Paolo Tozzi – INAF Osservatorio Astronomico di Trieste

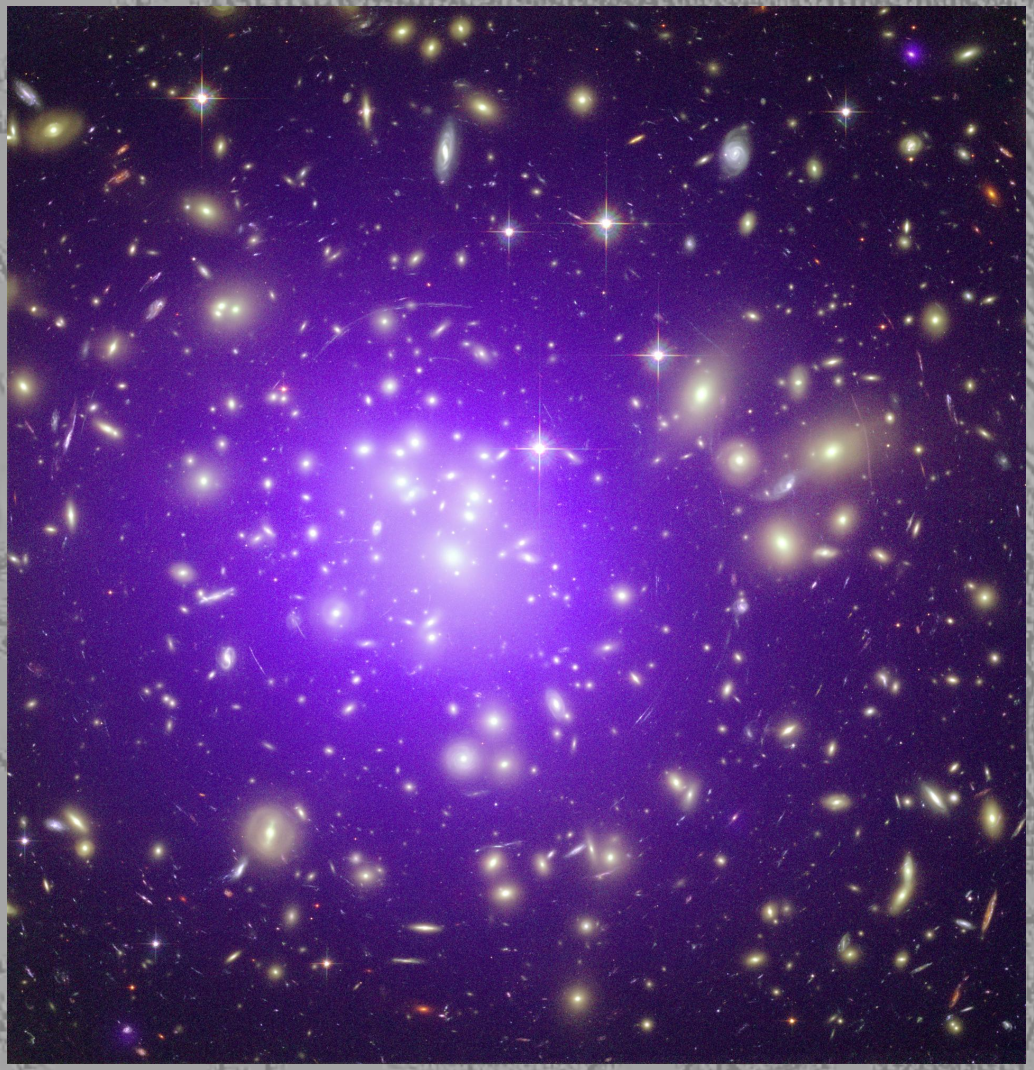
The radio feedback in cool core clusters at high-z

with

G. Giovannini, J. Santos, P. Rosati, +

X-ray extended emission from the hot plasma (15% of the total mass) in thermodynamical (collisional) equilibrium in the cluster potential well – optically thin, metal rich -> useful diagnostics

