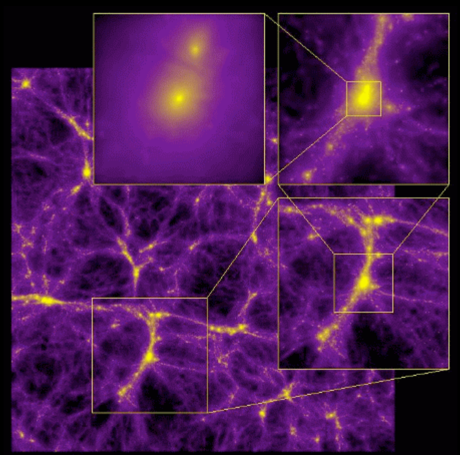
SZ scaling laws and high-resolution maps

Antonio da Silva

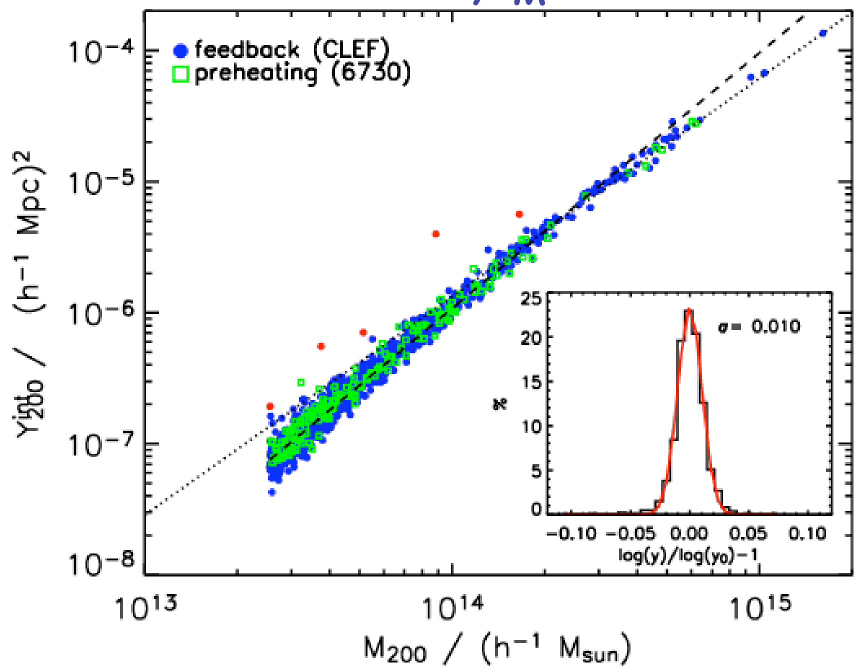
(IAS)



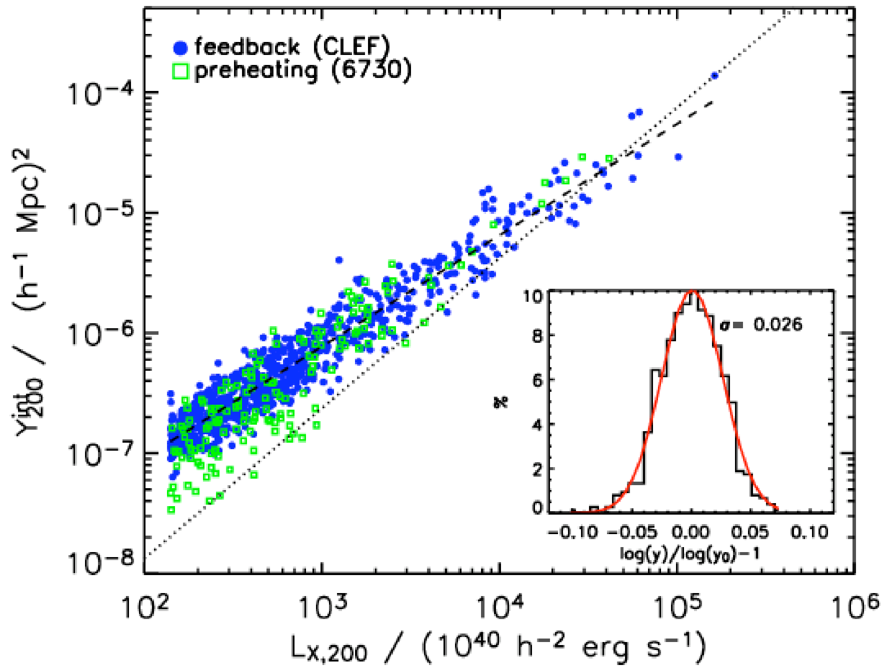
SZ - ALMA workshop, IAS Orsay, 7-8 April 2005

