ACCRETIONS IN GALAXY CLUSTERS

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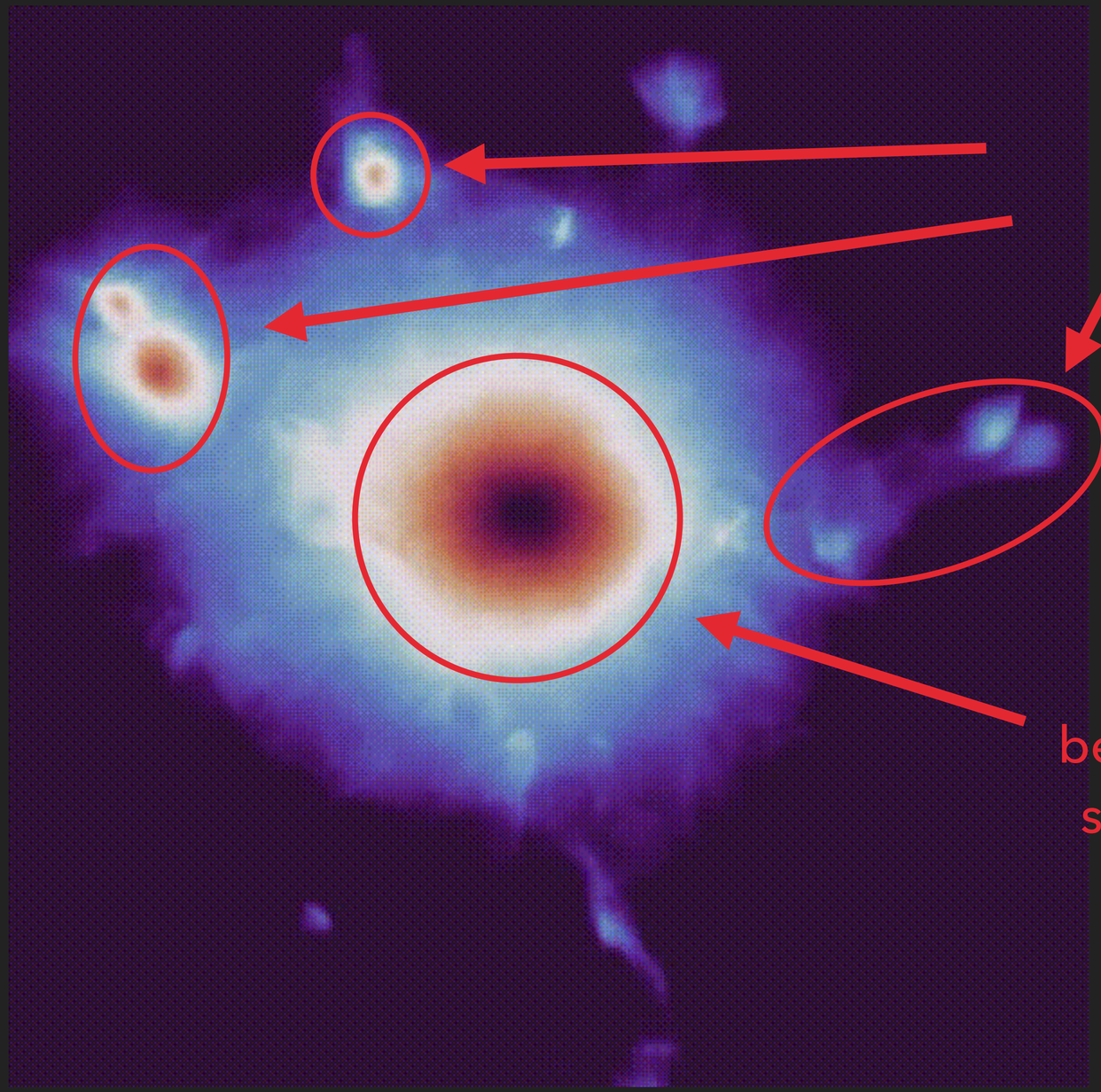
S. ETTORI, F. VAZZA, T.W. JONES, M. RONCARELLI

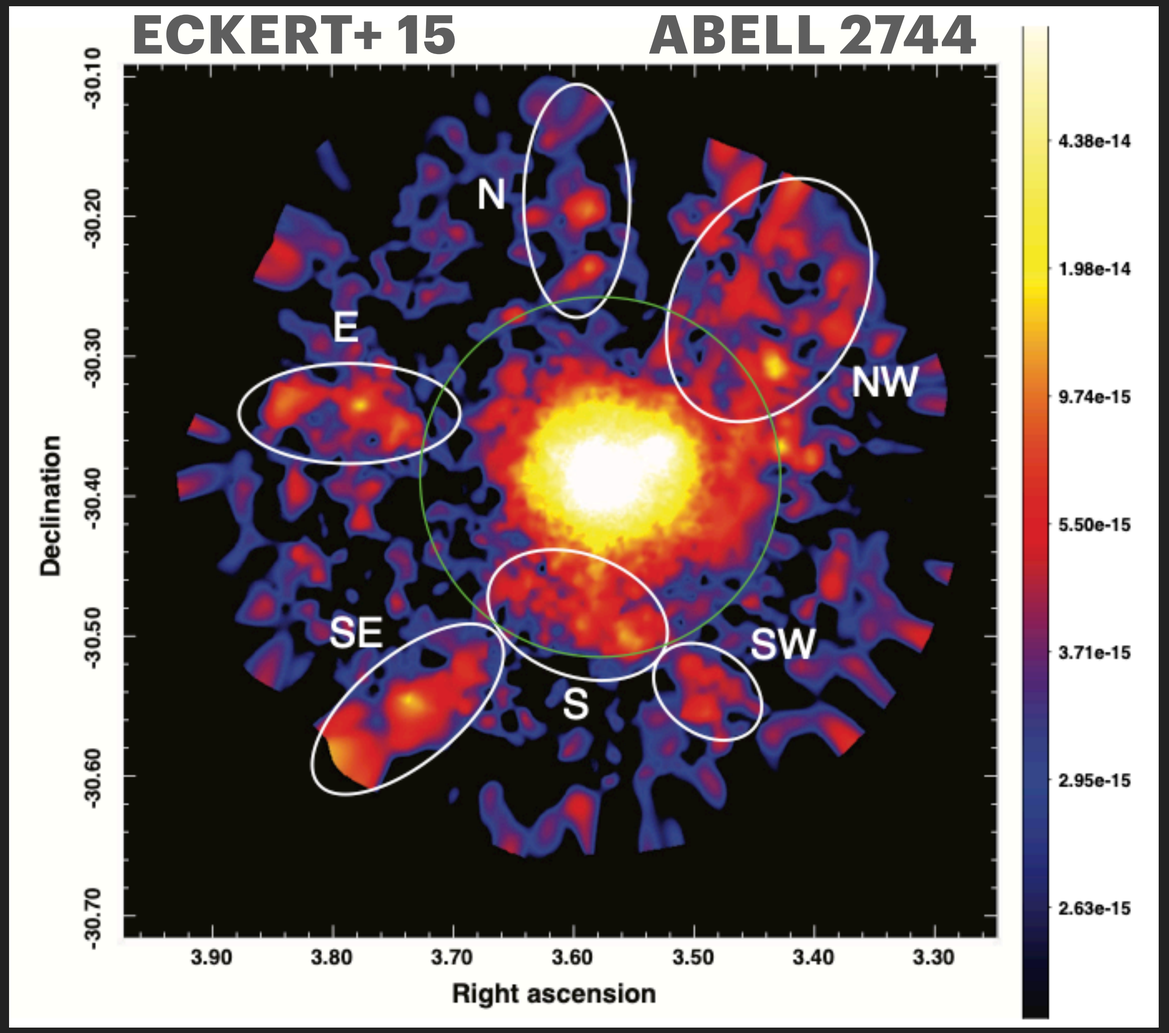

Accretions
Sources
Interactions
between accretion
sources and ICM

ACCRETIONS IN GALAXY CLUSTER

- Recent observations in X-ray band detected diffuse gas in filamentary structures (Eckert+ 15)

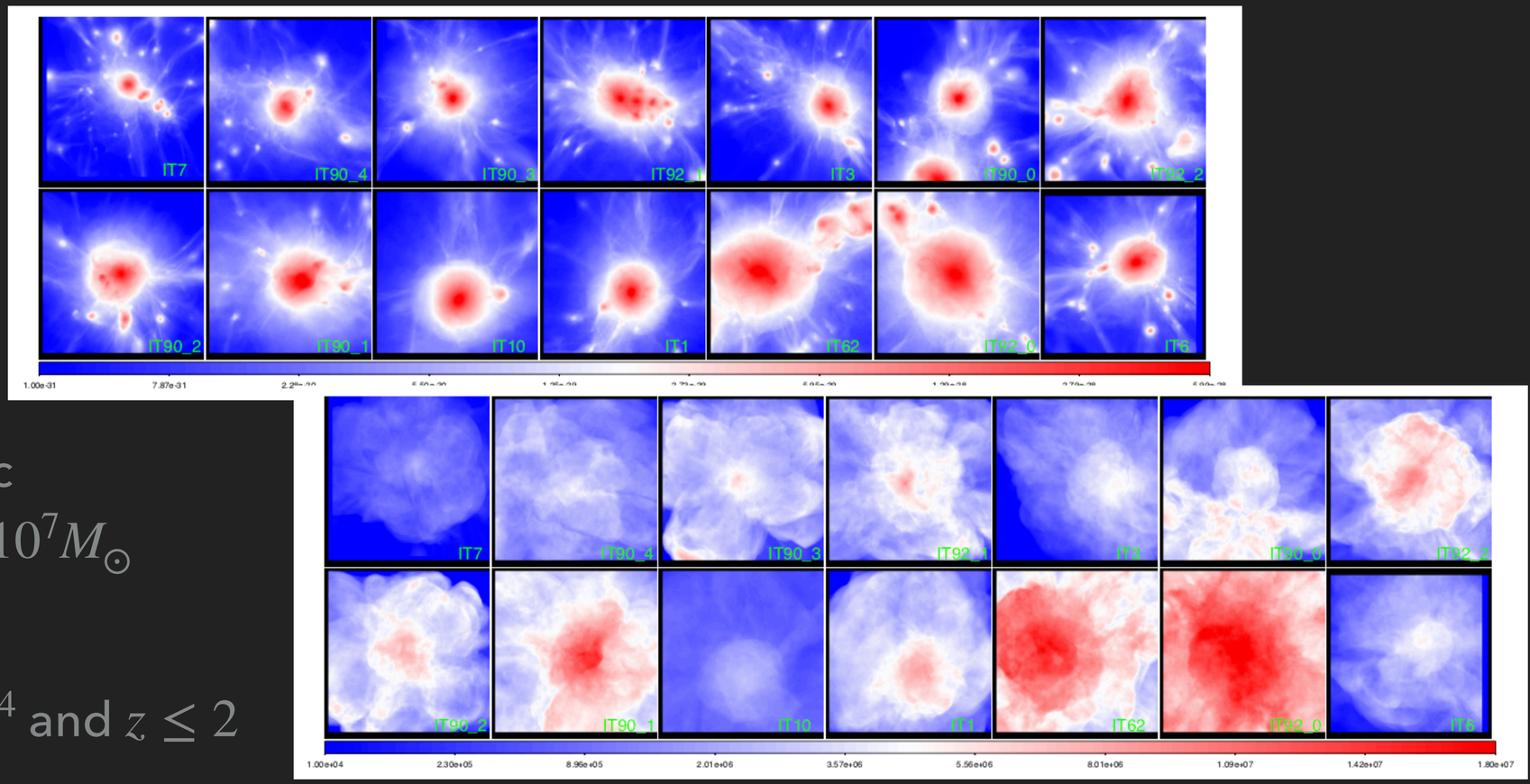
- Filamentary structures around galaxy clusters are mostly observed in the optical band (Connor+ 18)