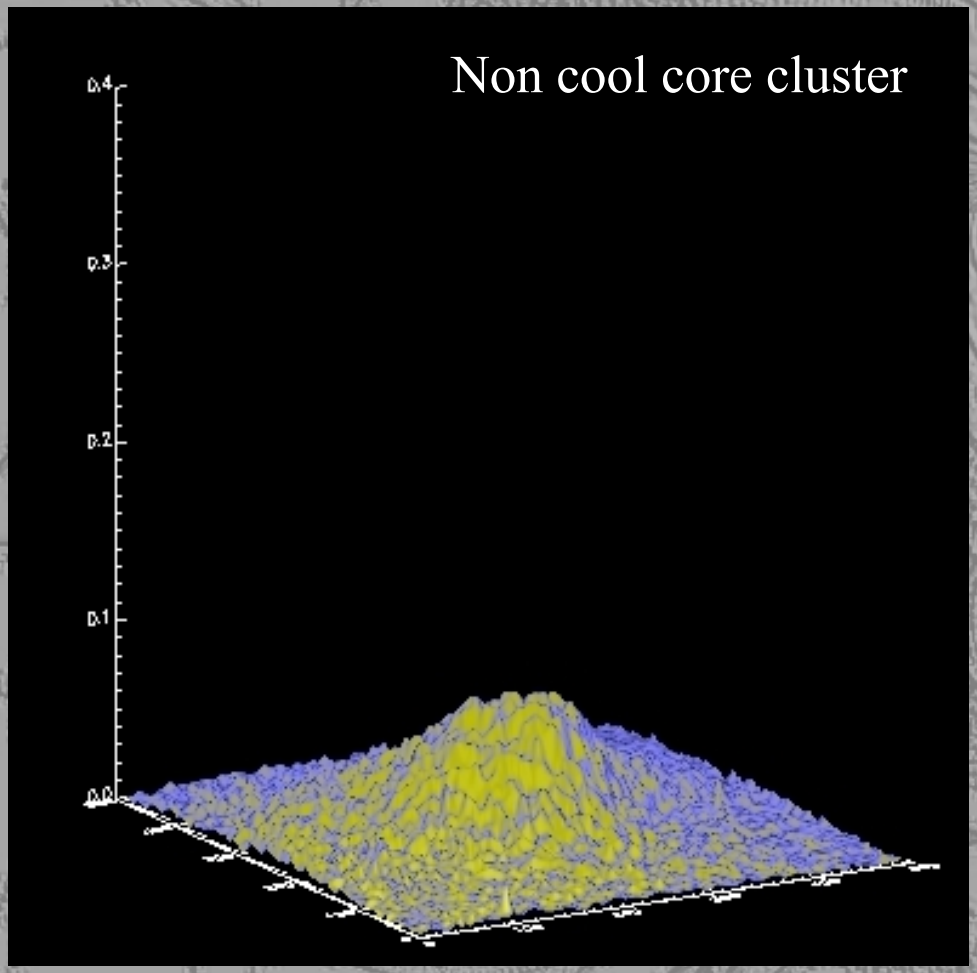
Abell 1689 HST+Chandra

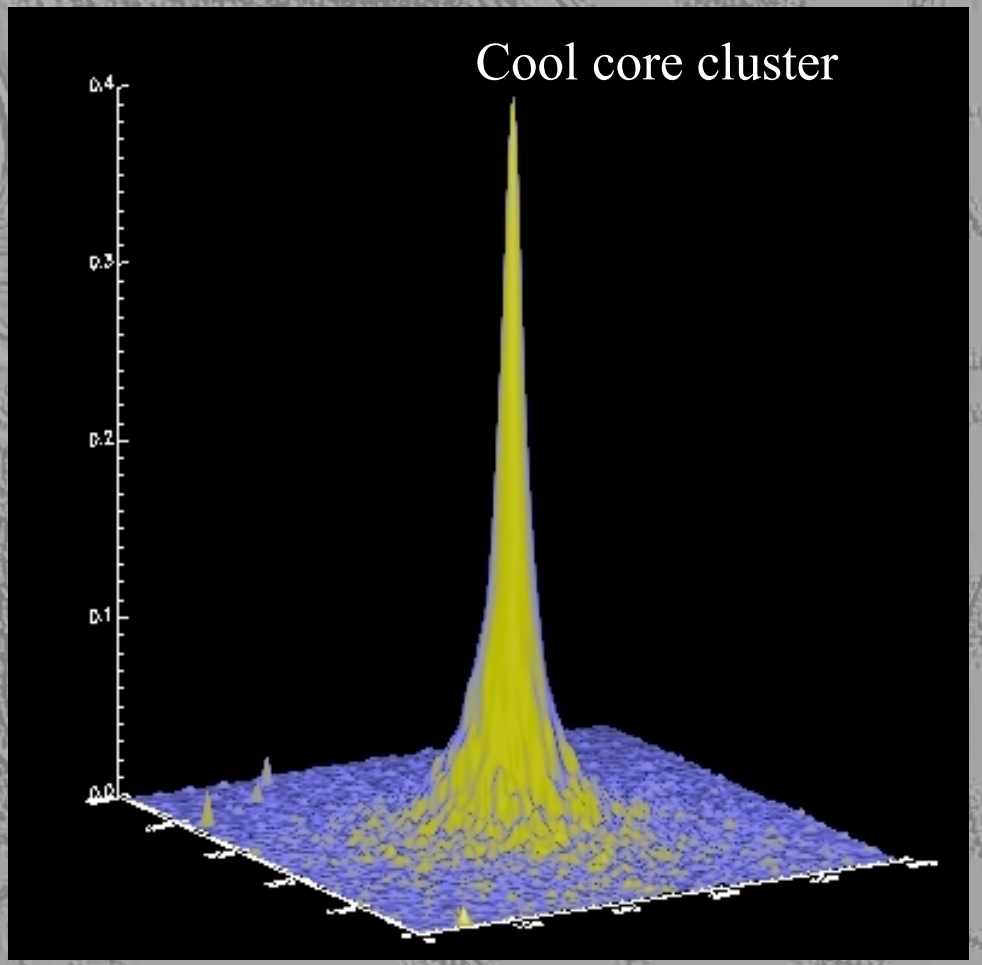


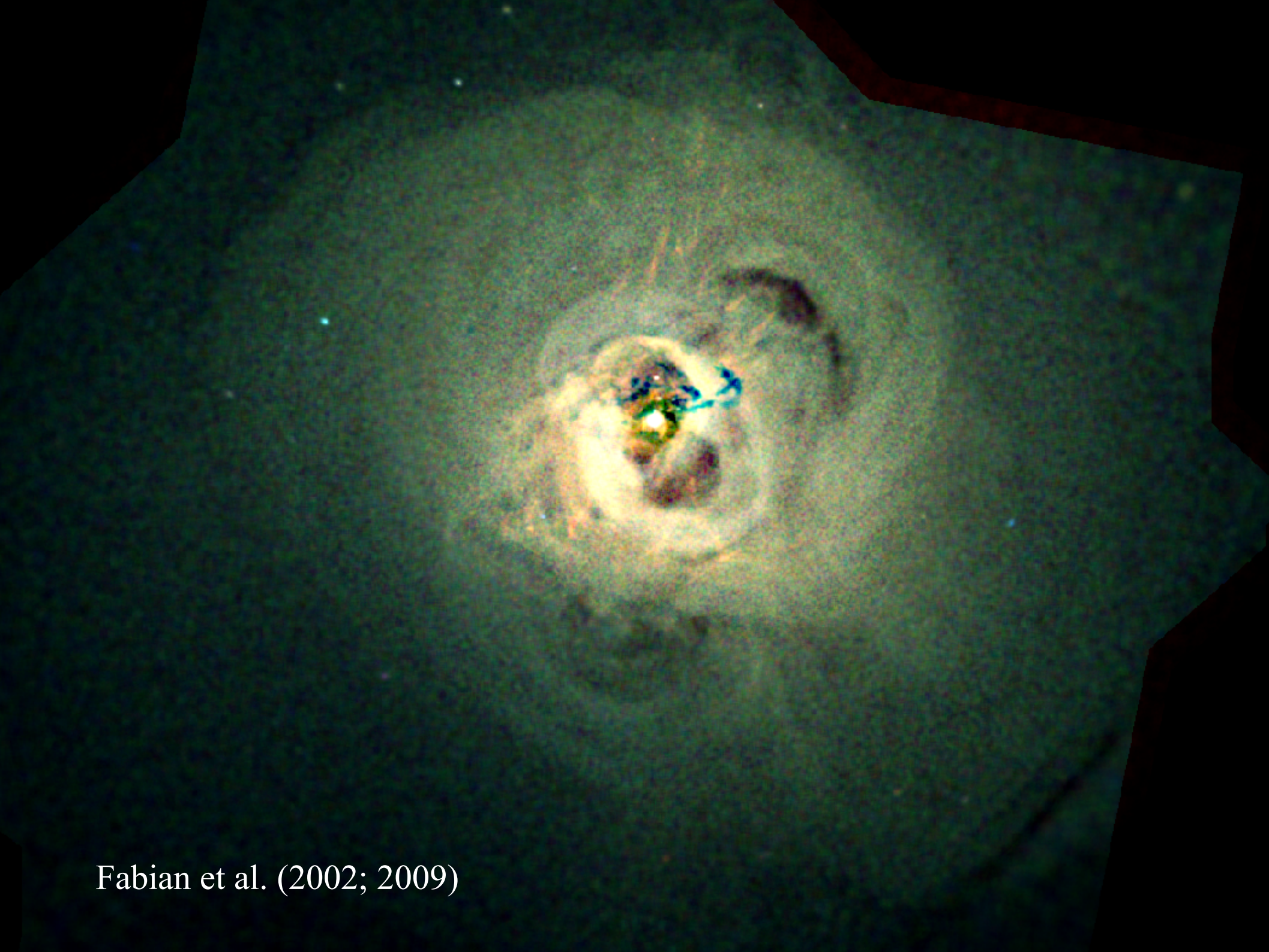
Noticeable differences in the surface brightness distribution

$$t_{cool} \equiv \frac{E}{\dot{E}} \equiv \frac{\frac{5}{2}kT}{n^2 \Lambda} \sim t_H T_8 \left(\frac{\Lambda}{10^{-23}}\right)^{-1} \left(\frac{n}{10^{-2}}\right)^{-1}$$

