Suzaku/XIS data and separate the AGN and cluster spectra



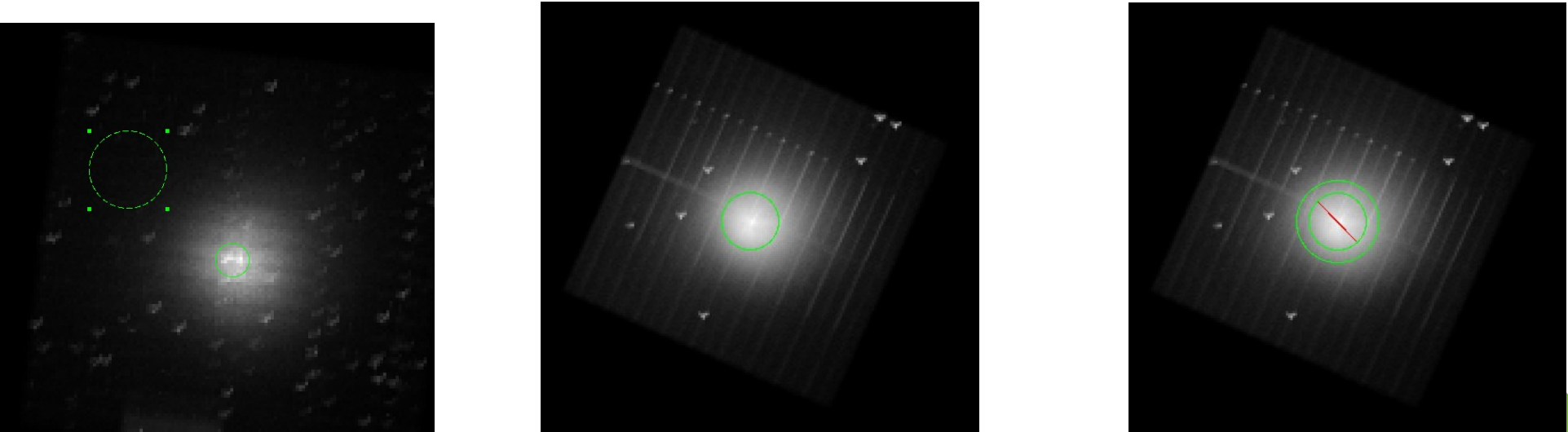
The recipe:

- The goal of the recipe is to separate the spectra with no use of the spectral fitting;
- The recipe is based on the fact of the presence of the bright recombinant line of Fe XVII near 6.65 keV in the X-ray spectrum of the cluster;
- The main idea of the recipe is to separate the spectra using the renormalized cluster spectrum as a background;
- The renormalization constant for cluster spectrum is to be chosen to remove the 6.65 emission line from the resulting (cleaned) spectrum.



Practical realization of the recipe on Suzaku/XIS data:

- Part 1: performing usual steps to obtain images;
- Part 2: choosing the regions: for the distant background, source and surrounding (nearest background)



Practical realization of the recipe on Suzaku/XIS data:

- Part 3: extract the background, source and surrounding spectra in the standard way for all cameras available;
- Part 4: merge the source, cluster and background spectra and response matrices into total spectra for all cameras (using `addascapec` routine);
- Subtract the background from the cluster spectrum using our script `clus_corr.py`.

Output of the `clus_corr.py` gives us a spectral file with the cluster counts cleaned from the background;



The cluster and spectra on this step looks like:

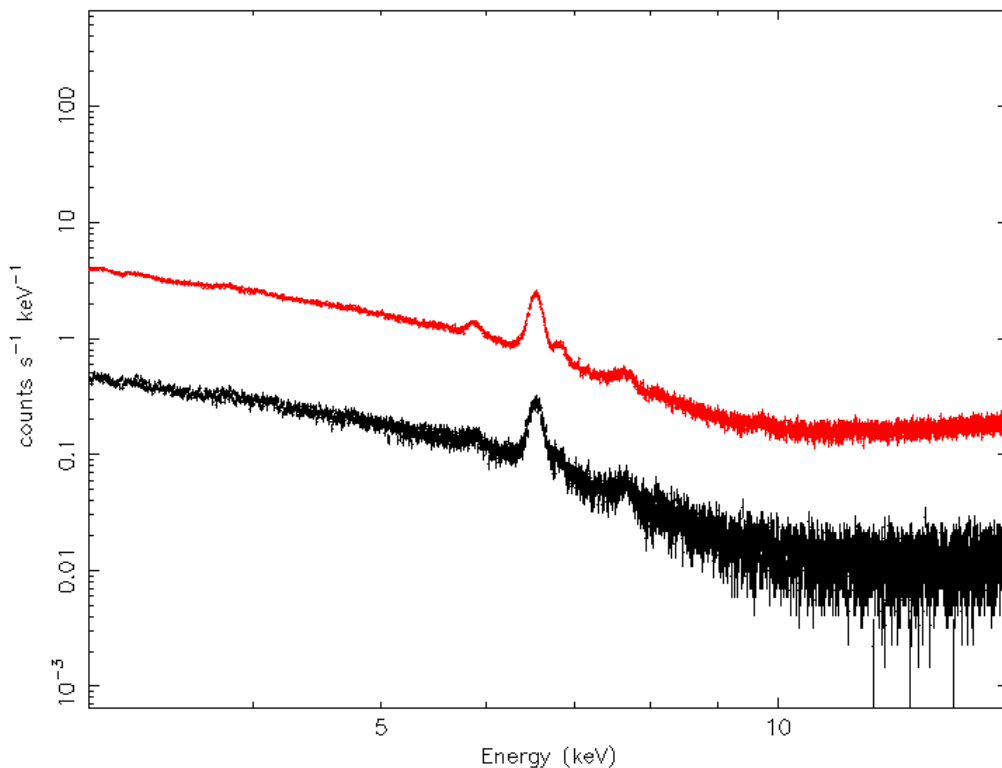
Red (AGN)

