Intense AGN activity in the merging cluster Cygnus A

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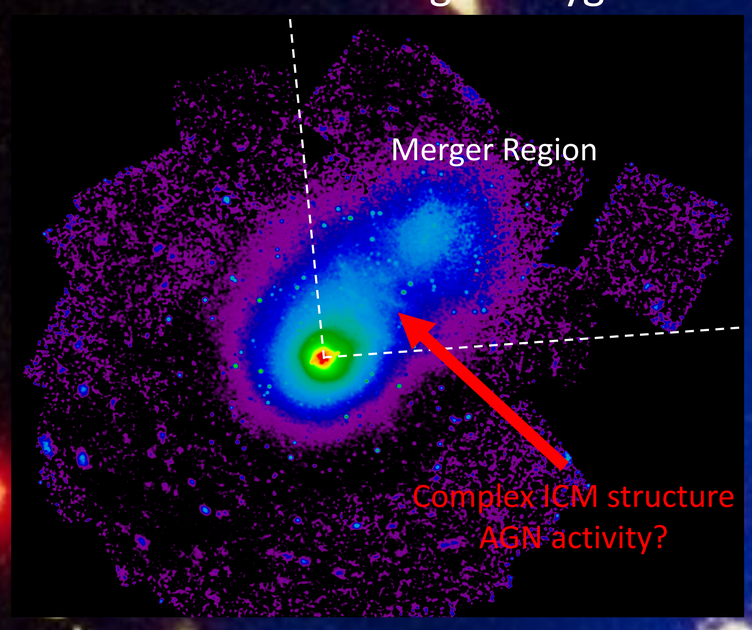
We analyze 2 Ms Chandra observation of the merging cluster Cygnus A. Due to its proximity (z=0.056), we can follow AGN feedback from kpc to Mpc scale. In our data, we see possible evidence of such process in the form of enhanced emission from complex ICM structures.

We also simulate the same observation using PyxSIM[1,2] and MARX[3] to create a smooth ICM emission. This simulation has been created using azimuthally averaged density and temperature profile from the data excluding the merger region.