Scaling laws @ z=0: SZ

Y-M



Y-Lx



$$Y \propto M^{5/3} \propto T^{5/2} \propto L_X^{5/4}$$

da Silva et al 2004

Non_radiative	Y-M slope =1.69
Radiative	Y-M slope = 1.79
Preheating	Y-M slope = 1.93

CLEF:

Energy feedback Y-M slope = 1.95

da Silva et al 2004

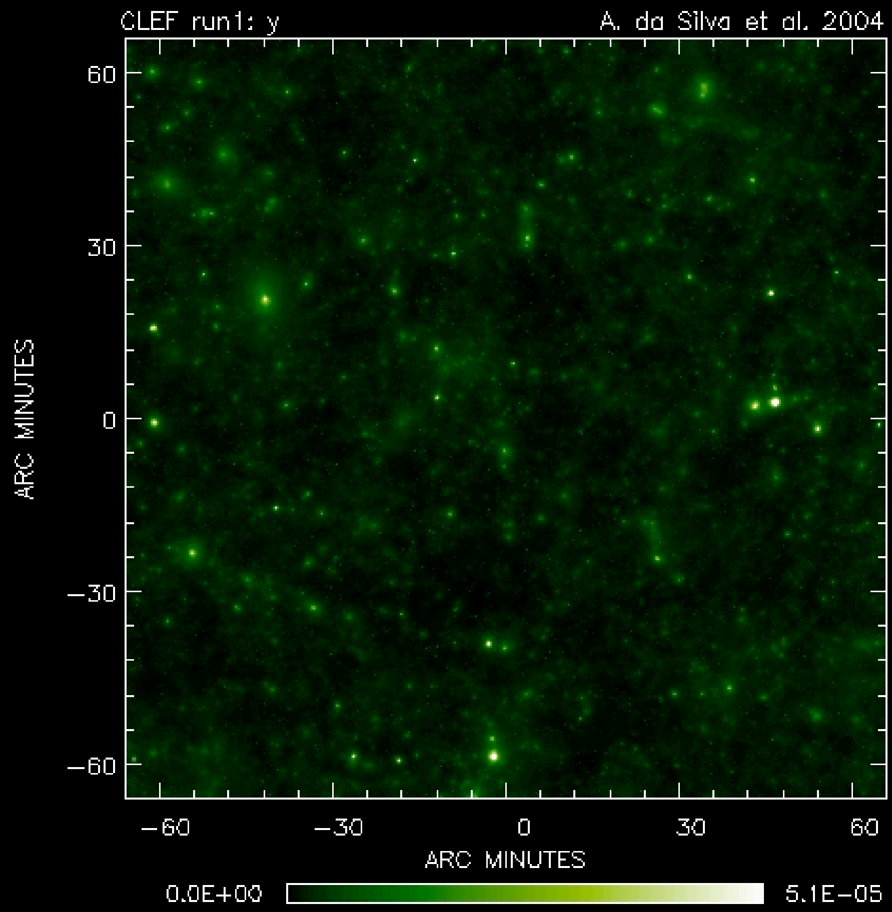
Preheating	Y-Lx slope = 0.98

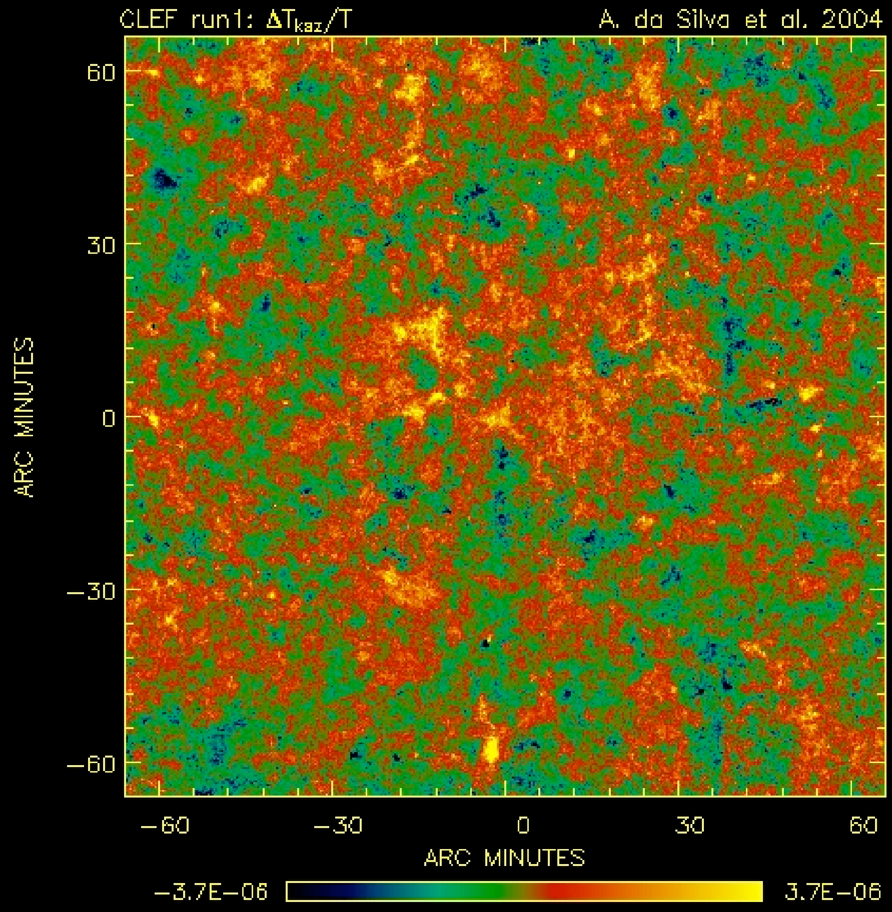
CLEF:

