

# Intense AGN activity in the merging cluster Cygnus A

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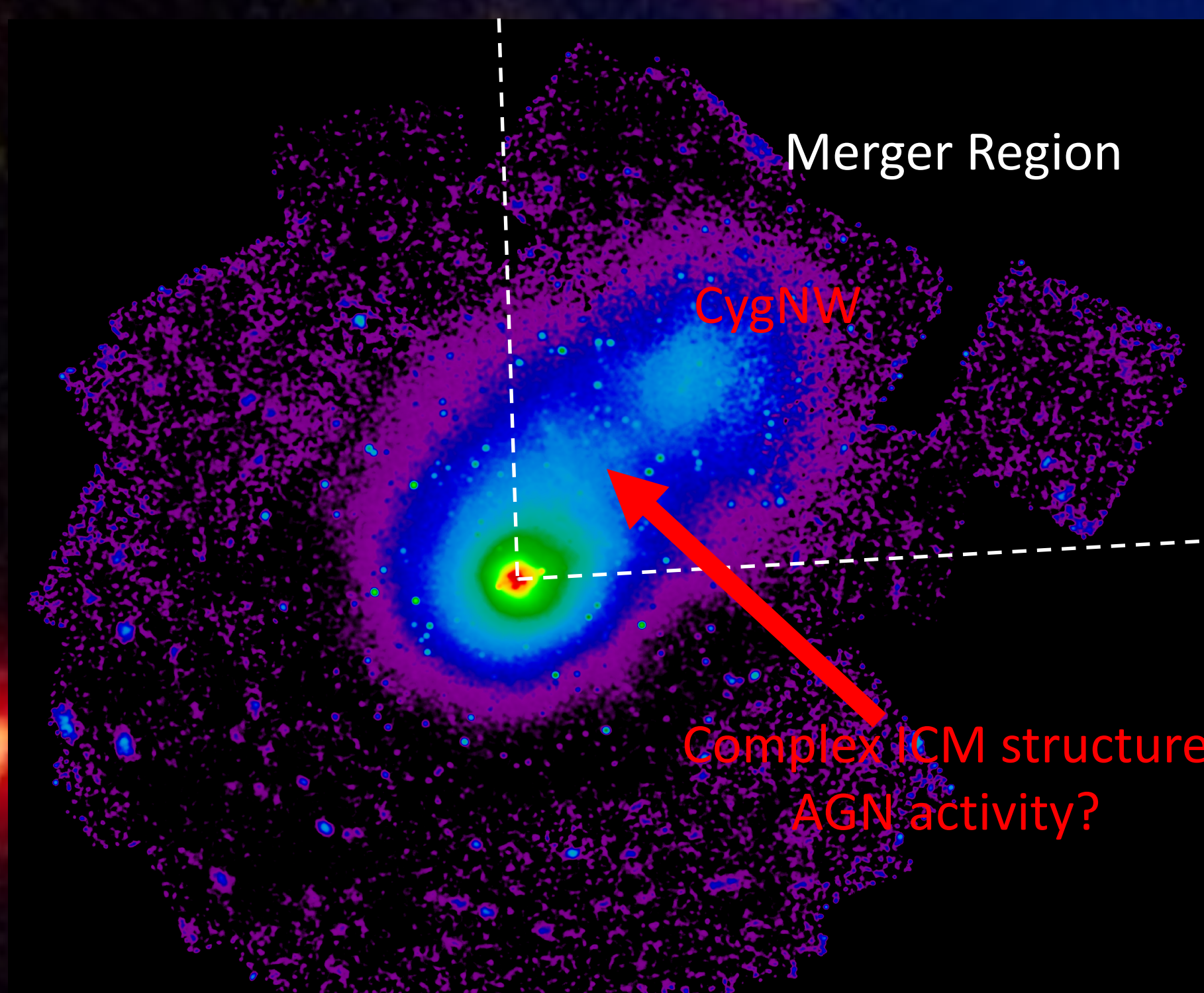
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Deep X-ray observations of the merging cluster Cygnus A reveal complex, filamentary structures in the region between the two merging subclusters – possibly due to ongoing merger in the system, long-term activity by the powerful AGN in Cygnus A, or a combination of both.