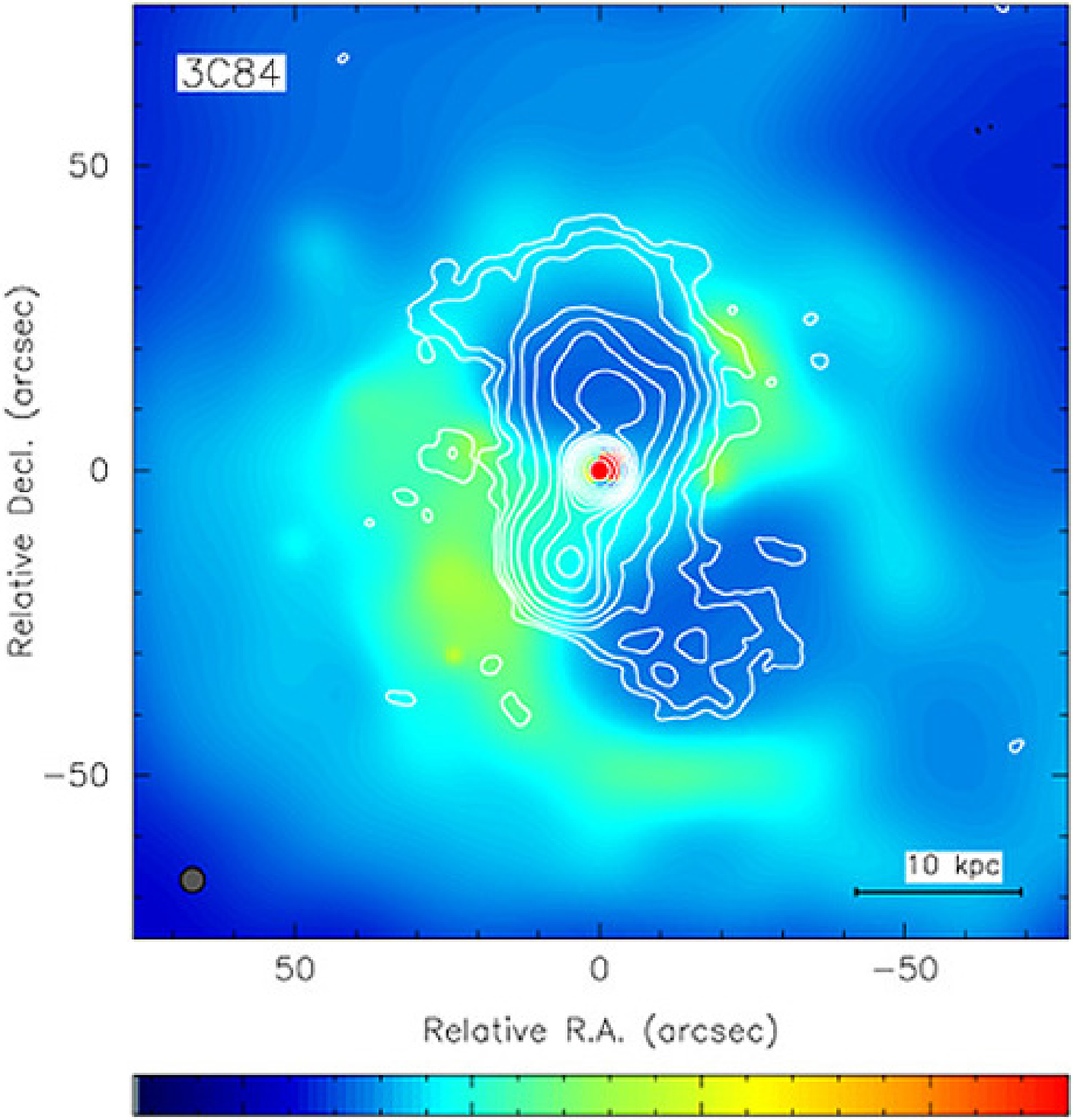
Cooling flows?







Fabian et al. (2002; 2009)



Perseus, Fabian et al. (2000)

Hydra A, Mc Namara et al. (2000)

Cool core riddle: still several missing pieces

How the energy emitted from the AGN subparsec scales couple so efficiently to gas distributed on tens of kiloparsec scales?

How the outburst energy is dissipated into the hot gas?

How much energy is transferred to thermal energy and how is distributed throughout the gas?

How the radio feedback evolve with redshift?

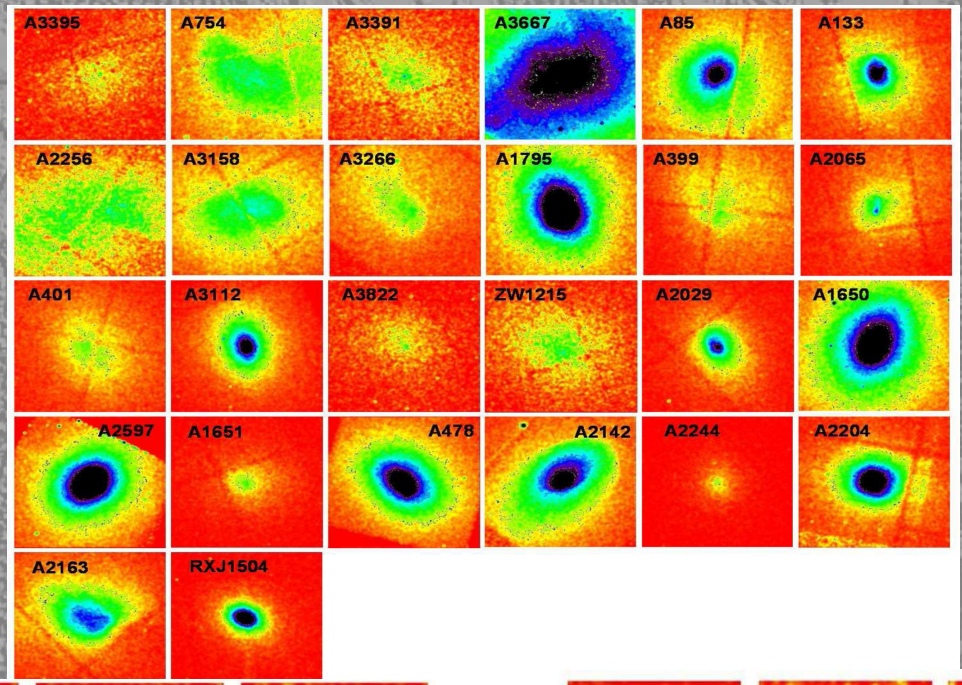
Ultimately, which role has the radio-feedback in the evolution of cosmic structures?