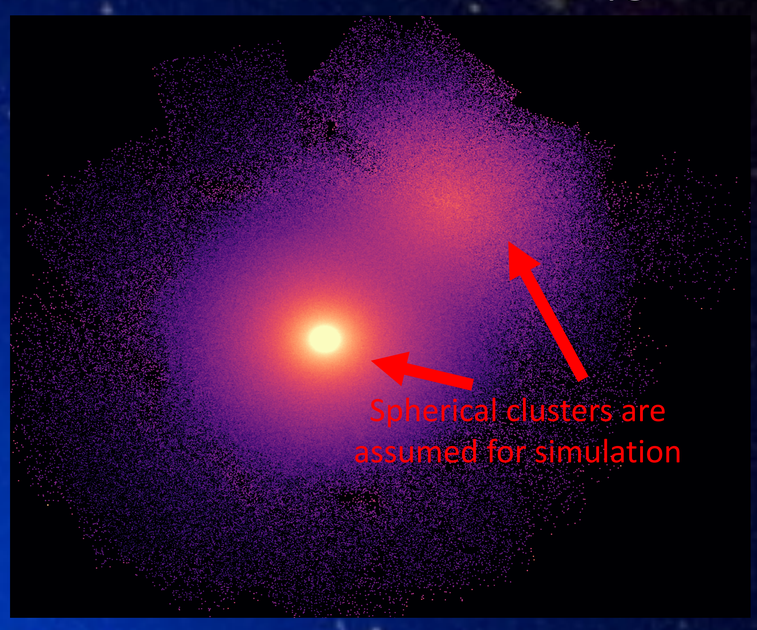
2 Ms Chandra image of Cyg A



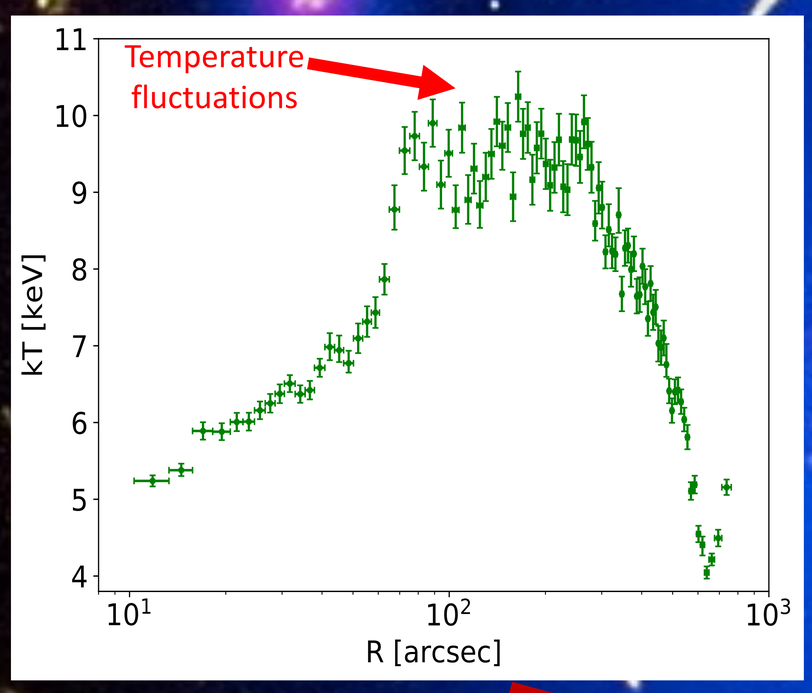
KEY IDEA

We want to estimate the amount of energy being dumped into the ICM by the cluster merger and possibly by the AGN activity. The data contains emission due to the relaxed ICM + enhancement due to the above processes. The simulation, on the other hand, contains emission only from relaxed ICM. Subtracting these two will leave behind the enhanced emission by the processes we are interested in.

2 Ms MARX simulation of Cyg A



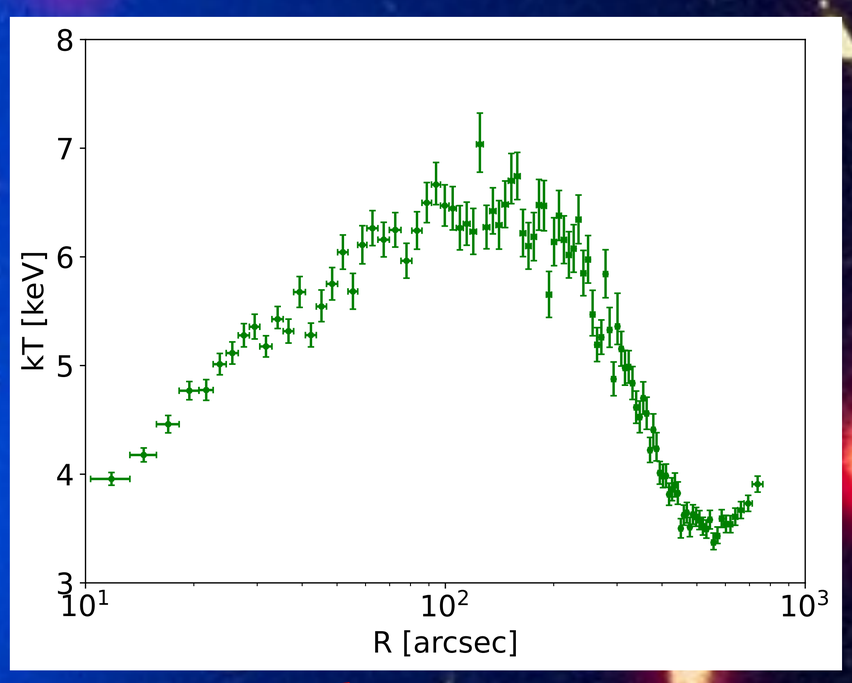
Temperature profile along merger region



Temperature profile along the merger region shows temperature bumps that are associated with the complex ICM structure.