- In Radio band, filamentary structures are observed, but they are mainly related with close pairs of galaxy clusters (Govoni+ 19)

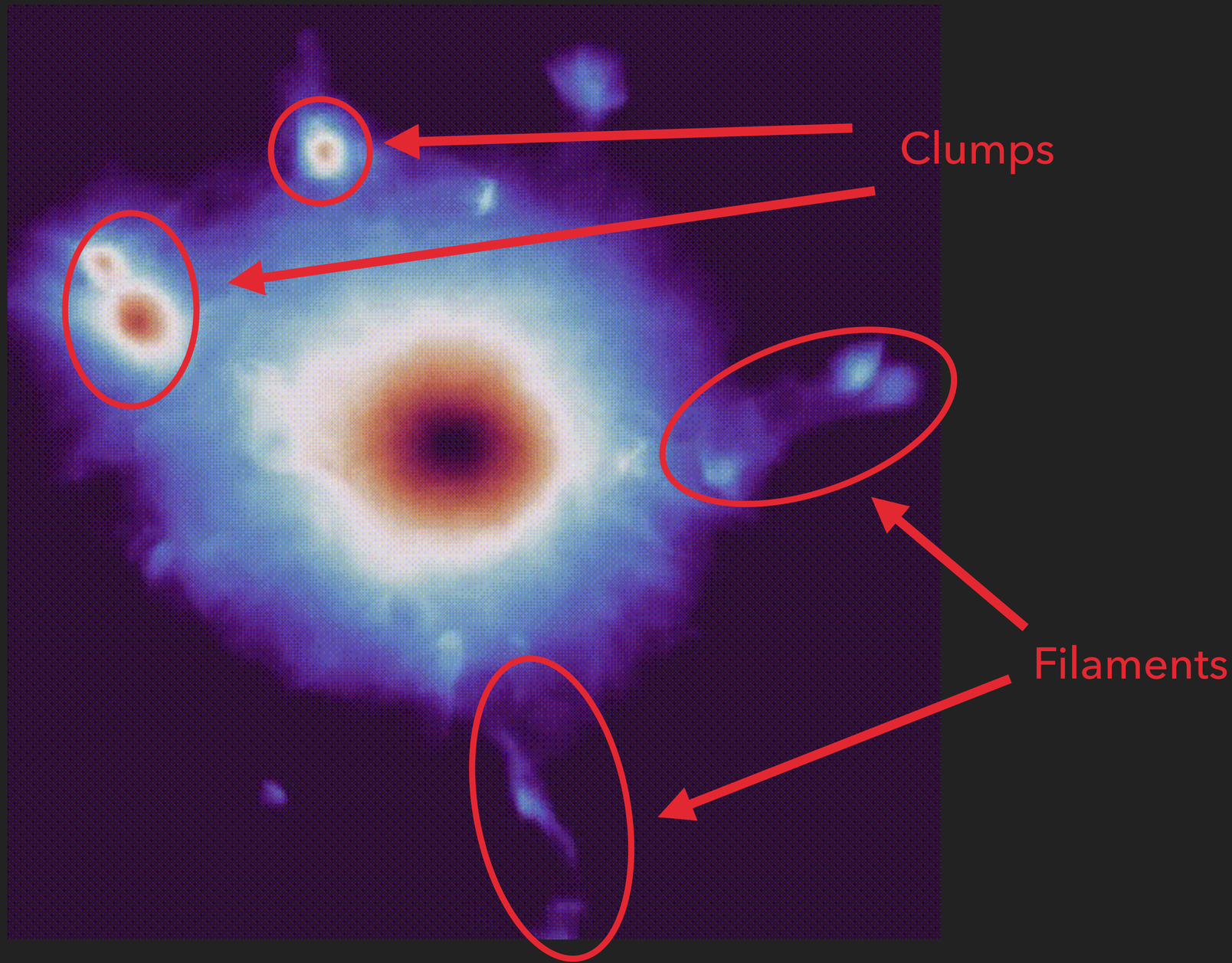


THE ITASCA SAMPLE

- Cosmological simulations performed by AMR grid code *ENZO*
- Non radiative simulations
- Final box 6.4^3 Mpc^3
- Final grid resolution ~20 kpc
  Final m_{DM} resolution $1.12 \times 10^7 M_\odot$
- $5 \cdot 10^{13} \leq M_{100}/M_\odot \leq 4 \cdot 10^{14}$ and $z \leq 2$
- Cosmological selection of independent clusters (Giocoli+ 12)



Vazza+ 17
Wittor+ 17
Angelinelli+ 20

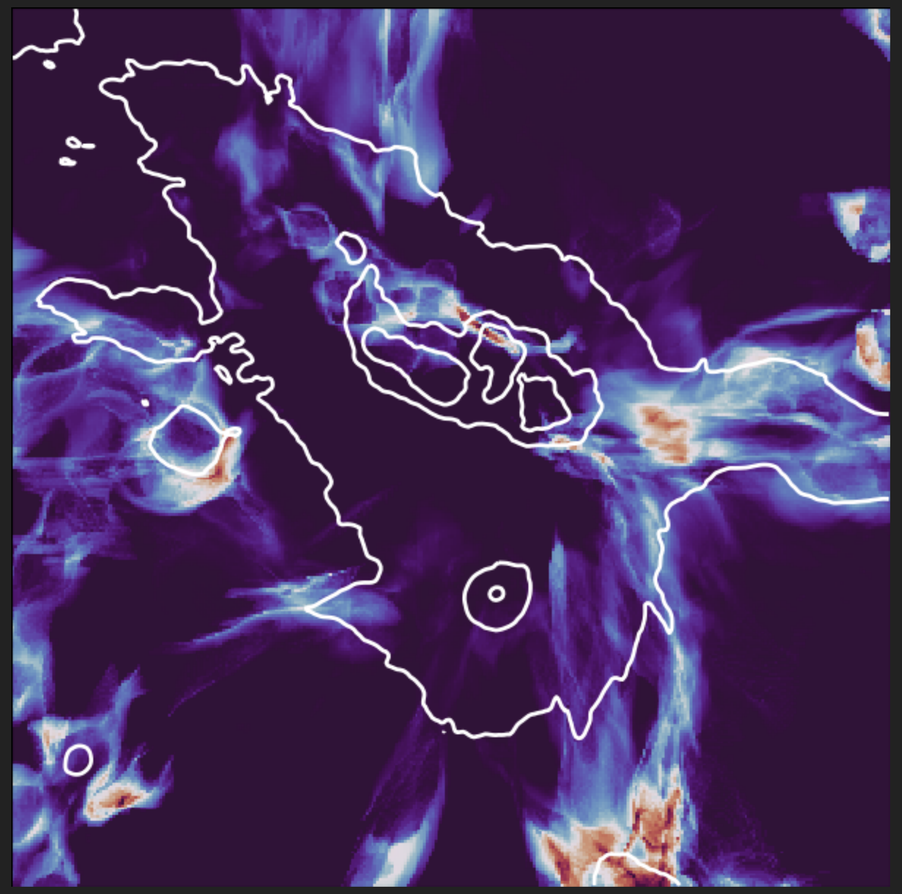

Clumps
Filaments

THE FILAMENTS

- Definition of a new proxy for the filamentary structures, using radial velocity and entropy

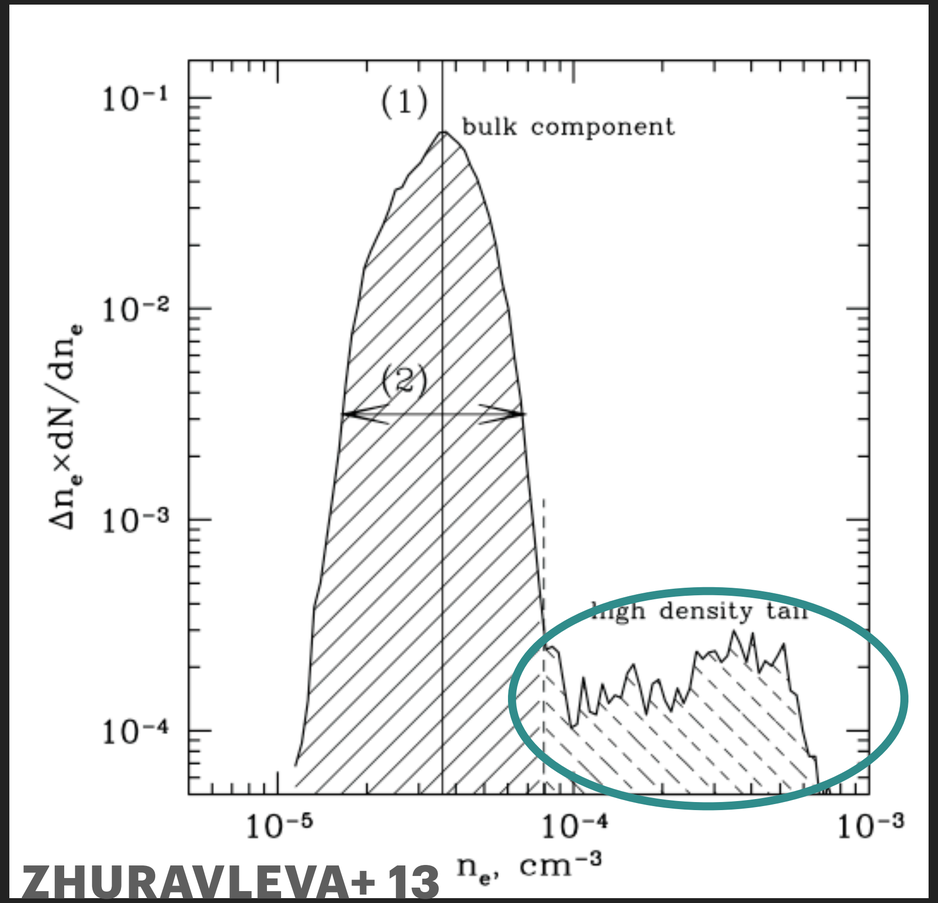
- Self similar proxy $$\frac{V_{rad}^2}{K} \propto \frac{M^{2/3}}{M^{2/3}} = CONST$$