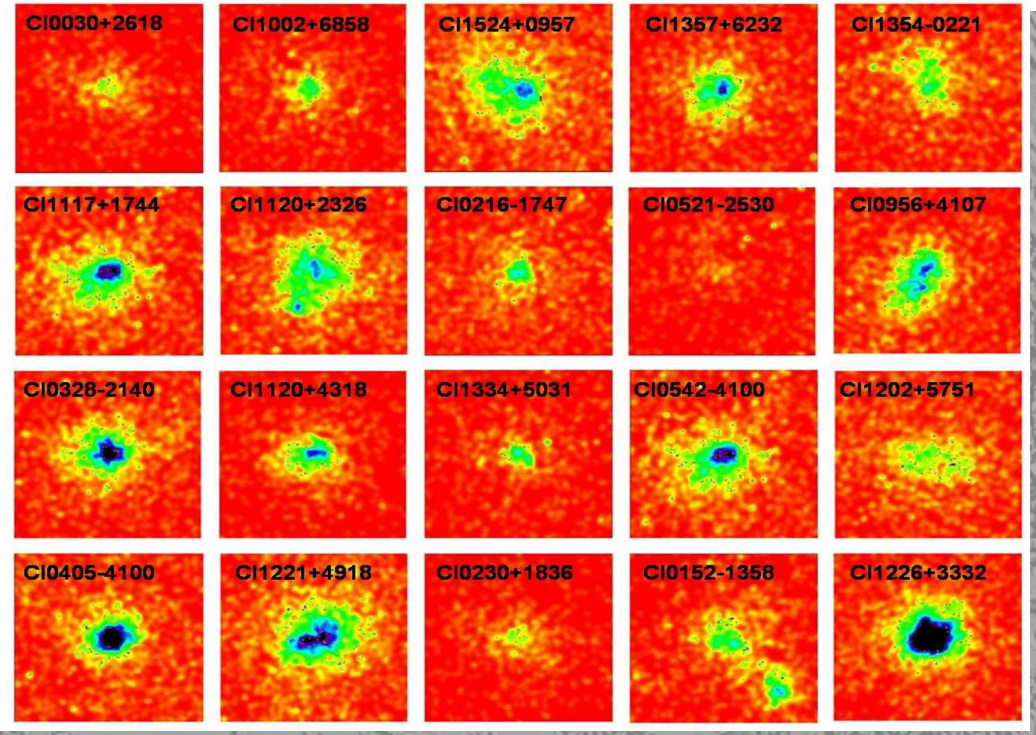
What is being done at present

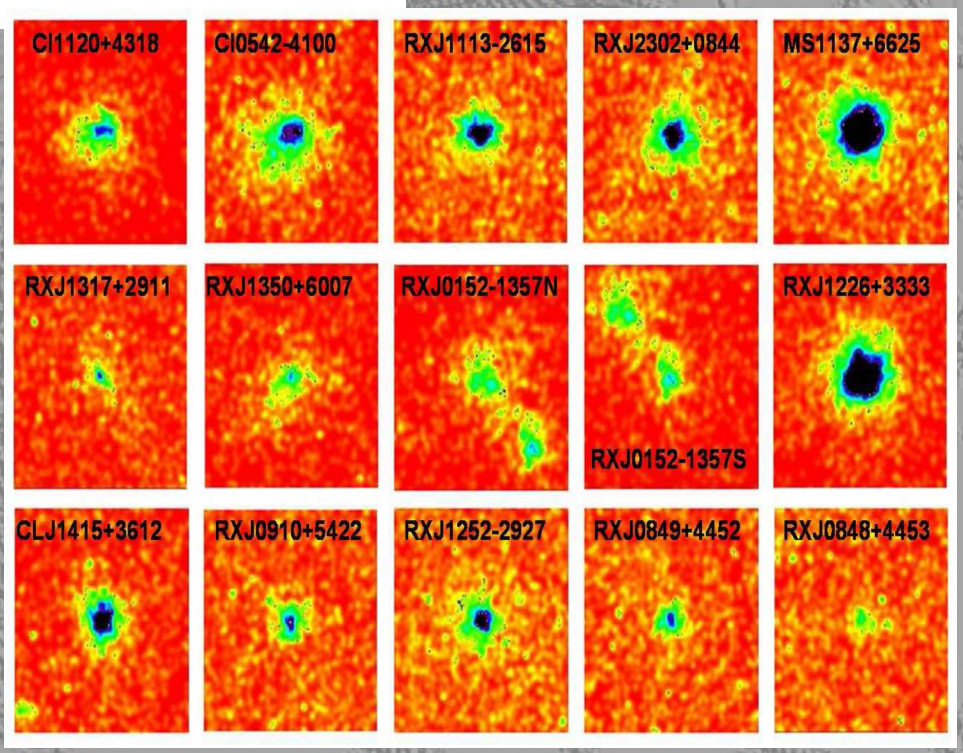
What can be done in the next few years

Could it be a case for SKA?

Evolution of cool cores with Chandra images of high-z clusters



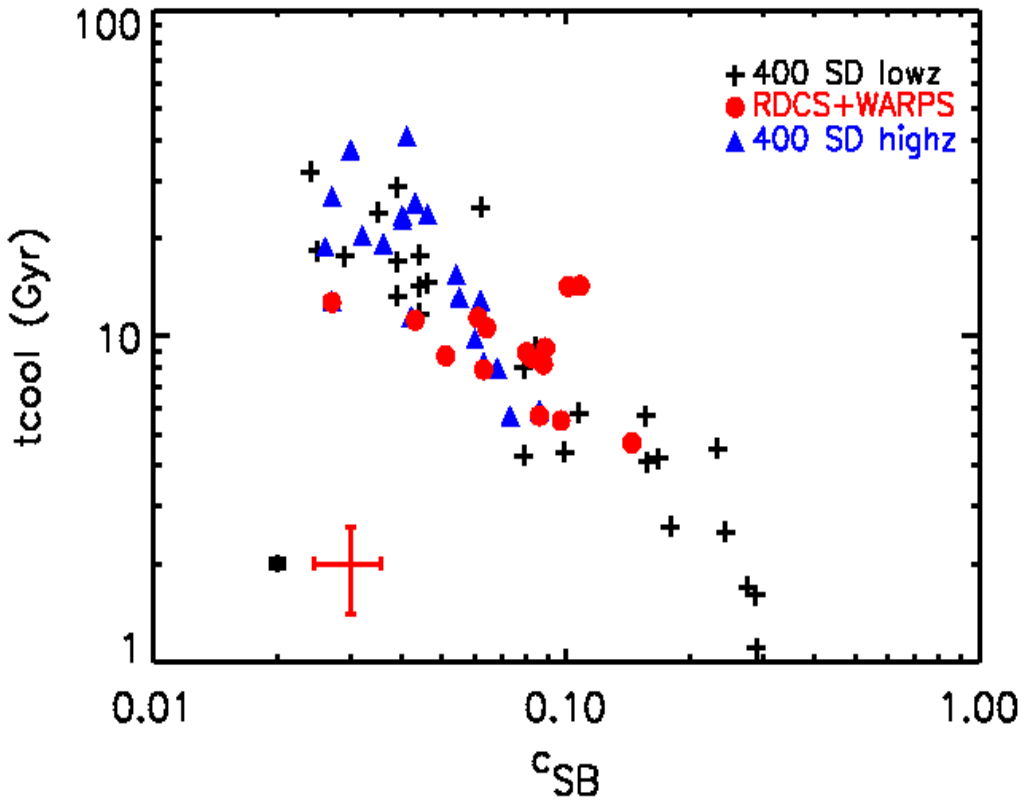


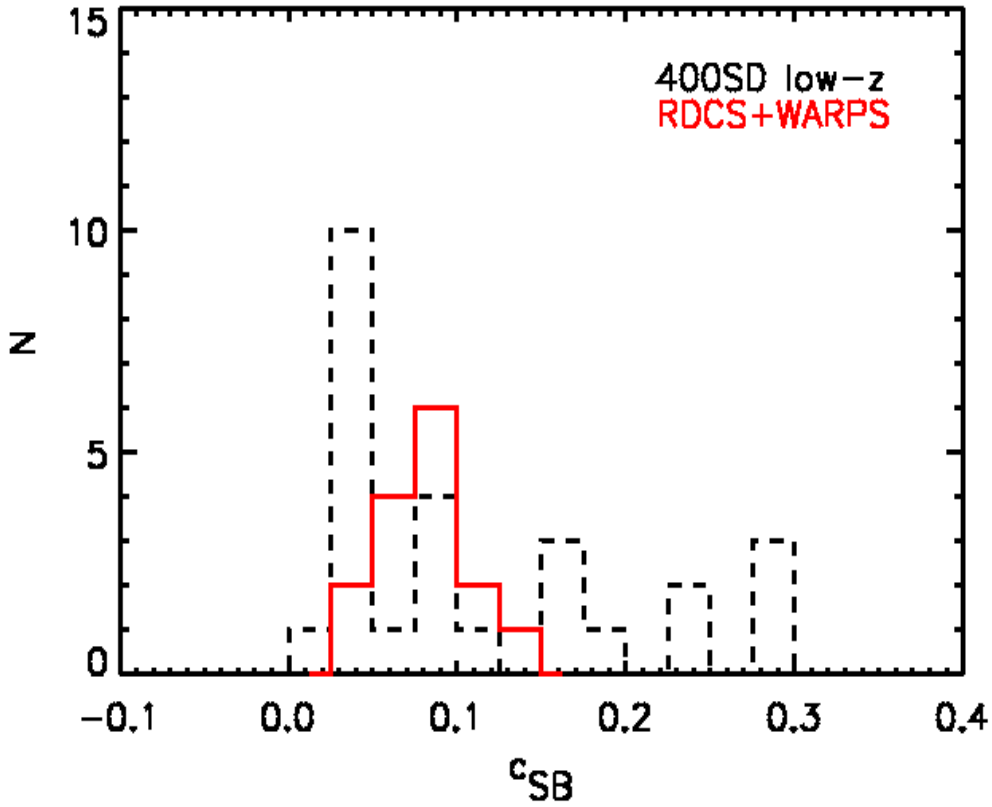


Santos et al. (2008; 2010)