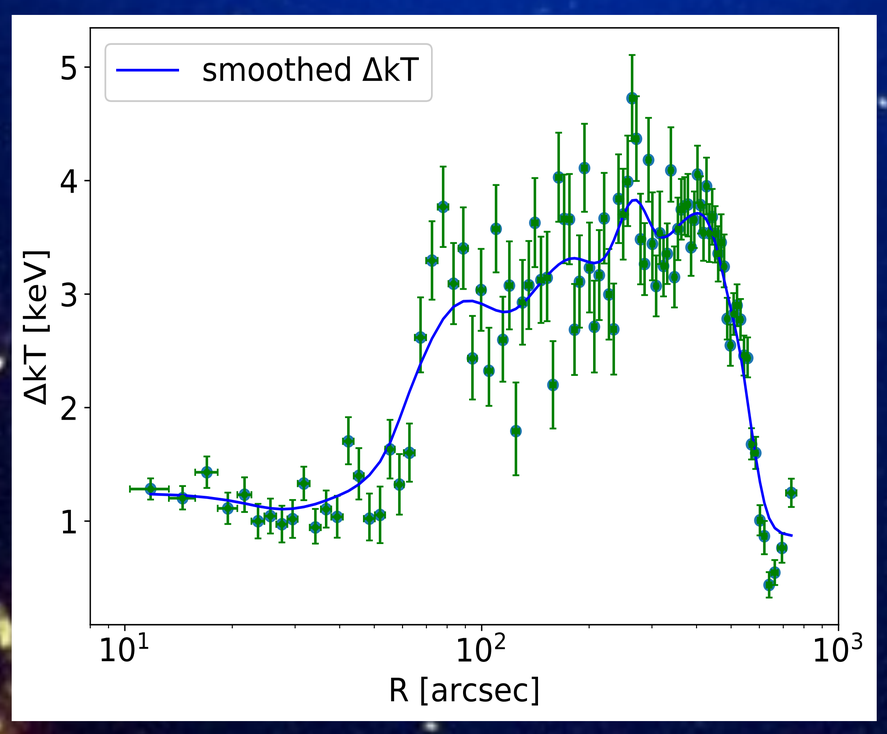
Simulation temperature map shows a smooth structure as expected from the model we put in.

Smooth temperature profile from simulation



SUBTRACT!

Temperature difference between model and simulation



The temperature difference between data and simulation reveals that there are several bumps of few keV in addition to a large-scale heating along the merger region.

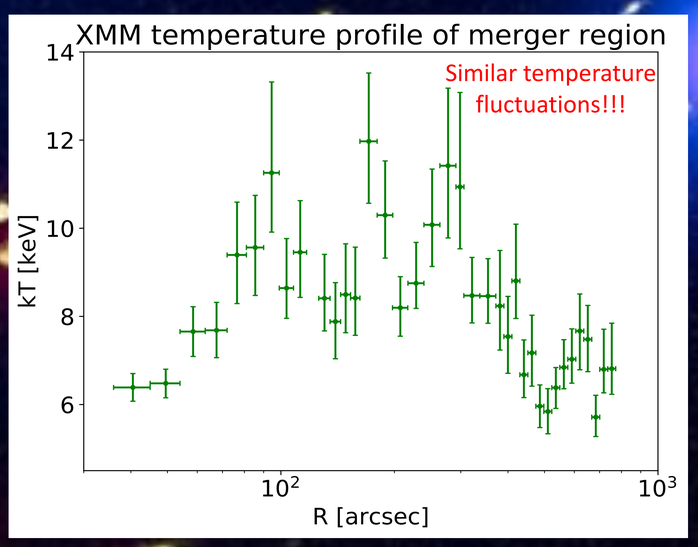
Each of these bumps could be produced by AGN outburts from Cyg A. The width of the bumps constrains the duration of the outbursts while their distance from CygA constrains how long ago the burst occurred.

CONCLUSION & FUTURE WORK

Although the exact origin of this structure is still under debate, AGN activity seems to be a simple explanation currently.

Assuming this complicated structure has been caused by AGN activity, we can estimate how much energy is being deposited in the ICM over time. This is presently under investigation.

We also plan to compare the temperature maps from XMM to see if we can constrain the energy release further. A preliminary result is shown below:



References

1. Biffi, V. et al. 2012, MNRAS, 420, 3545
2. Biffi, V. et al. 2013, MNRAS, 428, 1395
3. Davis et al. 2012, SPIE 8443, 84431A

Background Reading

1. Arnaud, K.A. et al. 1984, MNRAS, 211, 981
2. Reynolds, C.S. & Fabian, A.C. 1996, MNRAS, 278,479
3. Smith, D. et al. 2002, ApJ, 565, 195
4. Halbesma, T.L.R. et al. 2019, MNRAS, 483, 3851H