- The Filaments are tagged by $$\frac{V_{inf}^2}{0.05 \cdot \overline{K}} < \frac{V_{rad}^2}{K} < \frac{V_{inf}^2}{0.01 \cdot \overline{K}}$$



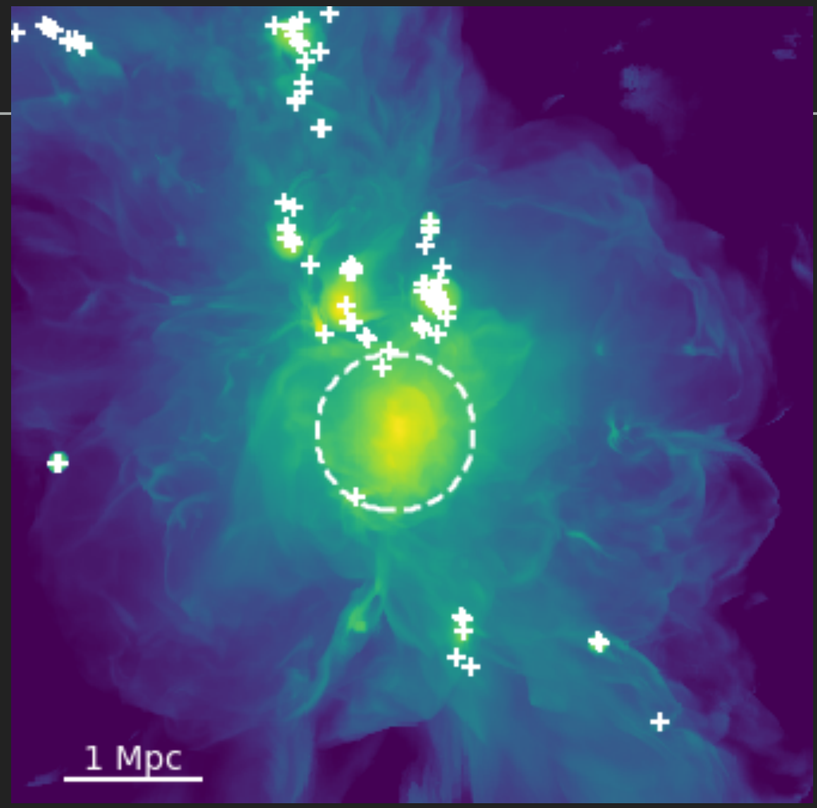
CLUMPS AS TRACERS OF FILAMENTS

- Clumps are the 1% densest cells in simulations (Roncarelli+ 13; Zhuravleva+ 13)
  - Mass threshold and Size threshold used to identify single clumps



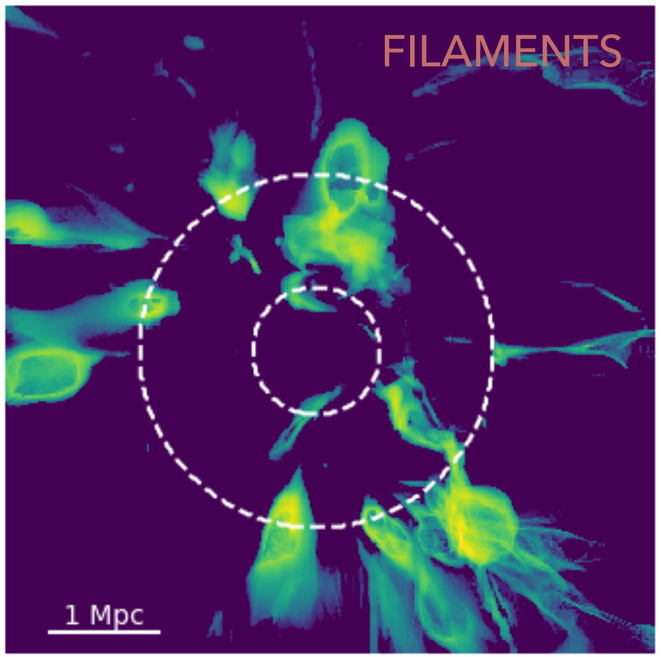
ZHURAVLEVA+ 13

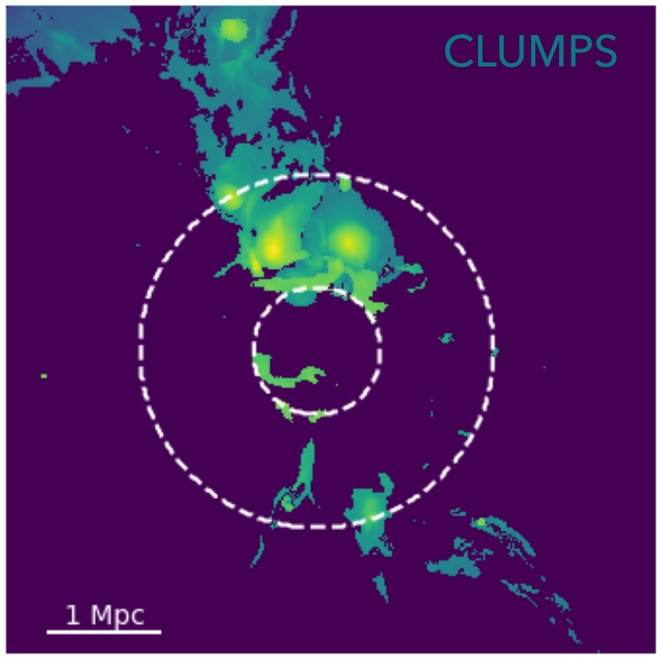
CLUMPS AS TRACERS OF FILAMENTS

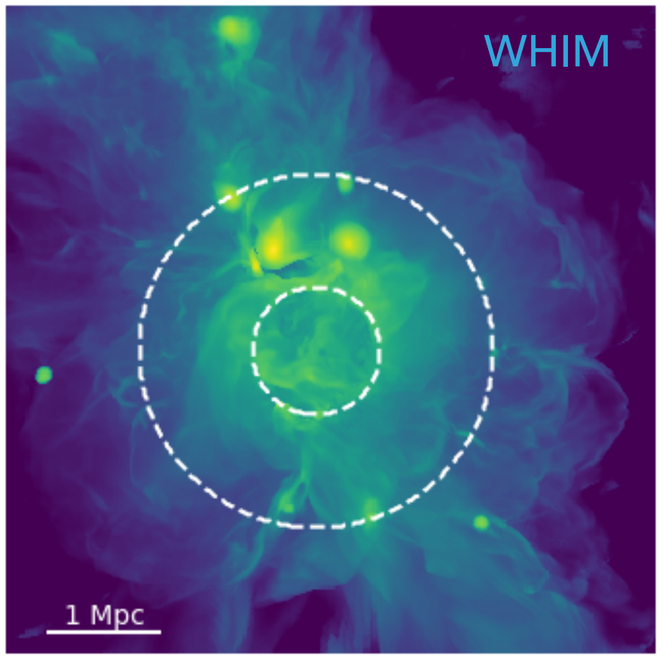


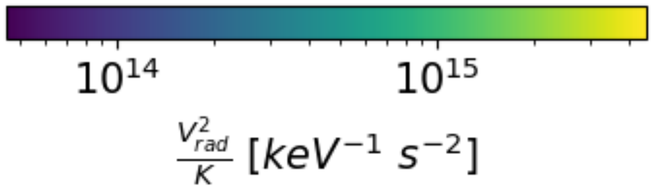
- Clumps are the 1% densest cells in simulations (Roncarelli+ 13; Zhuravleva+ 13)
    - Mass threshold and Size threshold used to identify single clumps
- The X-ray emission of clumps is higher than one from filaments
    - Can we use clumps to detect filaments?
    - What is the physical relation between clumps and surrounding filaments?