Energy feedback Y-M slope = 0.92

A. da Silva et al, astro-ph/0411649

Full-hydro. SZ sky patches 5 deg^2

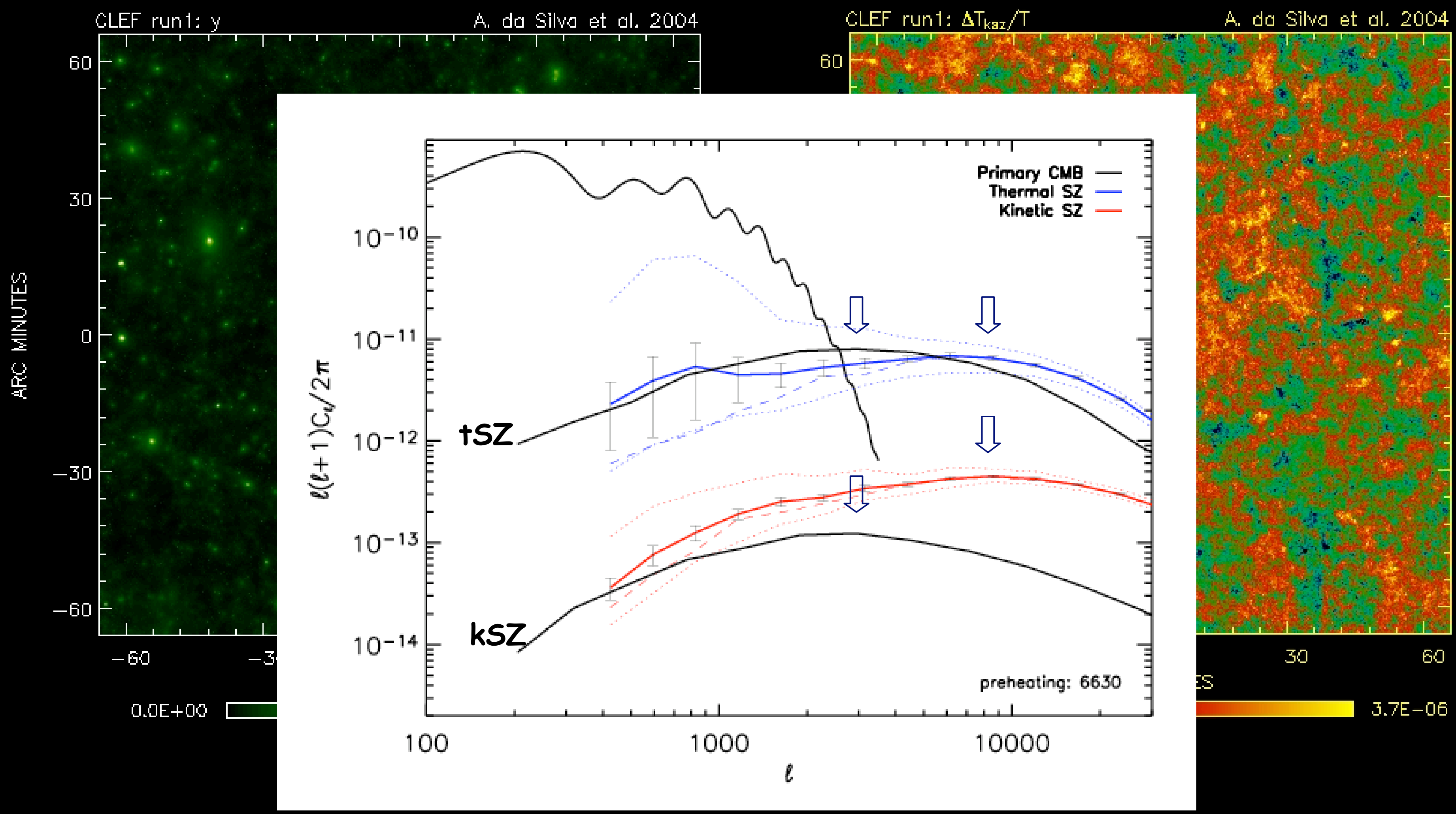




ymean = 3.6 E-6; Sigma_y = 2.0 E-6

Sigma_k = 9.67 E-7

Full-hydro. SZ sky patches: 5 deg^2

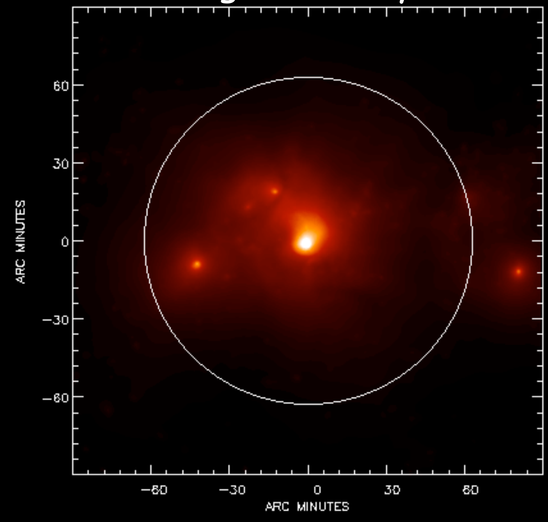


ymean = 3.6 E-6; Sigma_y = 2.0 E-6

Sigma_k = 9.7 E-7

CLEF cluster catalogues:

gas density