Black (cluster)

the line at 6.65 keV

(redshifted)

is clearly visible

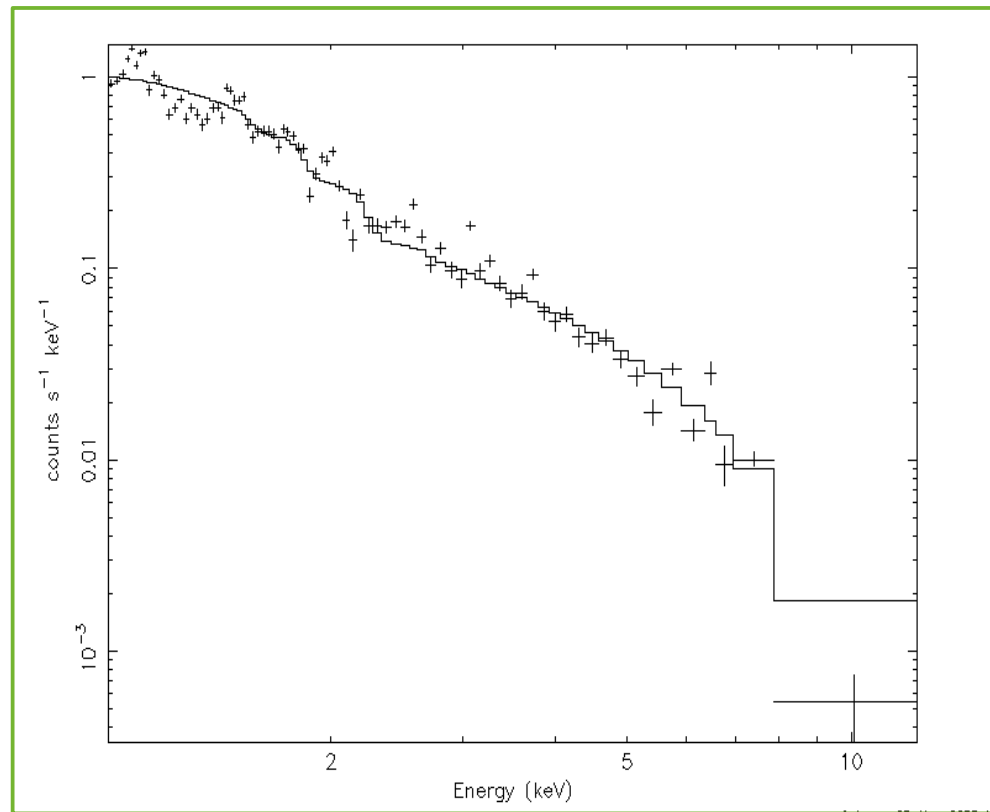


Practical realization of the recipe on Suzaku/XIS data:

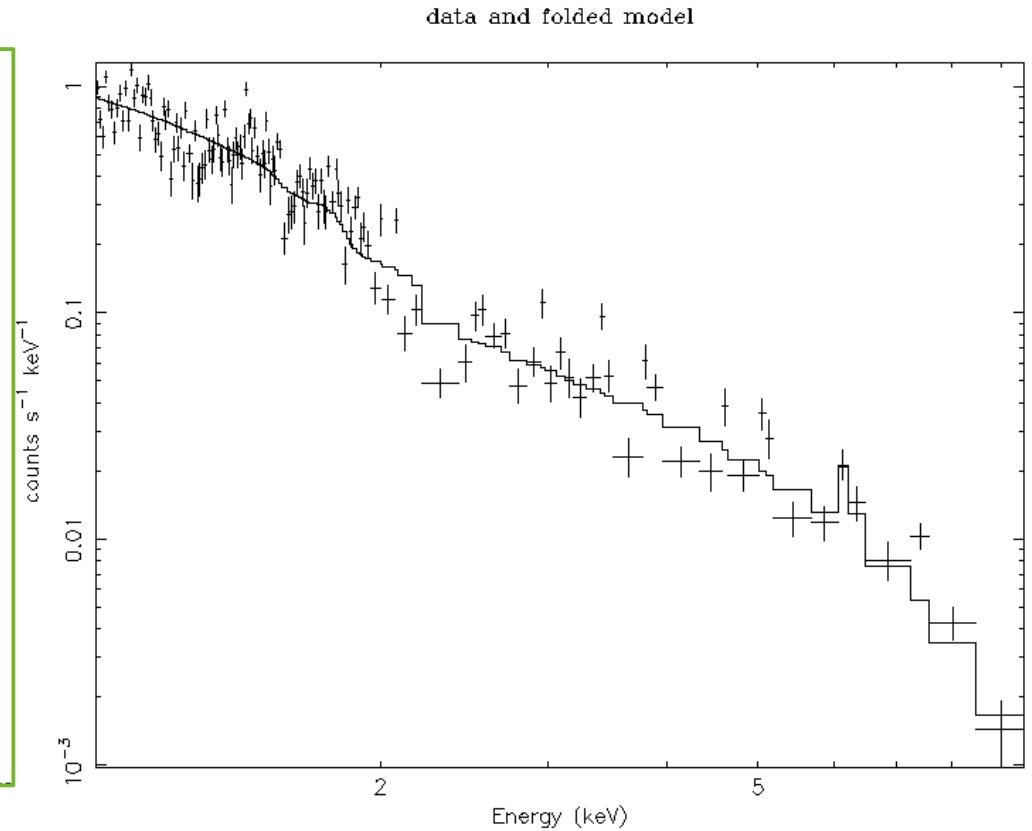
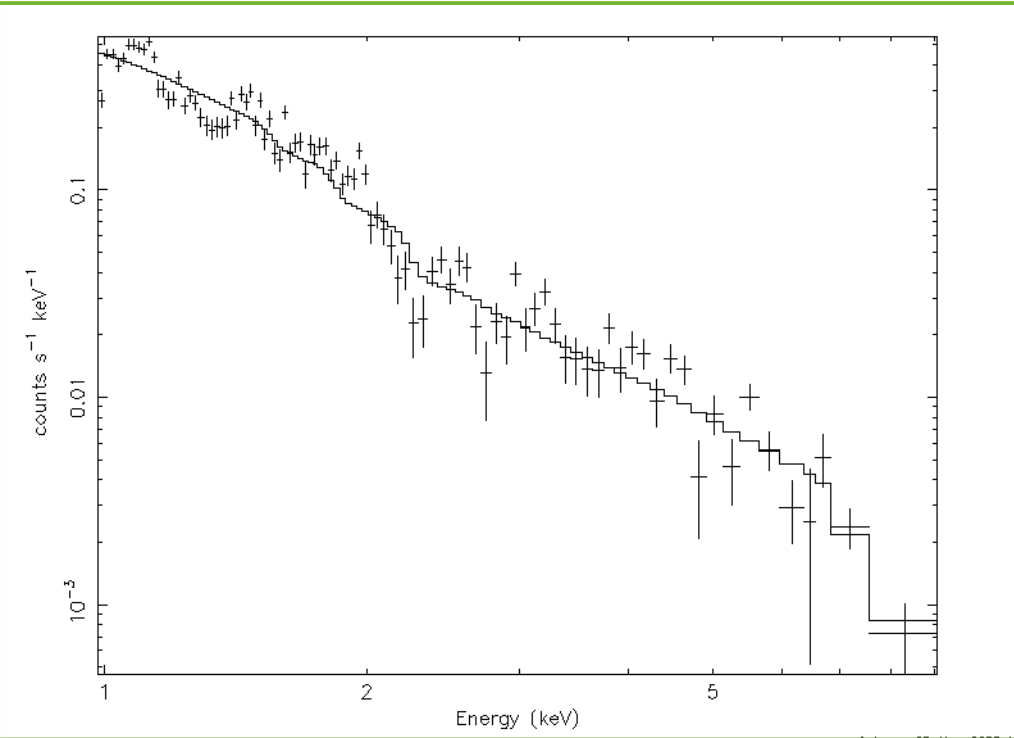
- Group the source spectrum (if needed) with the remote background;
- Load it in XSPEC with the cleaned cluster spectrum as a corfile and vary cornorm constant until the 6.65 line disappeared in the resulting spectrum;
- The source spectrum is cleaned of the cluster counterpart and ready to further analysis



The resulting spectrum looks like:



Results for other SCWs:



Conclusions:

- We cleaned the AGN spectra in NGC 1275 from the cluster traces successfully using the method of double step-by-step background subtracting based on the spectral feature (emission line) at 6.65 keV in the cluster spectrum;
- The method proposed in this work is based on the X-ray spectral features of the cluster and doesn't use spectral fitting/models;
- The method can be used similarly to other objects with X-ray bright surroundings with prominent spectral features.
- Our method appears to be quite effective even in case when surrounding is several times brighter than the central source (as it is with NGC 1275).