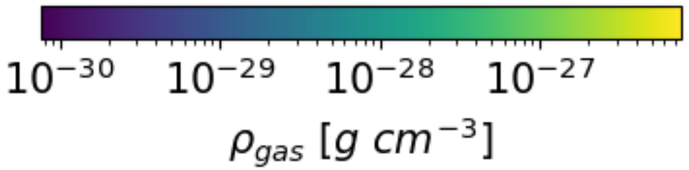
COMPARISON BETWEEN CLUMPS AND FILAMENTS

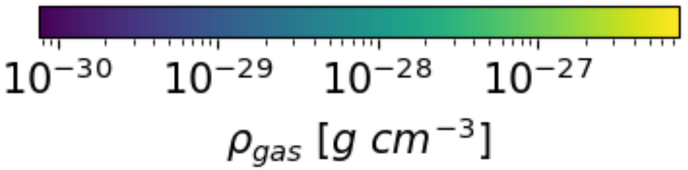




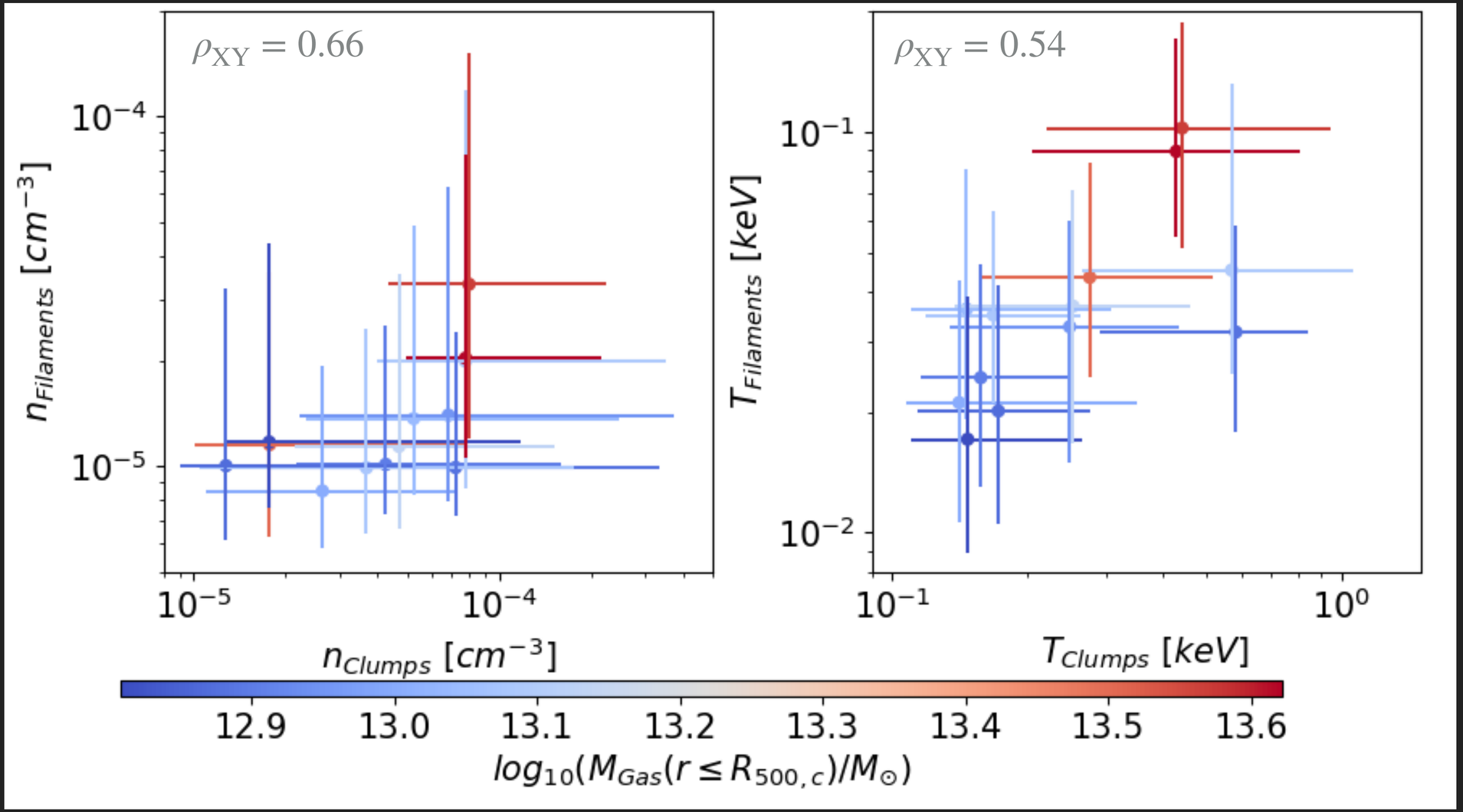








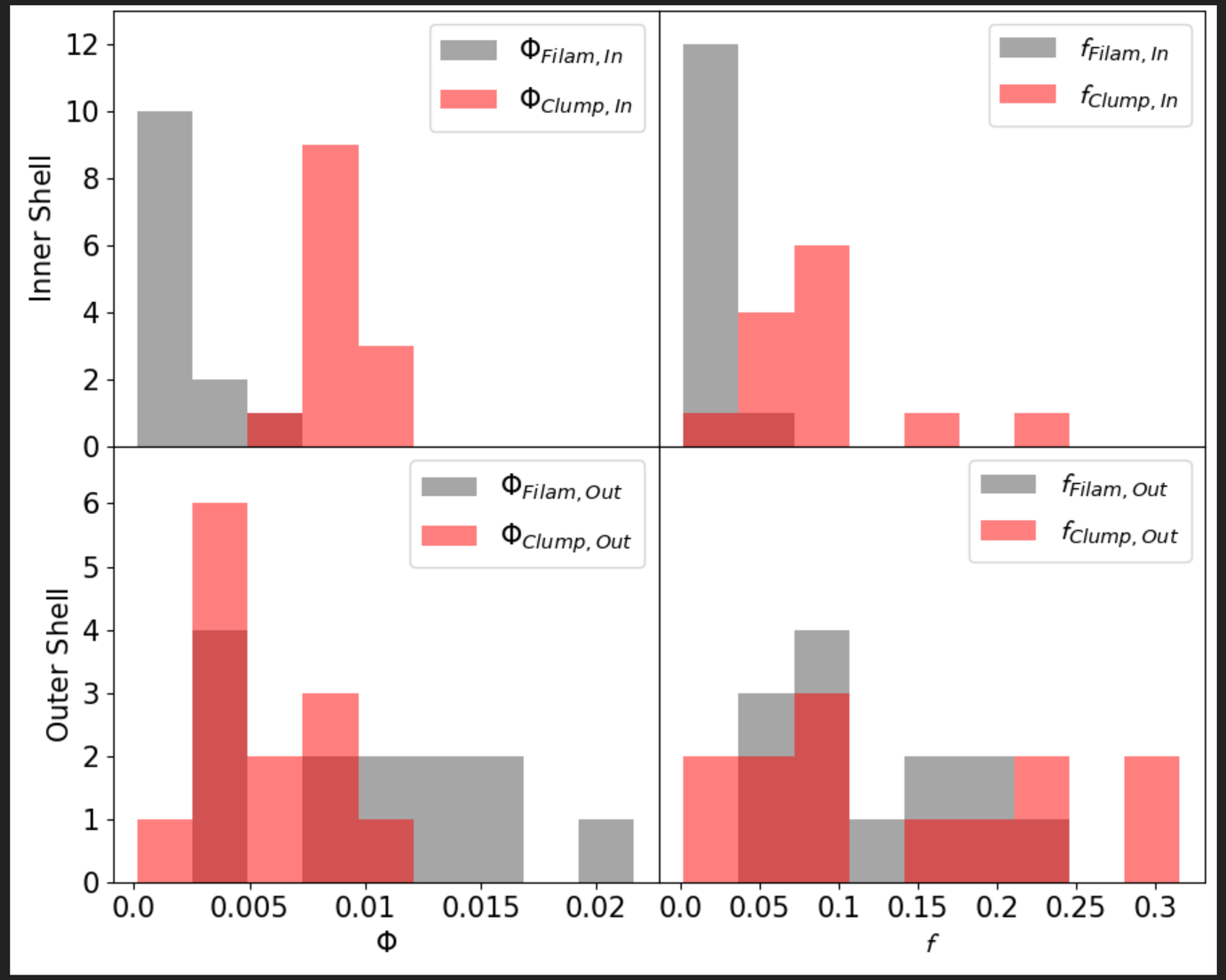
ARE CLUMPS GOOD TRACERS OF FILAMENTS?



ARE CLUMPS GOOD TRACERS OF FILAMENTS?

$1.0 < r/R_{500,c} < 2.8$

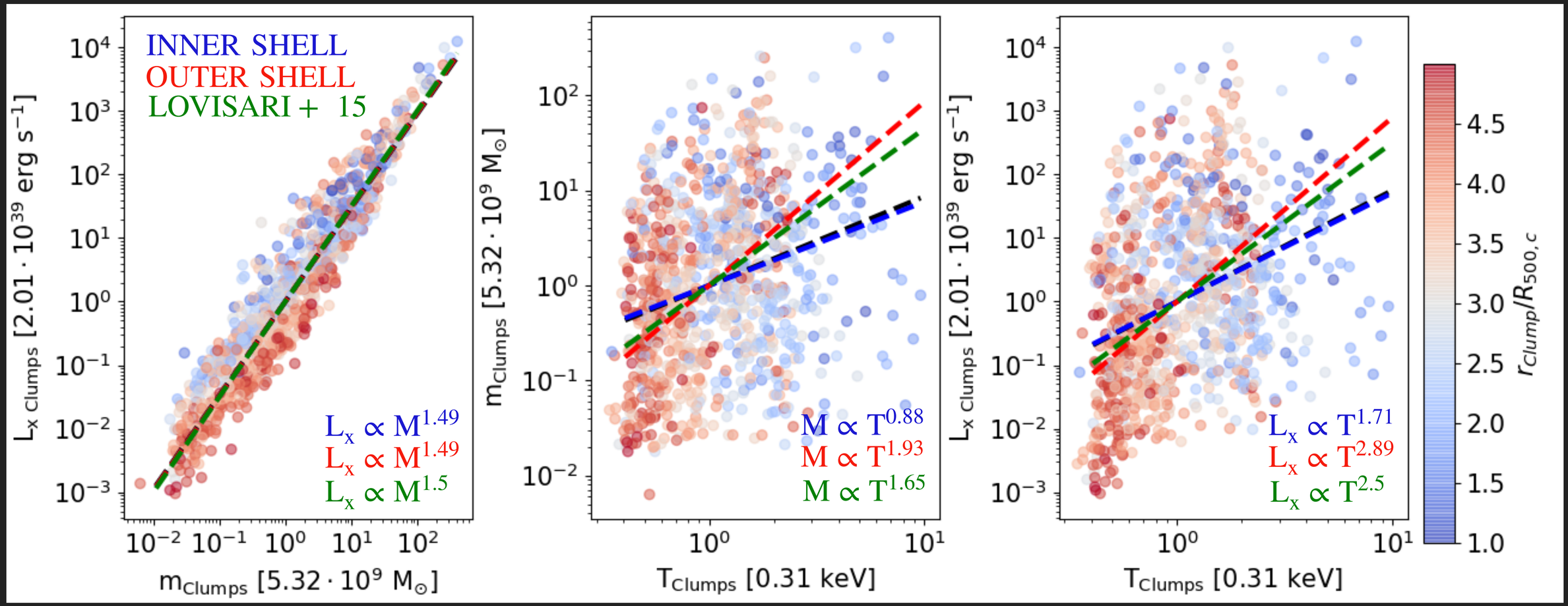
$2.8 < r/R_{500,c} < 5.0$



$$\Phi = \frac{\mathscr{V}_{\mathrm{k}}}{\mathscr{V}_{\mathrm{Shell}}}$$

$$f = \frac{\mathrm{m}_{\mathrm{k}}}{\mathrm{M}_{\mathrm{Shell}}}$$

ARE CLUMPS SMALL CLUSTERS?



Compared with: Lovisari+ 15
Eckmiller+ 15

THE CHALLENGE OF DETECTING CLUMPS AND FILAMENTS GAS

- Mock of X-ray emission maps of the clusters in the soft band (0.3-2.0 keV)

- Running the *CIAO* tool *WAVDETECT*
  - Mexican-Hat Wavelet source detection
  - Wavelet scale from ~60 to ~600 kpc
  - Background emission derived from universal profiles of density and temperature (Ghirardini+ 17)