In order to isolate the observed structures in the merger region from the underlying cluster, we have constructed a model for the smooth, undisturbed ICM in the system. The simulation was based on azimuthally averaged density and temperature profiles of the two undisturbed sub-clusters as measured outside the merger region.

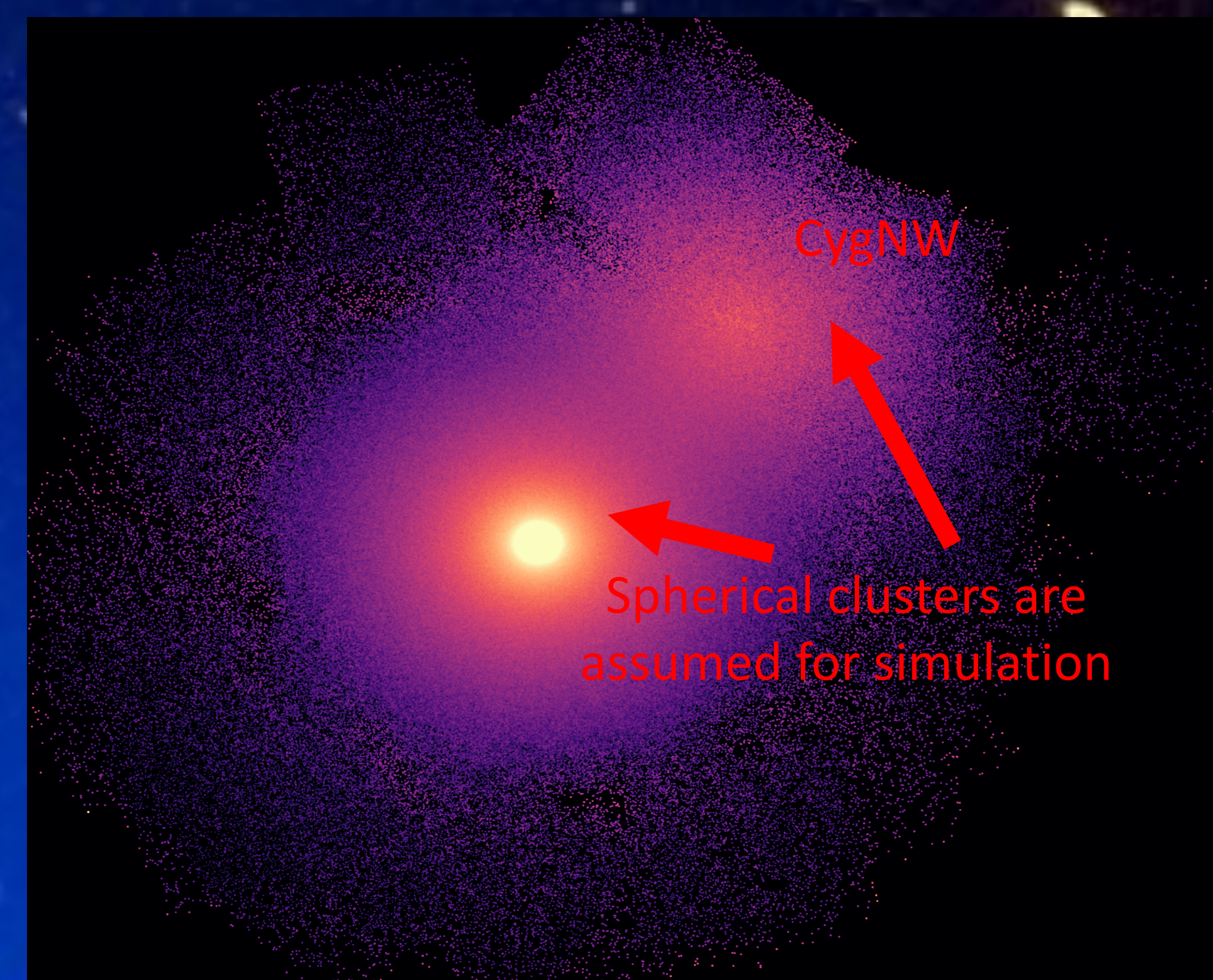
2 Ms Chandra image of Cyg A



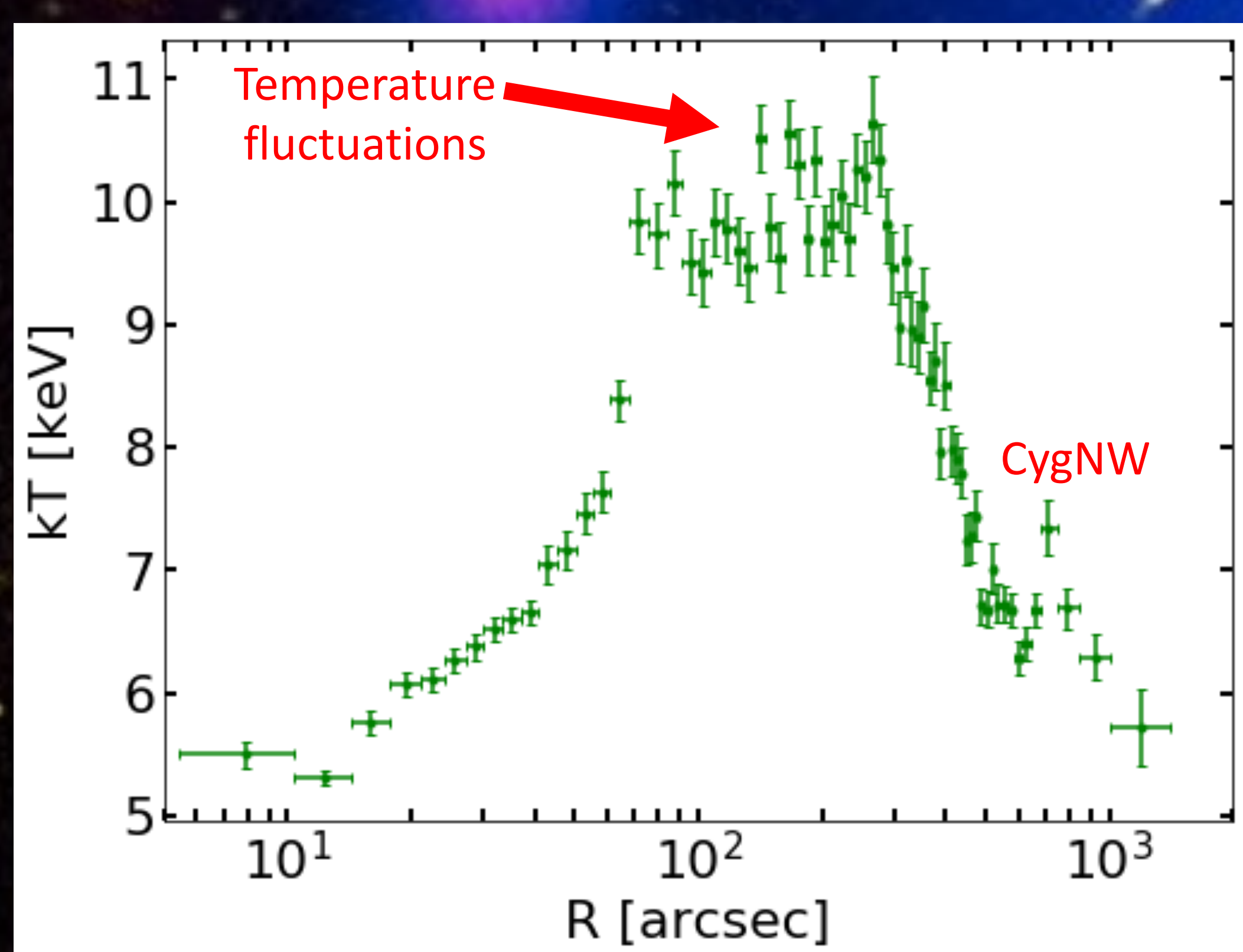
## KEY IDEAS

- We want to estimate the amount of energy deposited into the ICM over time by the cluster merger and possibly due to AGN activity.
- The ICM temperature along the merger region is enhanced by the above processes.
- The temperature from simulation, on the other hand, contain information only about the relaxed subclusters.
- Subtracting these two will leave behind the excess temperature by the processes we are interested in.