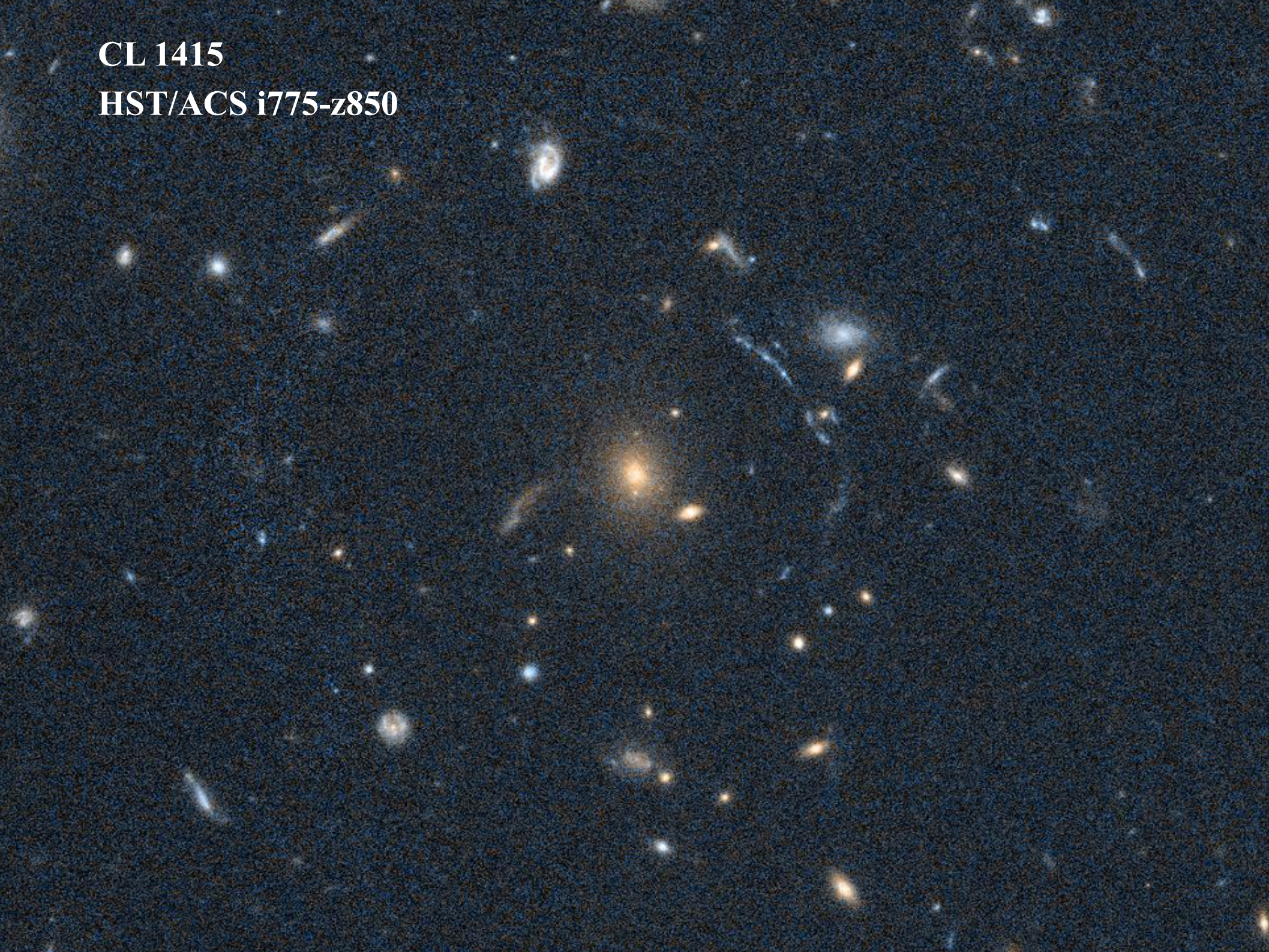
Surface brightness concentration

A simple concentration parameter is an excellent proxy for the cooling time and can be applied uniformly to a complete flux limited sample.
Well developed cool cores are present at high-z, not as prominent as in local clusters though