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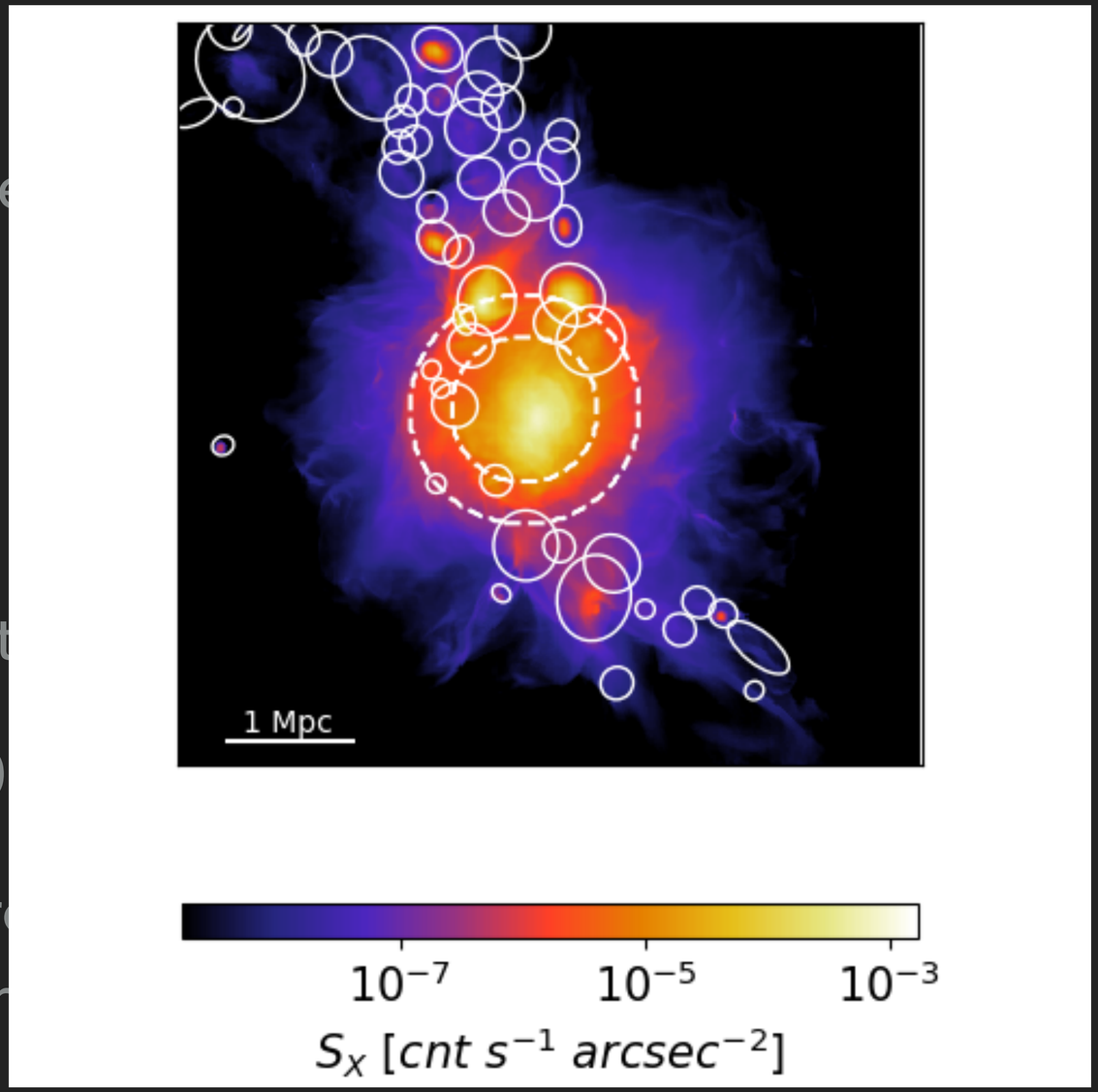
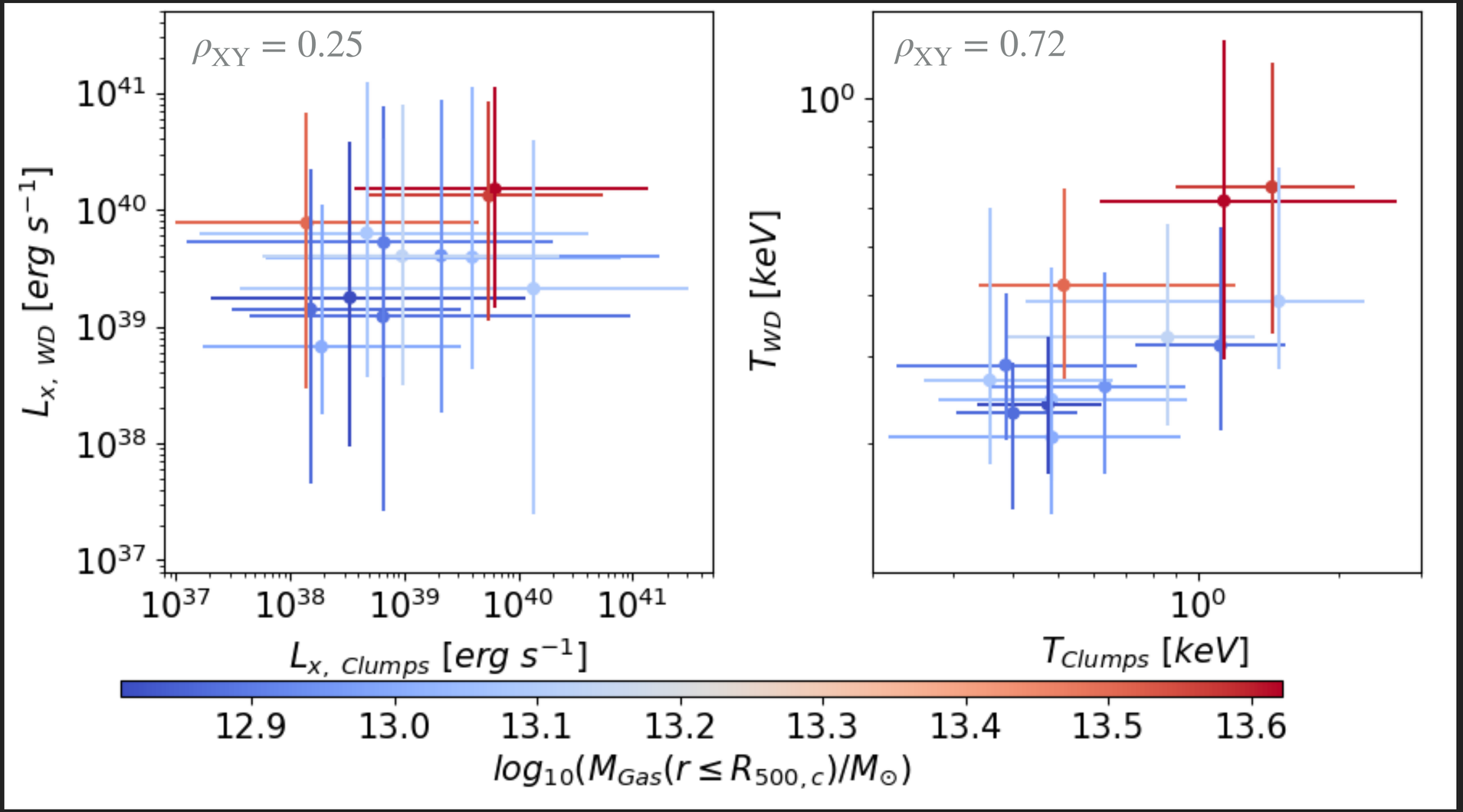


PROJECTION EFFECTS ON CLUMPS



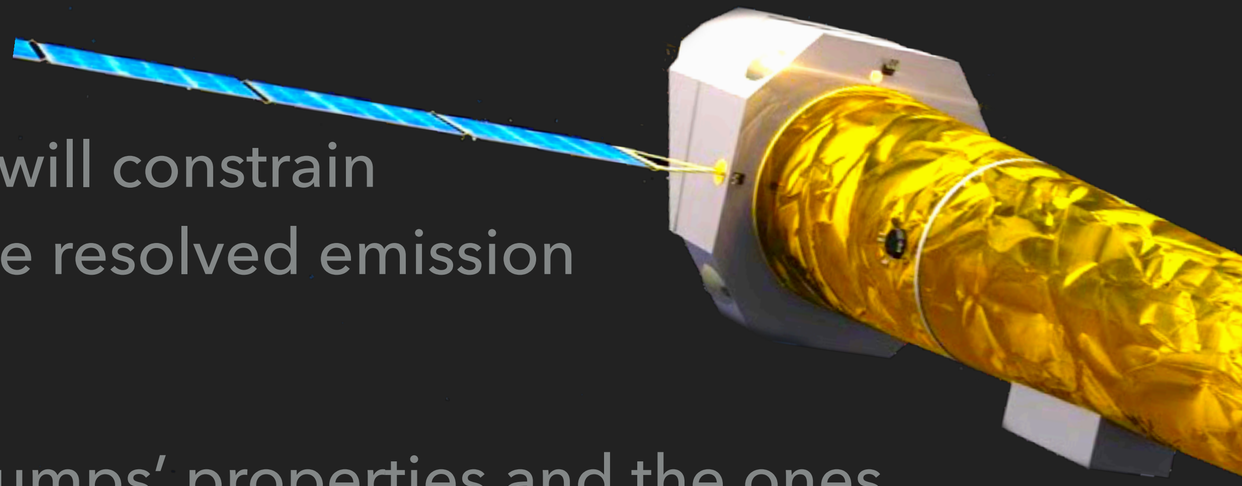
ADVANCED TELESCOPE FOR HIGH-ENERGY ASTROPHYSICS - ATHENA

- To characterize the clumps (and possibly the filaments) around a galaxy cluster, we consider a strategy that involves the use of both WFI and X-IFU instruments:

1. we use the entire FOV of WFI, centered on a good candidate for this scientific goal, to detect the clumps (e.g. by applying WAVDETECT on the soft-band images)

2. dedicated pointed X-IFU exposures will constrain the physical quantities describing the resolved emission from these clumps

3. through our correlations between clumps' properties and the ones associated to the filaments, we will speculate on the underlaying (mostly unresolved) emission from filaments