2 Ms PyxSIM<sup>1,2</sup> and MARX<sup>3</sup> simulation of Cyg A



Measured temperature profile along merger region

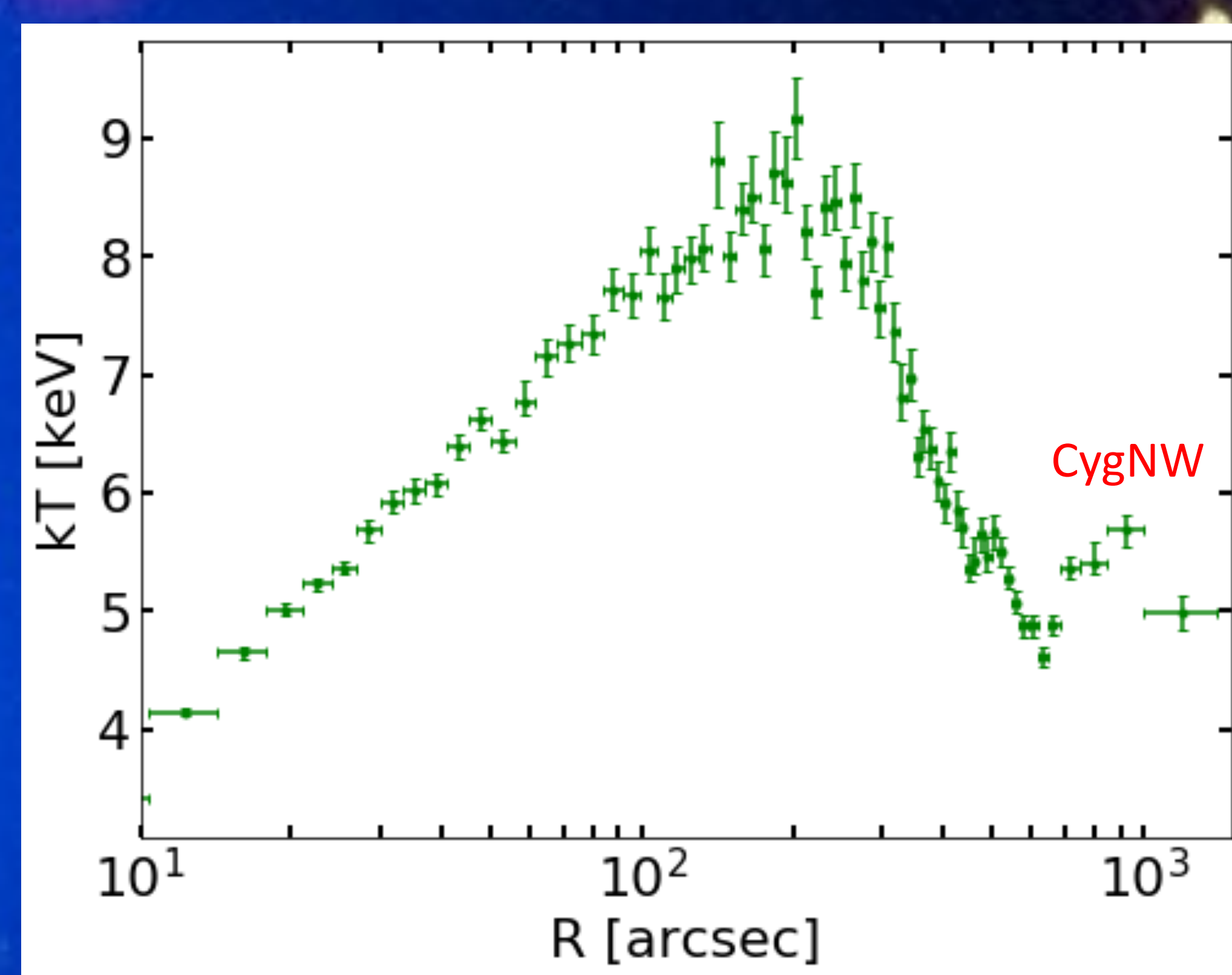


Temperature profiles are obtained by extracting spectrum in annular regions across the merger region and fitting it with a single temperature APEC model.

Clear temperature fluctuations are present that can be attributed to the complex ICM structures.

The temperature profile measured from the simulation shows a smooth structure as expected based on the input model.