Large catalogue:

- wide range of mass (up to 2e15Msun/h)
- 36 snapshots 0<z<15

Templates of clusters for all sky maps

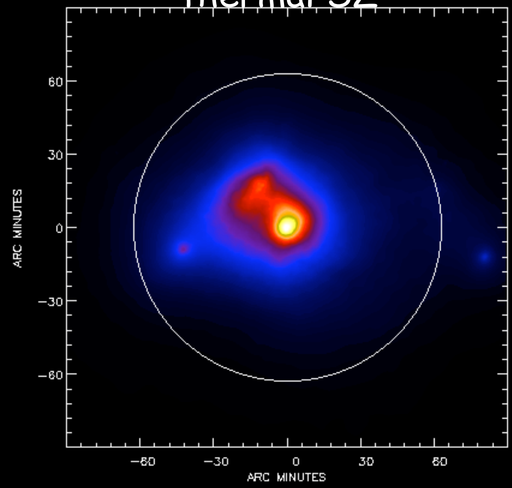
- N-body + hydro cluster (Shafer et al 2004)
- Analytical (Melin et al 2004)
- Advantages:

  ~10 000 clusters 0<z<1.46
  ~500 clusters at z=0 with TX>1keV
  ~50 clusters at z=0 with TX>3keV

- Important aspects:

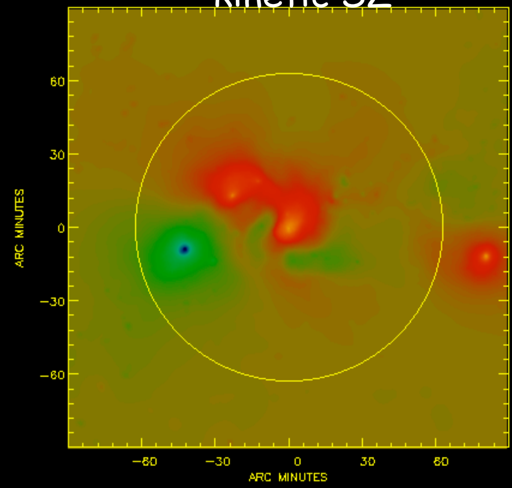
- scaling with non-gravitaional physics
  - Y(R) convergence
  - different z clusters are not independe (one sim.)

thermal SZ



ymax=2e4

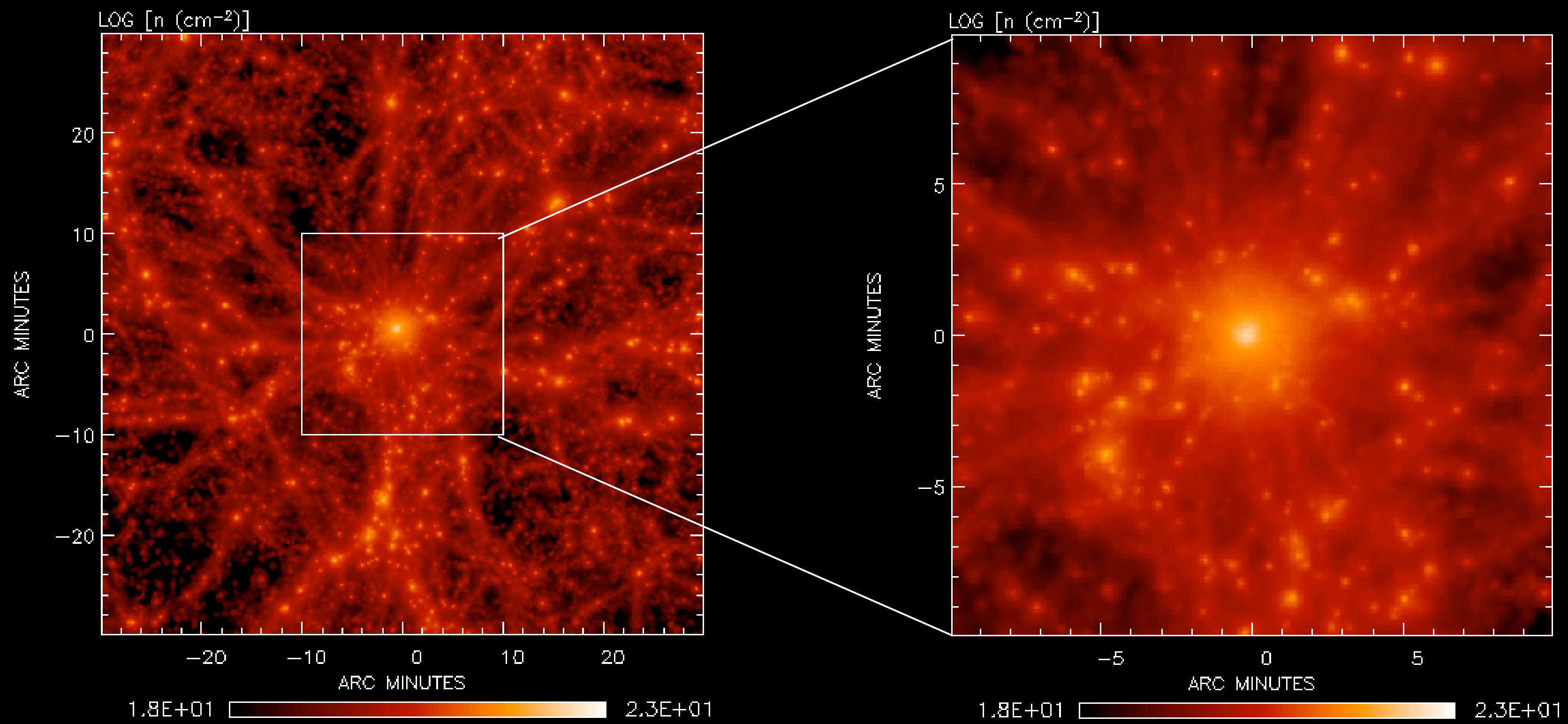
kinetic SZ



[-5e-5, 5e-5]