WHAT WILL ATHENA OBSERVE? SIXTE SIMULATIONS

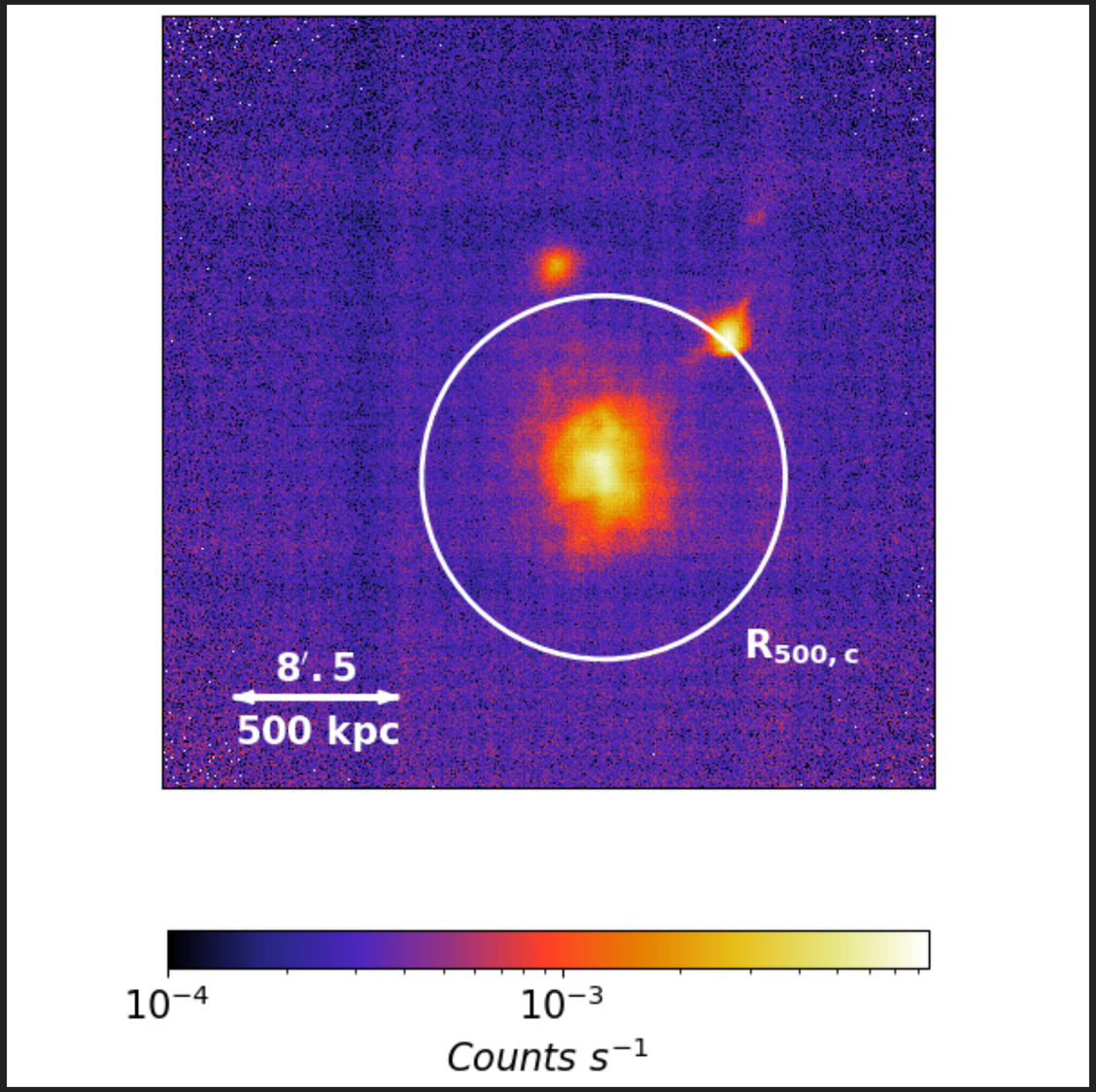
WFI

FOV: 40’x40’

Texp: 100ks

Bkg: Phys + Inst

0.1-2.0 keV



Clusters

$M_{500,c} = 6.69 \times 10^{13}\ M_\odot$

$R_{500,c} = 554.1$ kpc

$M_{200,c} = 1.03 \times 10^{14}\ M_\odot$

$z = 0.05$

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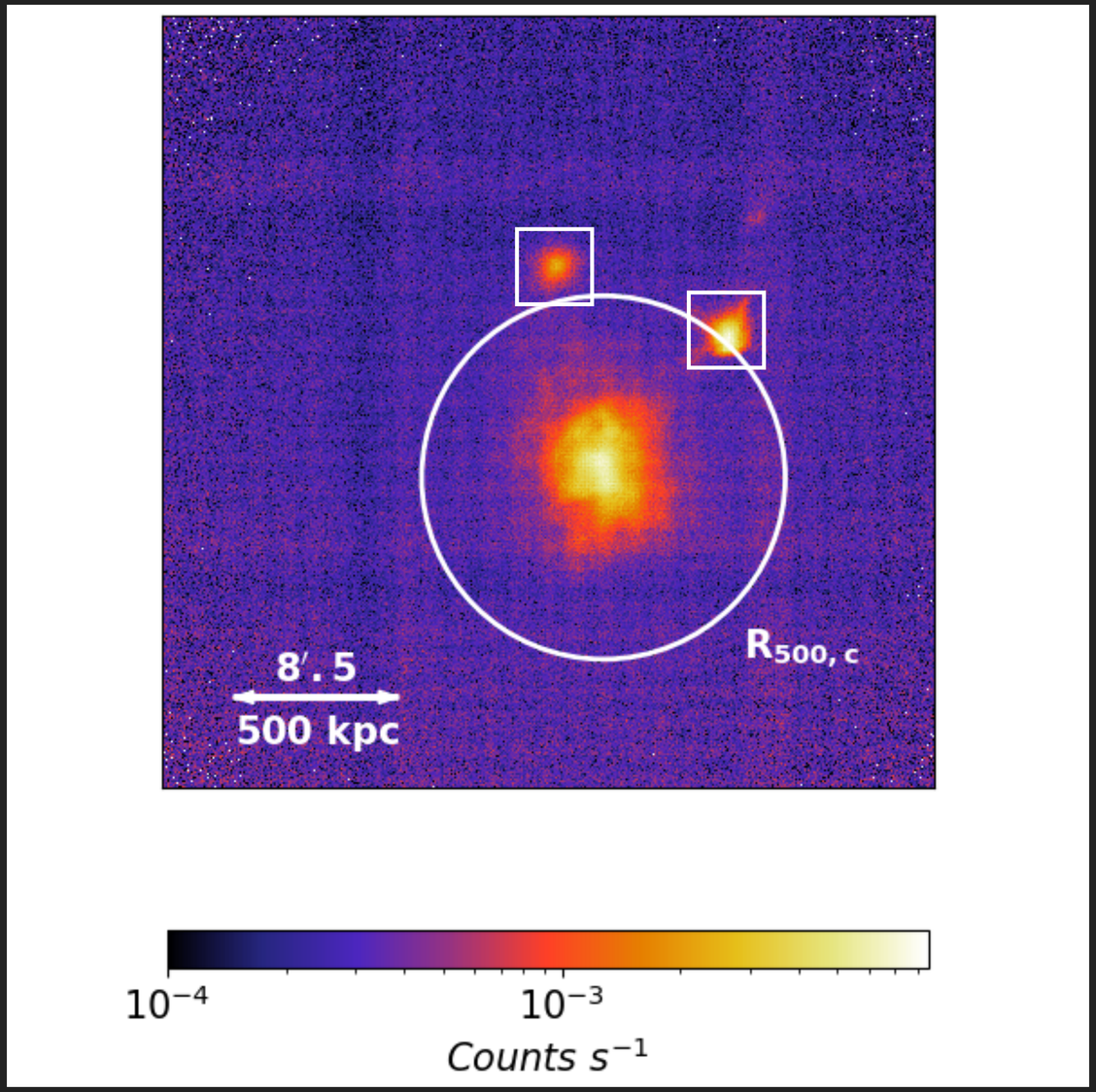

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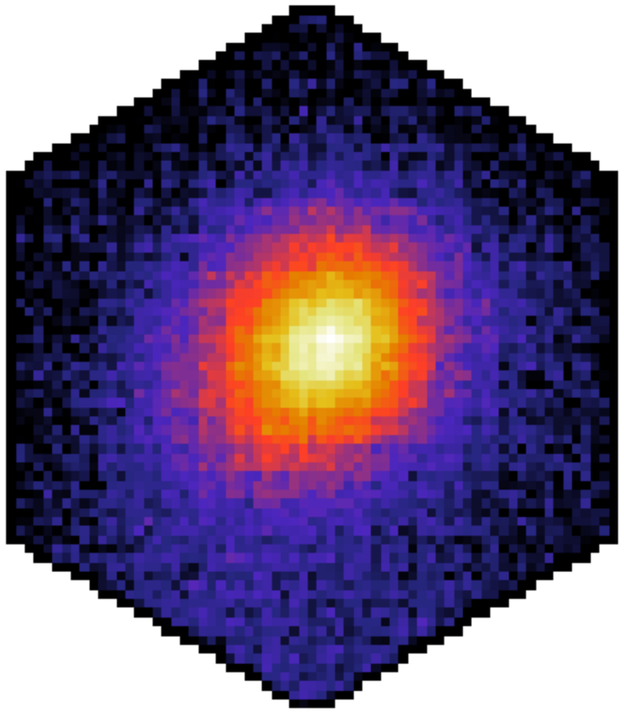
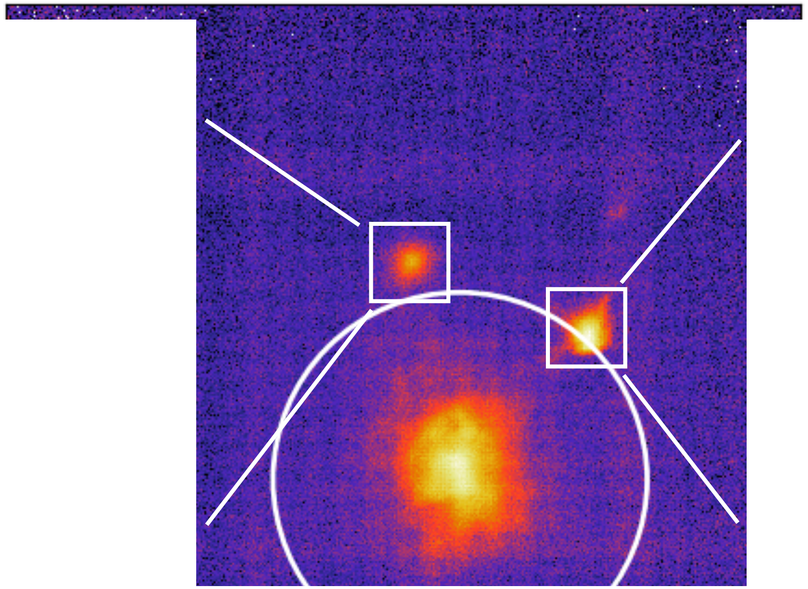
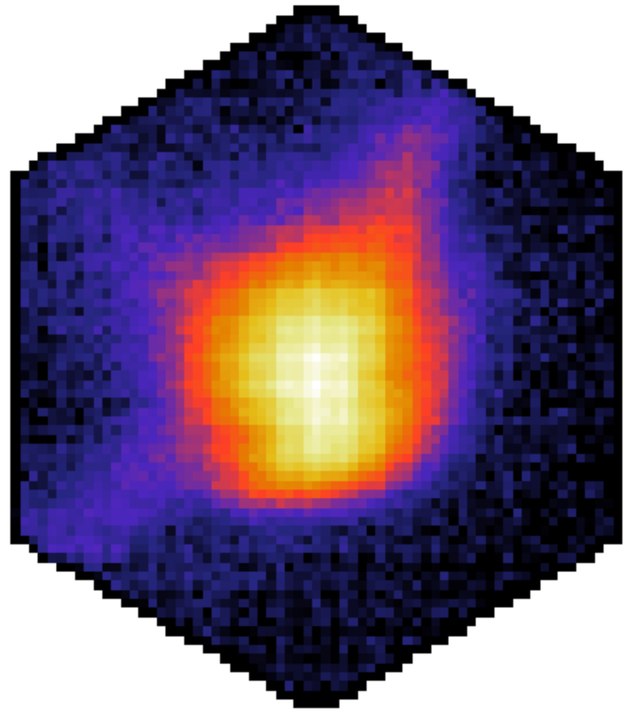