Measured temperature profile from simulation

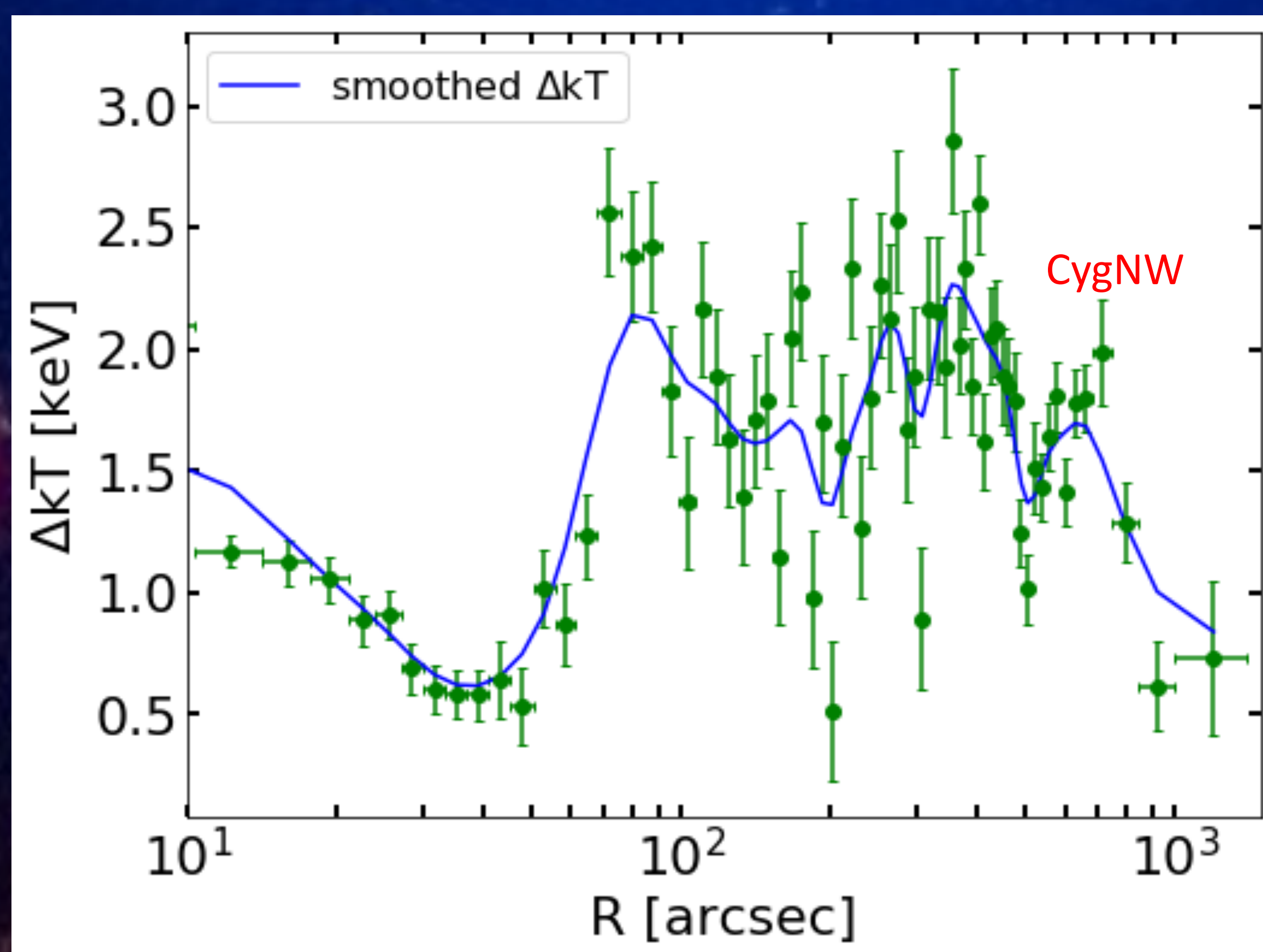


We interpret the large-scale temperature offset over the whole region as due to effects of merger shock. The fluctuations superimposed on top of this overall temperature enhancement are difficult to reconcile with a merger and we argue that AGN activity is the more likely origin for these features.

Assuming an AGN activity origin, the magnitude, width, and location of these fluctuations contain information about the strength, duration, and age of past AGN outbursts.