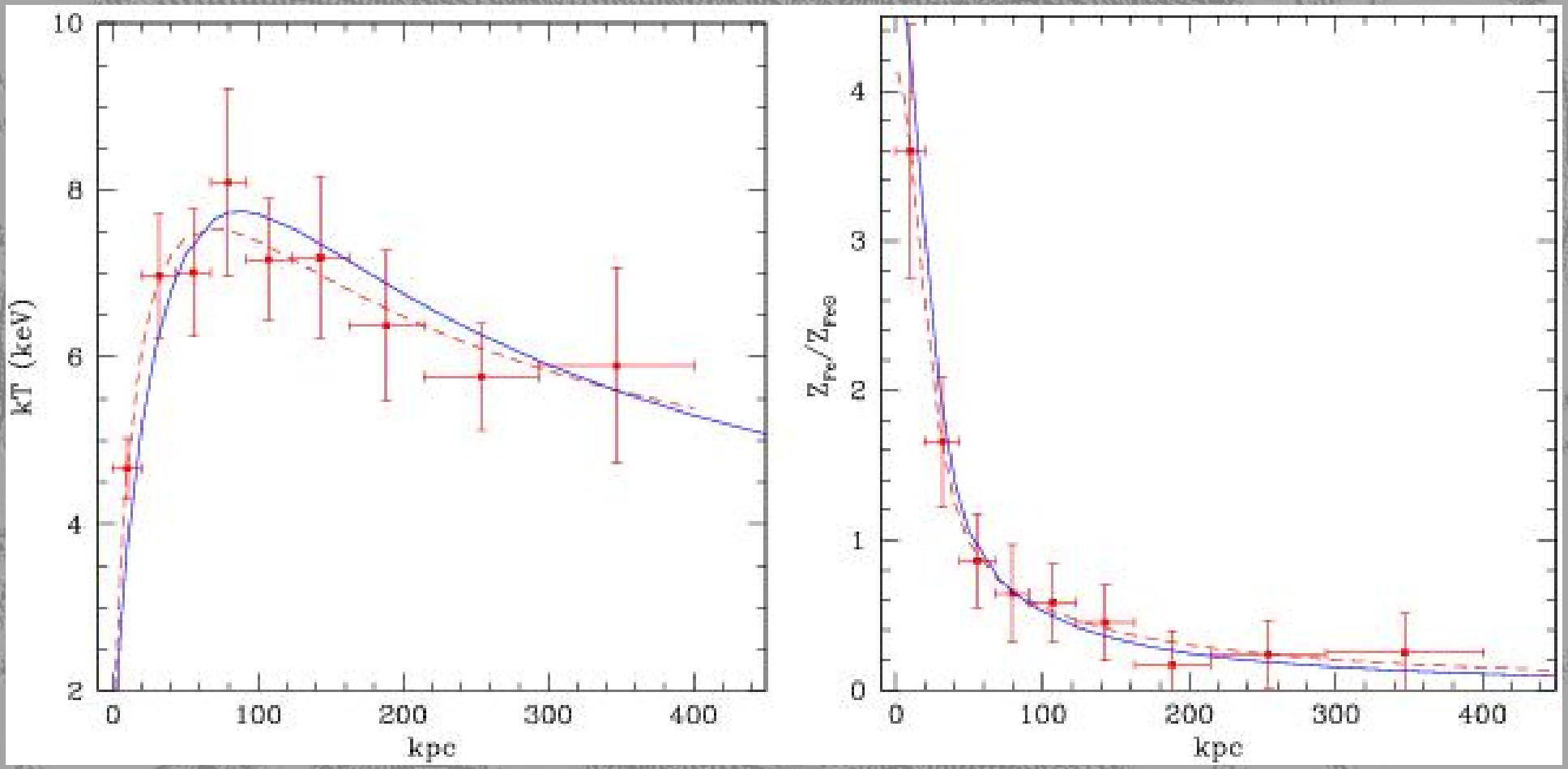


Santos et al. 2010


CL 1415
HST/ACS i775-z850

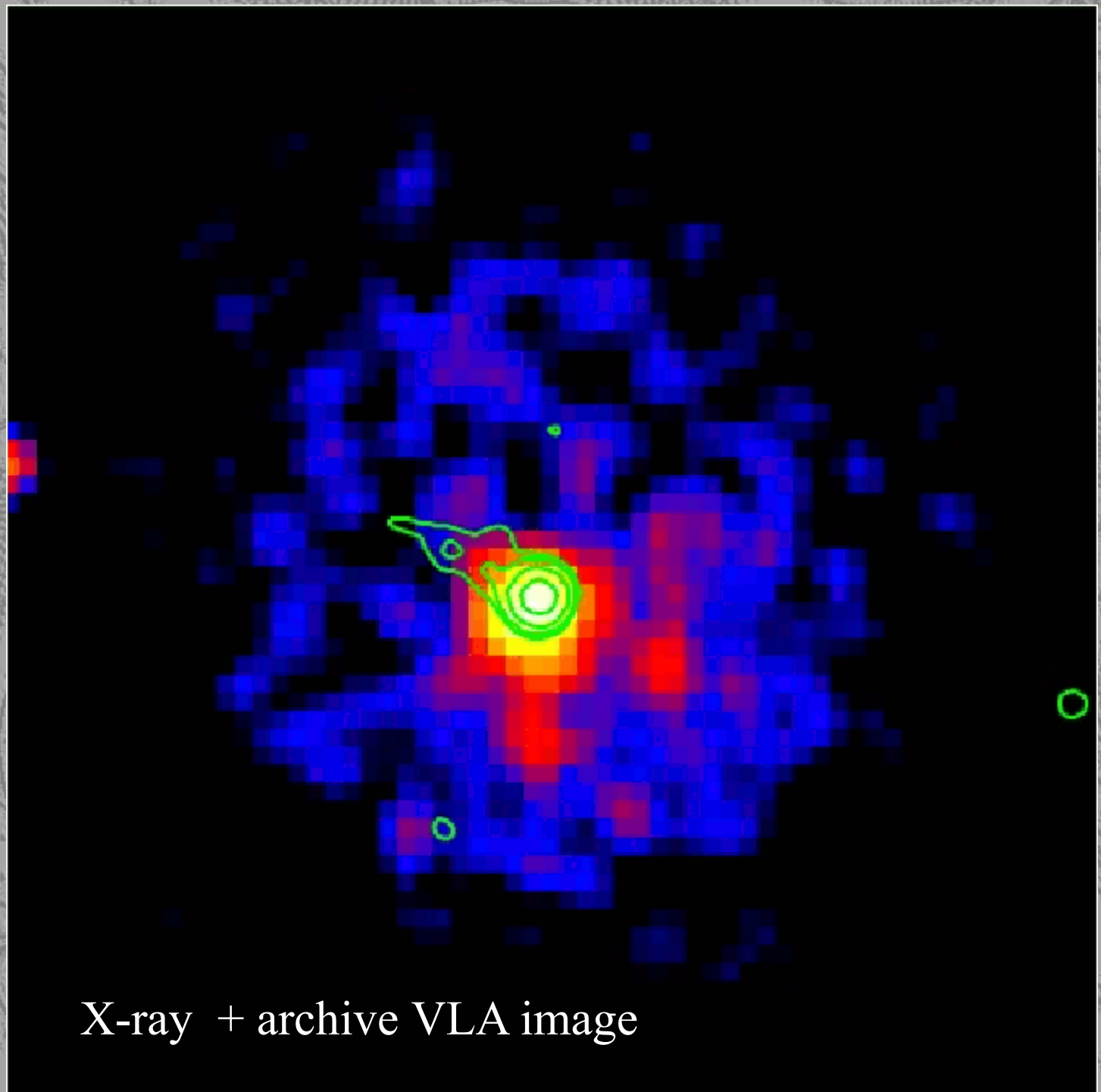
CL1415 @ z=1, a CC in the distant Universe