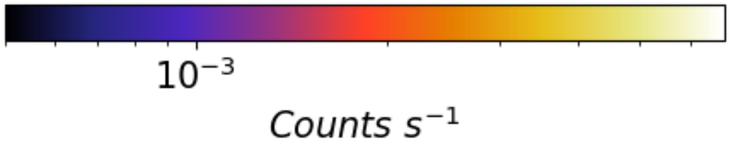
XIFU

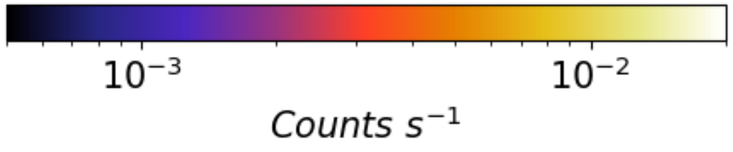


Texp: 100ks

Bkg: Phys + Inst

0.1-2.0 keV





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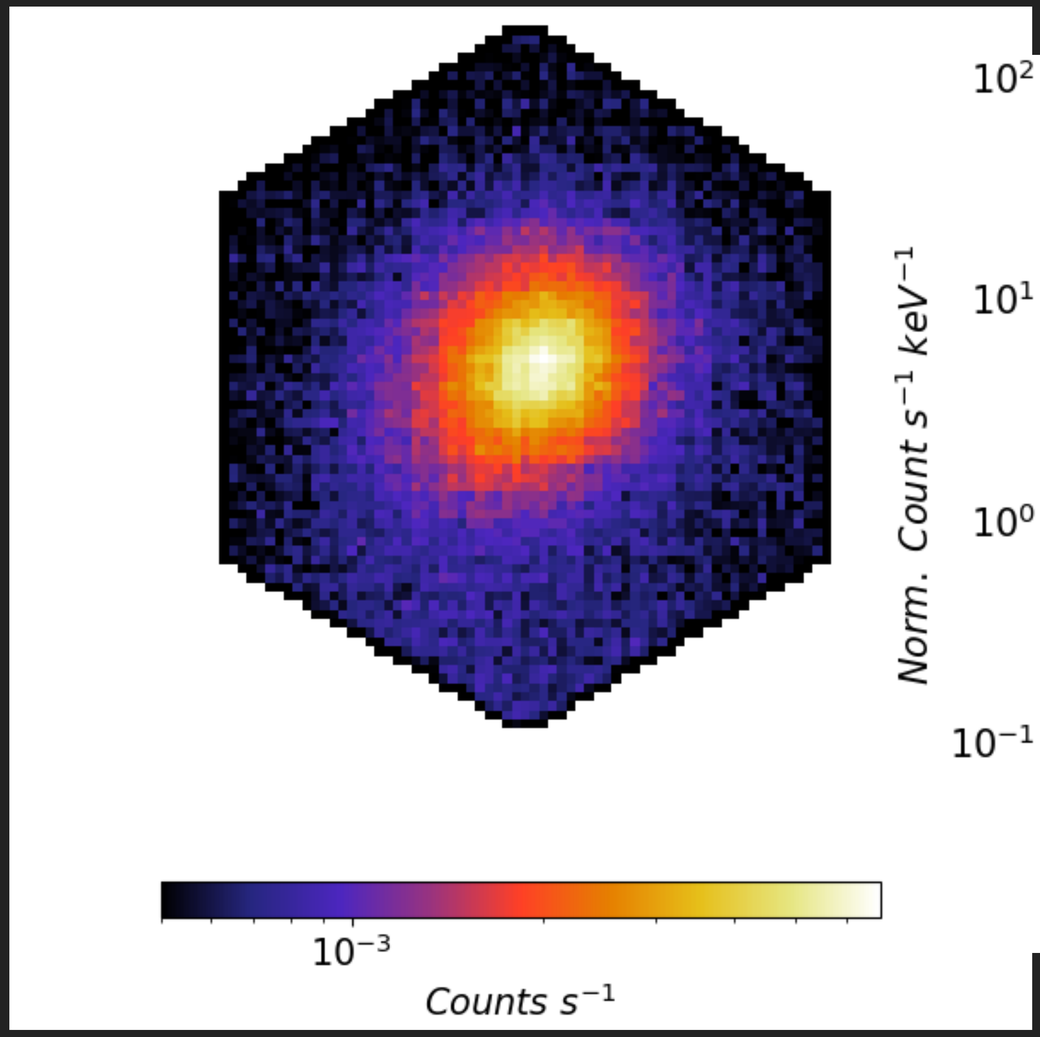