## SUBTRACT!

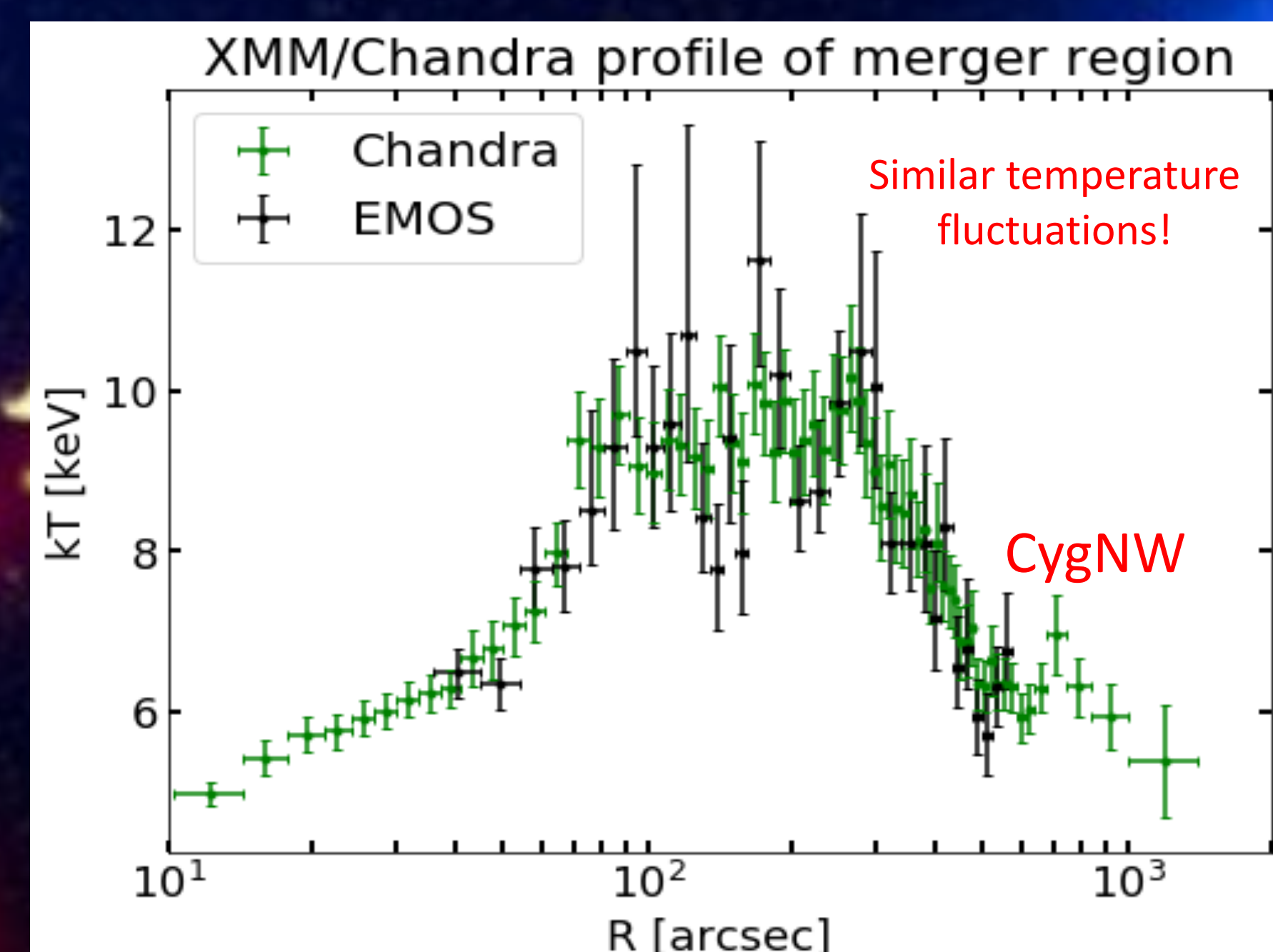
Temperature difference between data and simulation



## CONCLUSION

- The location of the fluctuations imply that Cygnus A has been active for the past 400 Myr.
- The strength of the fluctuations suggest an injection of  $10^{60}$  ergs over this timescale.
- This value is almost 30% of the energy deposited by the merger shock.

We also compare the temperature profile from XMM to see if the results are consistent with Chandra. We find that XMM and Chandra results are highly consistent after taking care of systematic effects:



## References

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## Background Reading

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- Reynolds, C.S. & Fabian, A.C. 1996, MNRAS, 278, 479
- Smith, D. et al. 2002, ApJ, 565, 195
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