Angular resolution ~ 25 kpc in the inner regions

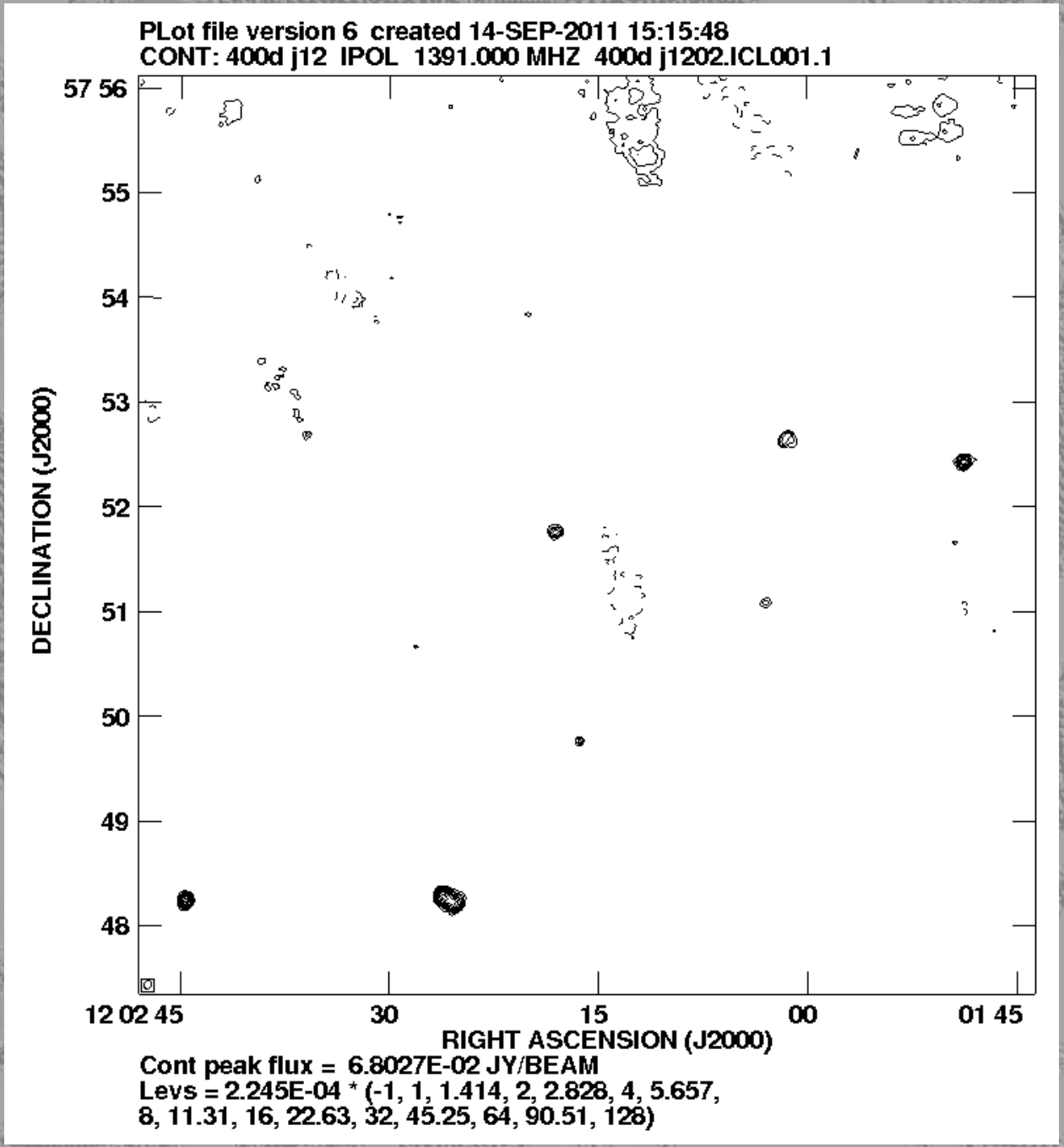


Santos et al. (2012)

CL1415 @ z=1, a CC in the distant Universe



EVLA ~ 1 hr imaging at 1.4 GHz of the center of high z clusters



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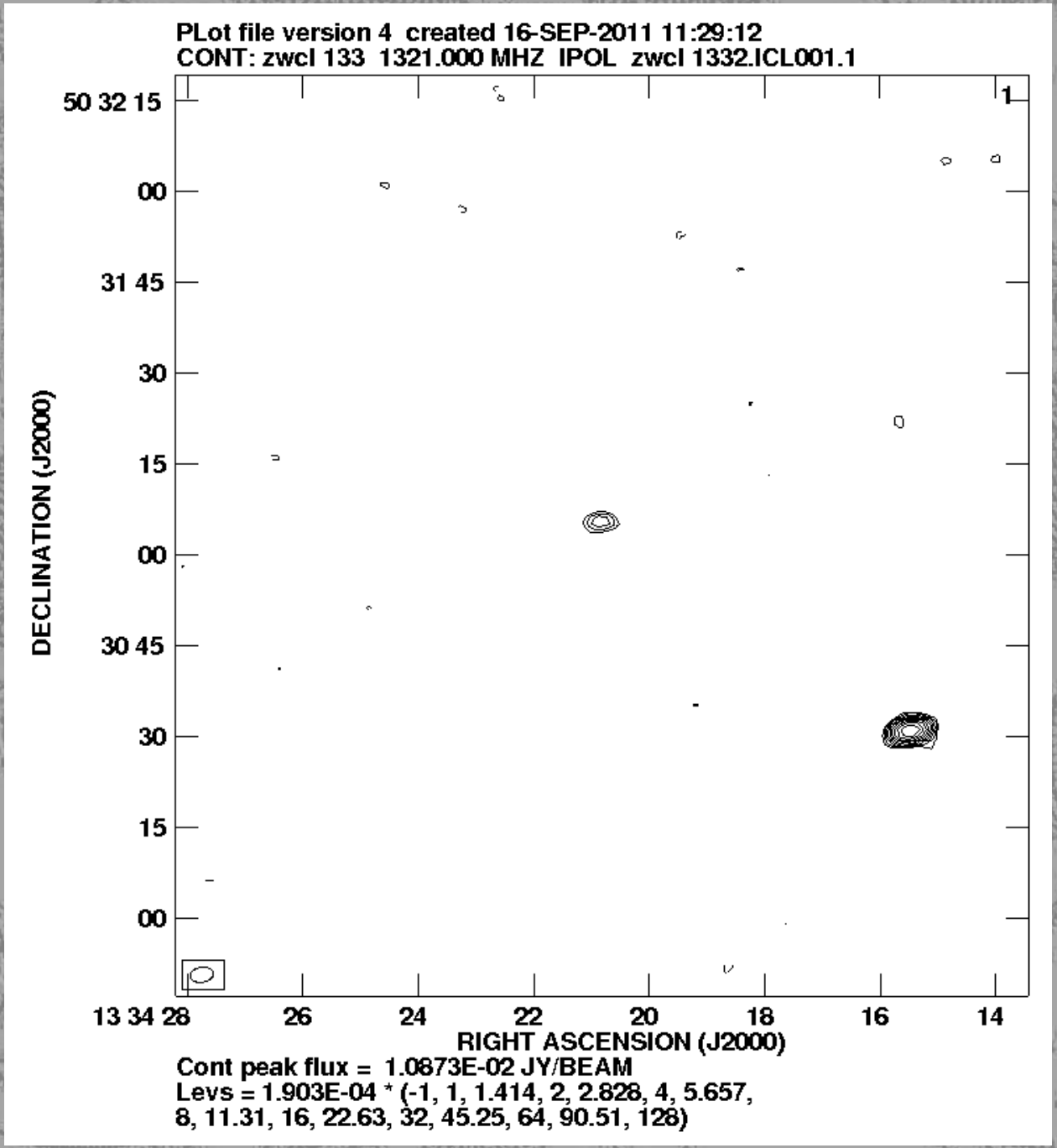