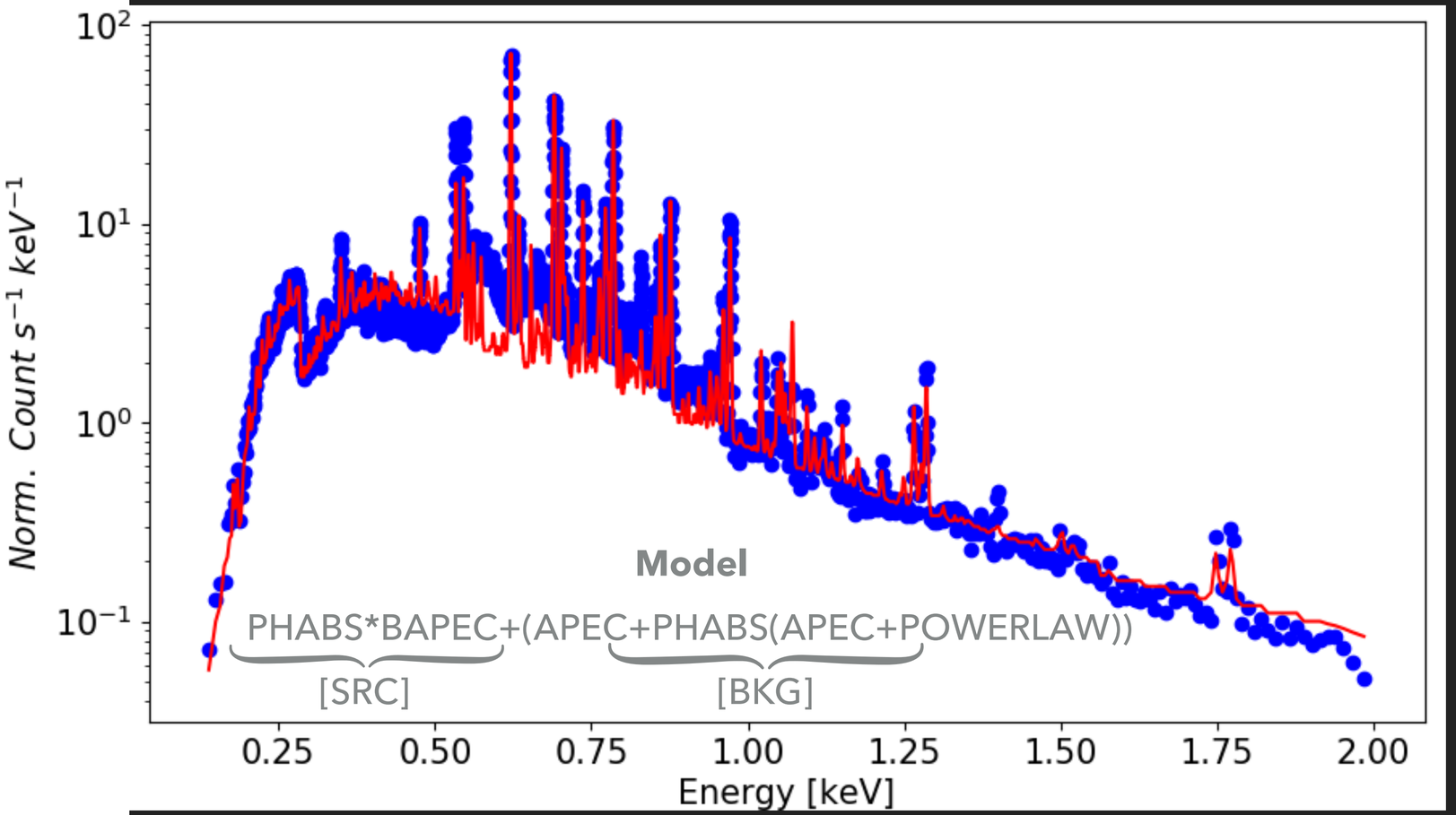

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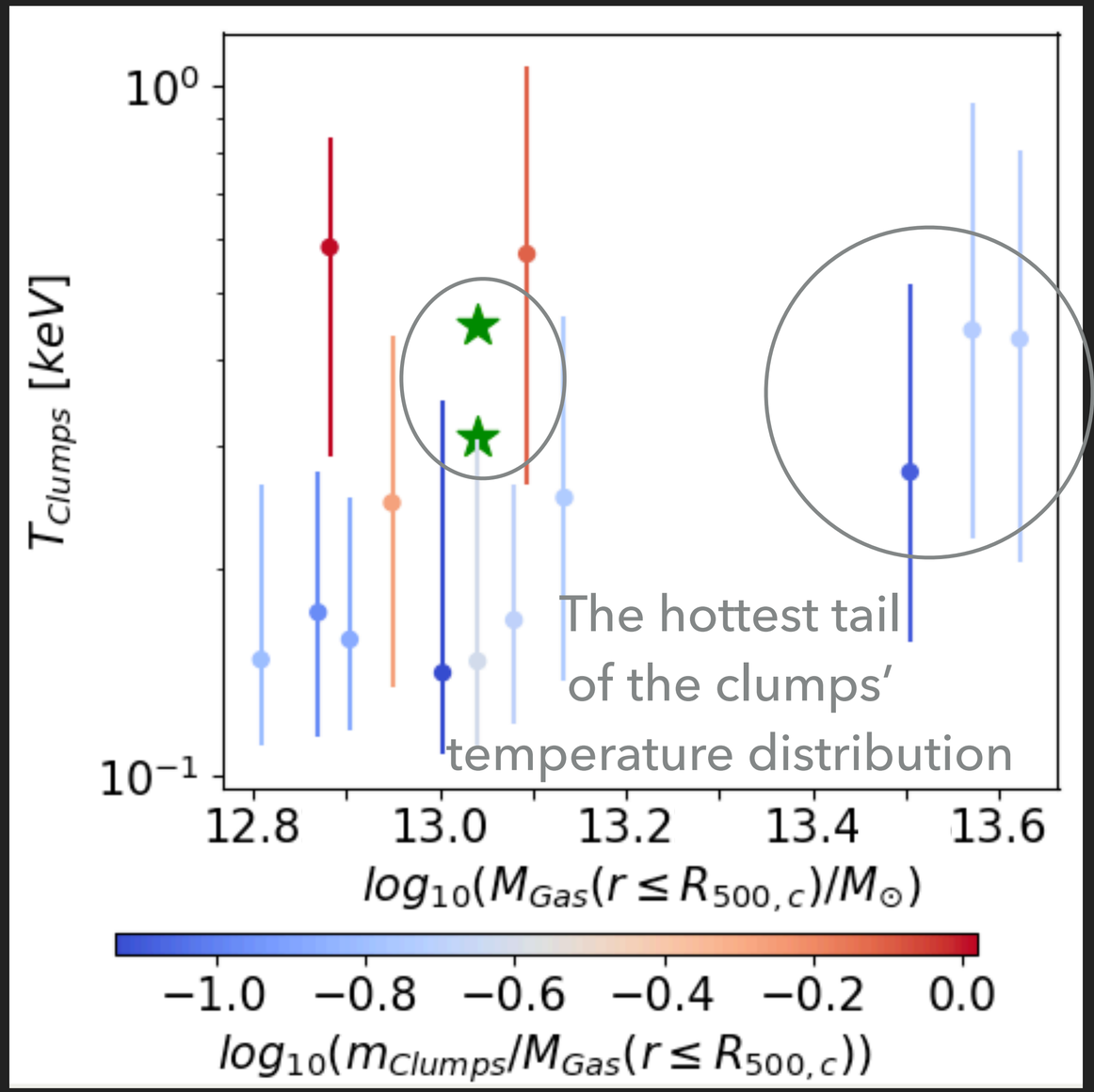
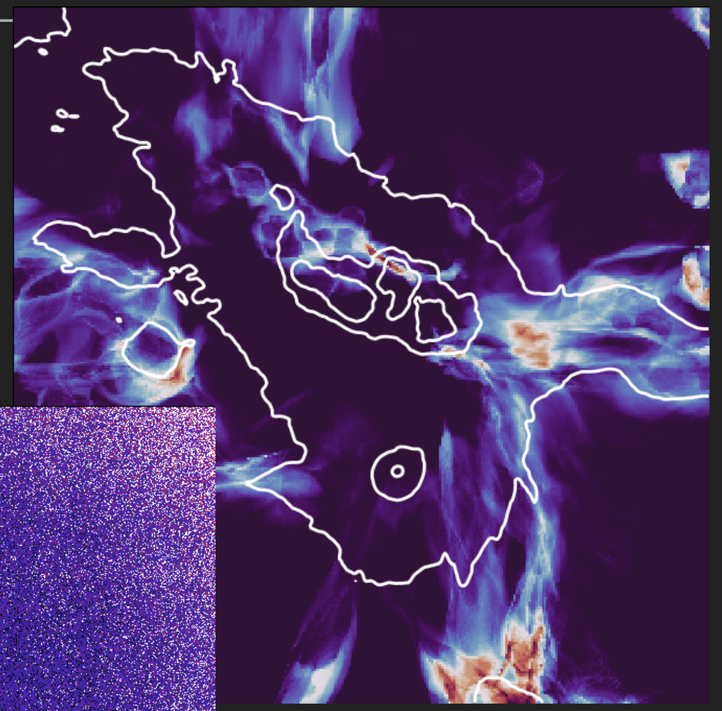
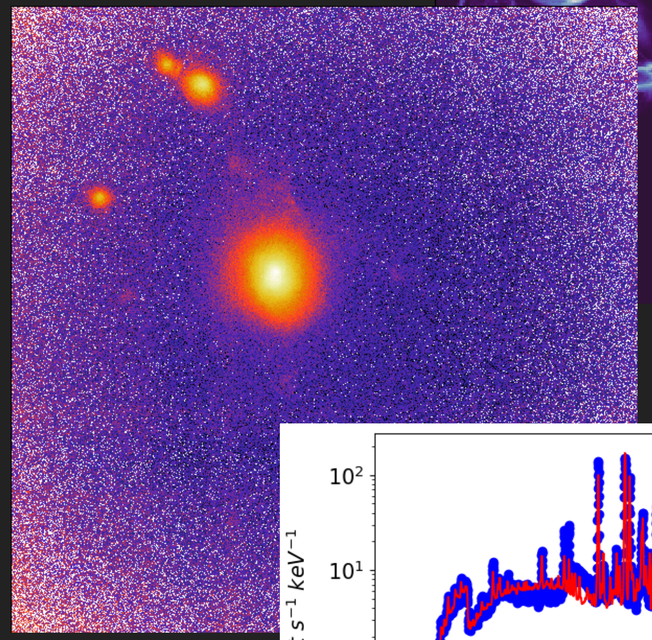


Higher is the cluster's mass, higher is the clumps' temperature, easier is the clumps' detection

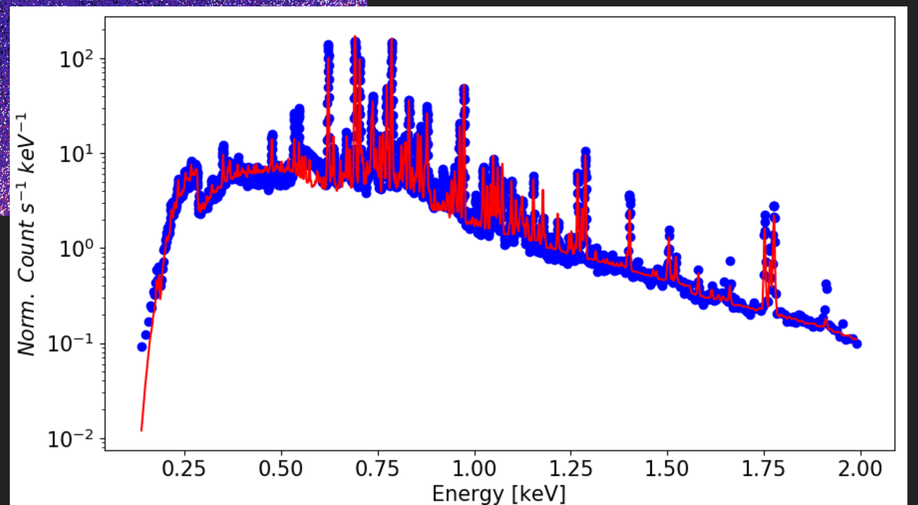
RESULTS

- We identify Clumps and Filaments in simulations and we study the correlations between them.





- Clumps are easier to be detected in soft X-ray images; Clumps can be used as tracers of the mass/emission associated to (mostly unresolved) Filaments



- The combination of WFI and XIFU will provide a new view on the accretion phenomena

RESULTS

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- Clum soft X used as tracers ission associated to (mostly resolved) Filaments
- The combination of WFI and X vide a new view on the accretion p

Properties of clumps and filaments around galaxy clusters

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2 INAF, Osservatorio di Astrofisica e Scienza dello Spazio, via Pietro Gobetti 93/3, 40129 Bologna, Italy
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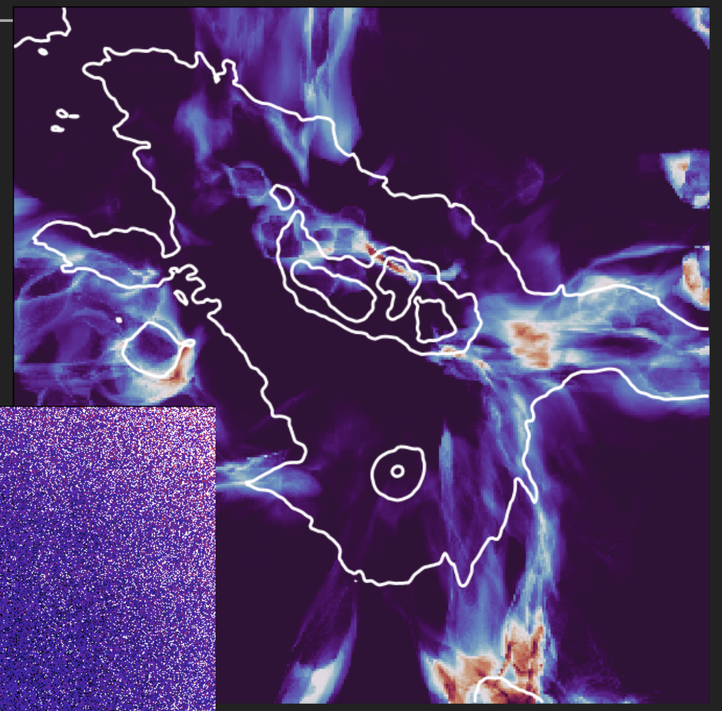

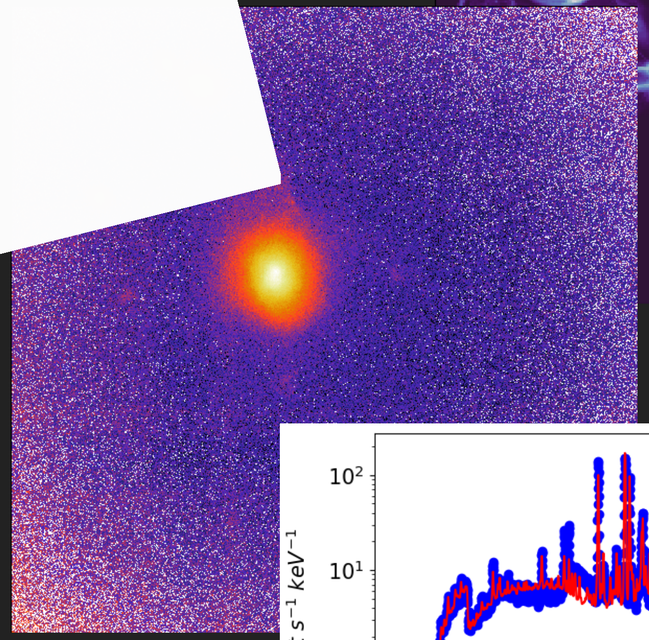

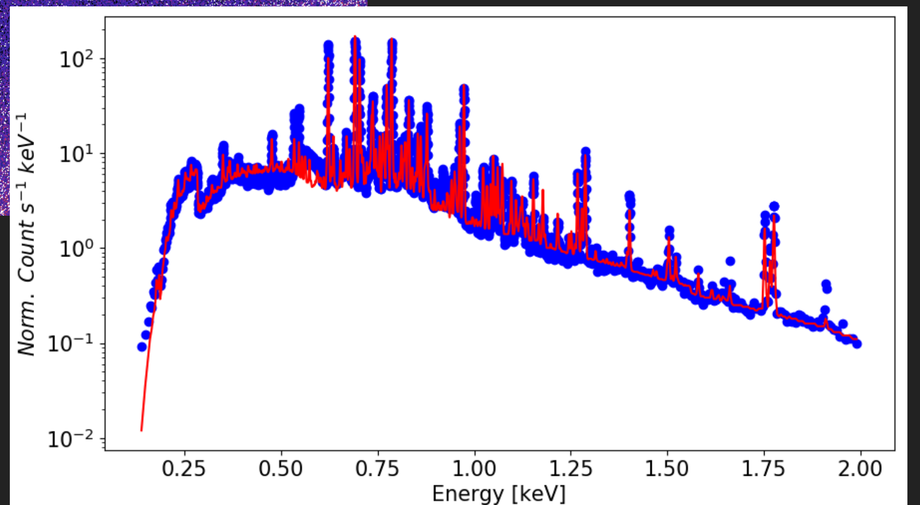

THANKS FOR YOUR TIME