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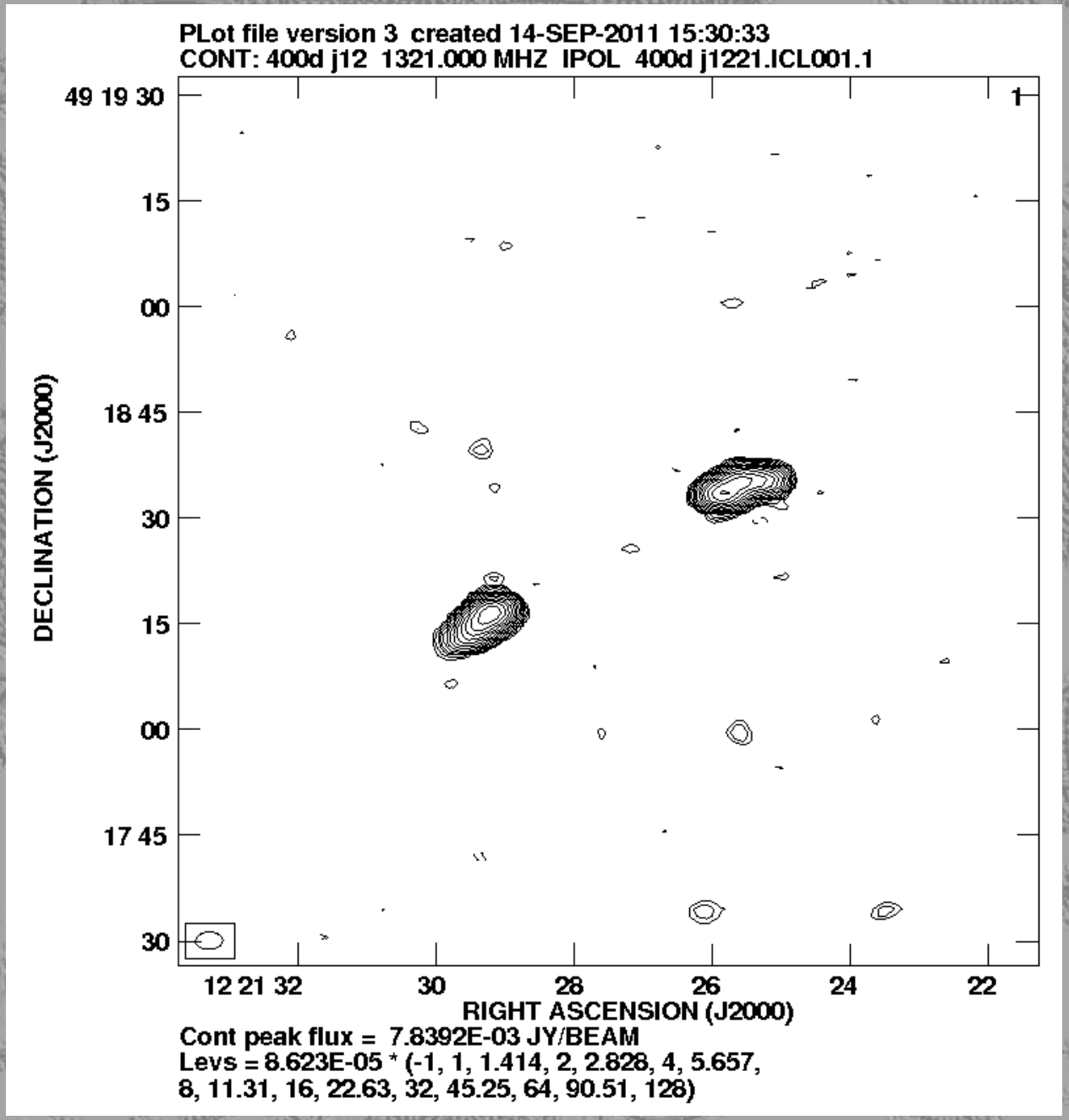


What can be done:

1-20 Ghz subarcsec imaging at microJy/arcsec^2 level to trace the freshly injected relativistic electrons and capture the formation of the bubbles (transfer of mechanical energy to the ICM) up to high redshift.

Spectral index maps to investigate the effects of jet/IGM/IMC interactions

Cross correlate with lower frequencies to follow the older bubbles imprinted onto the ICM as a result of the ~10^7-10^8 year duty cycle of the central radio Galaxy

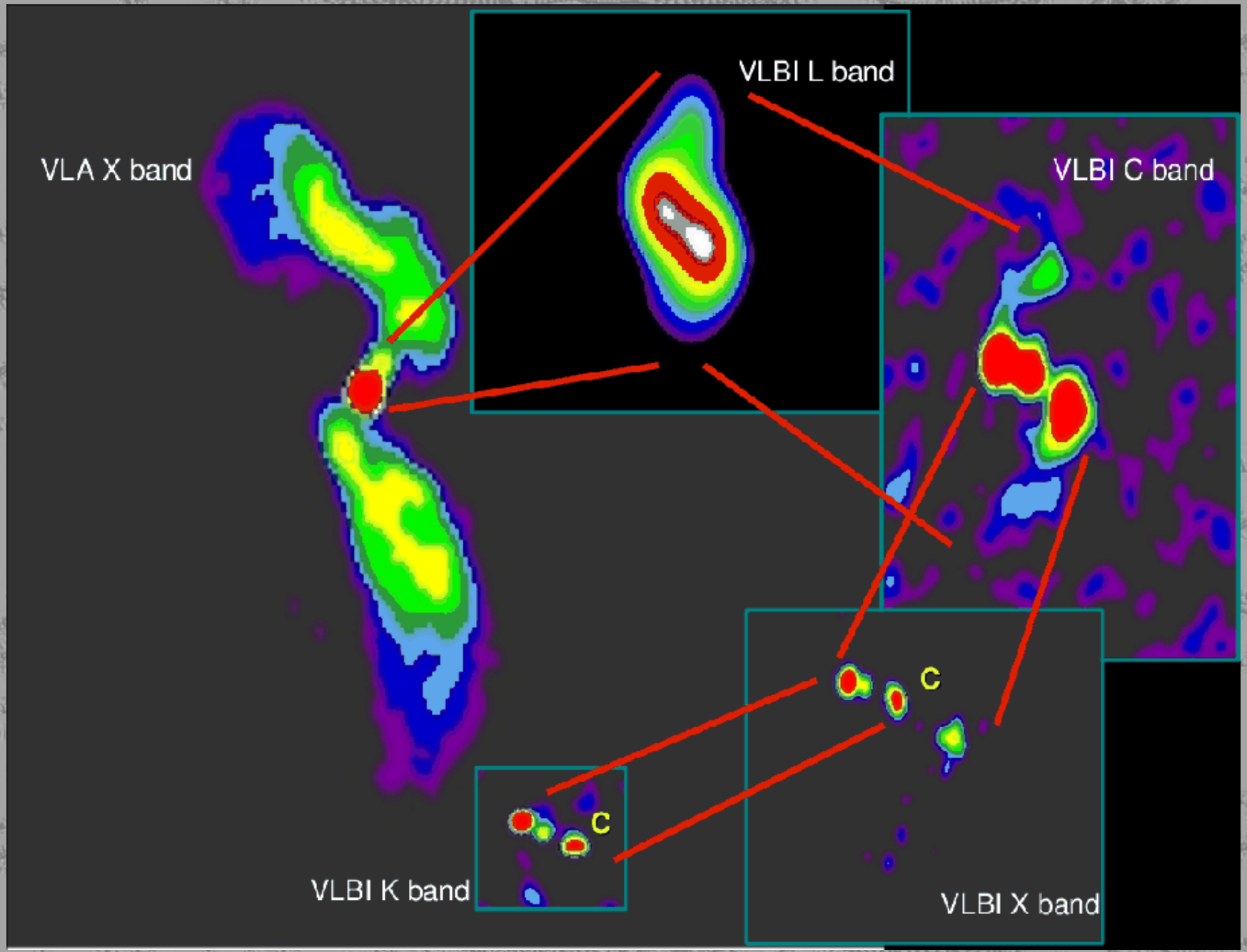
Increase the statistics of observed sources

This can be a science case for SKA

What is missing:

A future high resolution facility in the X-ray band to cope with the modern Radio sky.

Parsec scale properties of 4C26.42 in the cool core cluster A1795



Liuzzo, Taylor, Giovannini & Giroletti 2009

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Conclusions

Understanding the radio feedback in cool cores is crucial to understand the radio feedback in normal galaxies. At present it is thought that radio feedback is a primary actor in determining the star formation history of galaxies, the physics of the central regions of galaxy clusters, and ultimately the life cycle of the cosmic baryons in densest regions.

Understanding how the radio AGN transfer its energy to the surrounding gas over a broad energy of energy and scales and cosmic epochs is a key problem in modern astrophysics and presumably it will still be an open issue in the next 10 years, leaving room for SKA to revolutionize a field which originated with X-ray observations but it may be dominated by radio observations in the future.

LOFAR and EVLA observations can pave the way for a better understanding and for a better strategy to approach this scientific case in the SKA era.