High-resolution cluster maps:

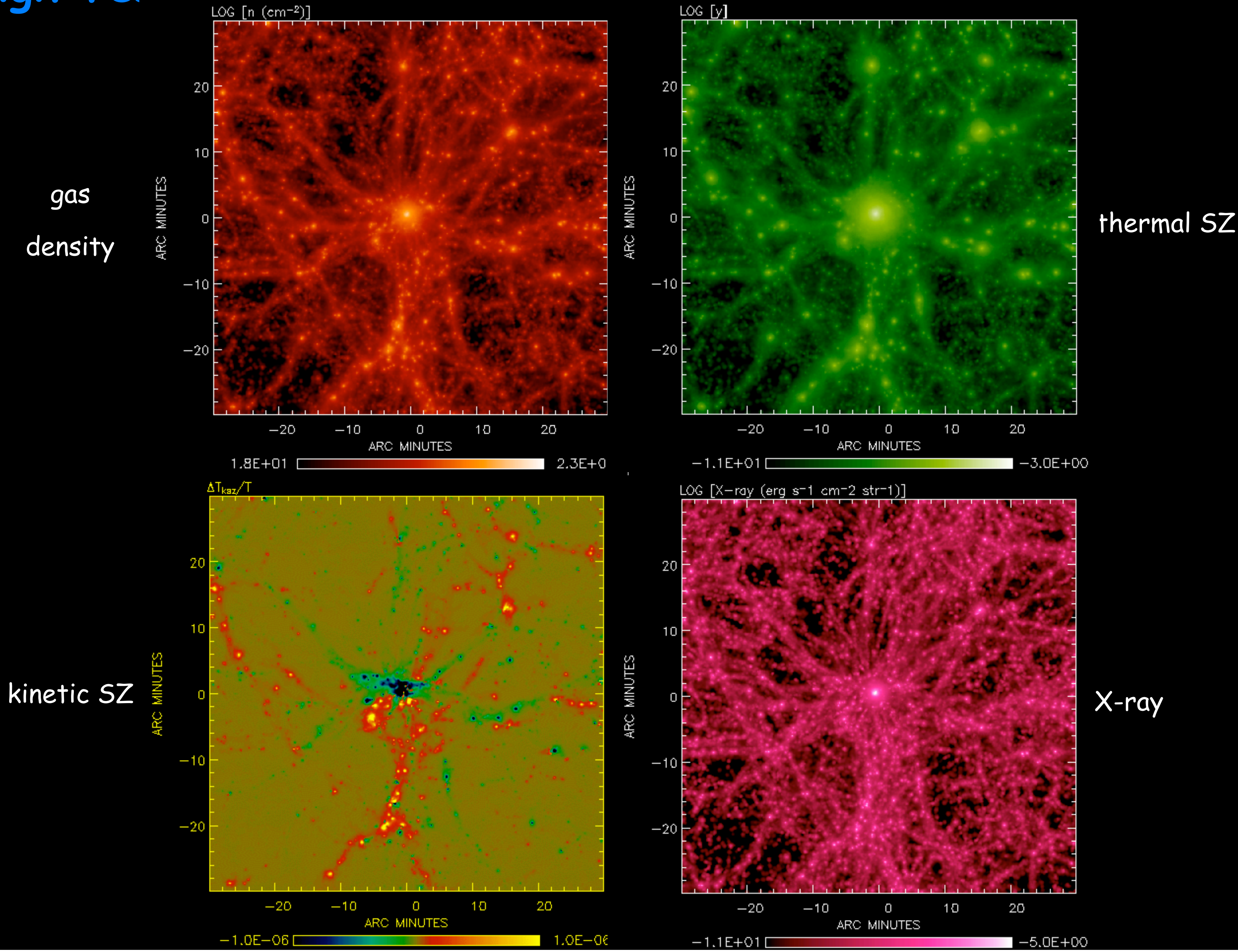
gas density



Cluster simulation:

- soft_phy=2.8 (10*a) kpc/h ⇨ pixel size: ~3 arcsec @ z=0.75
- mgas=2.1 e8 Msun/h ; mdark=1.1 e9 Msun/h
- non-radiative physics

High-resolution cluster maps:



High-resolution polarisation maps:

CMB quadropole induces linear polarisation:

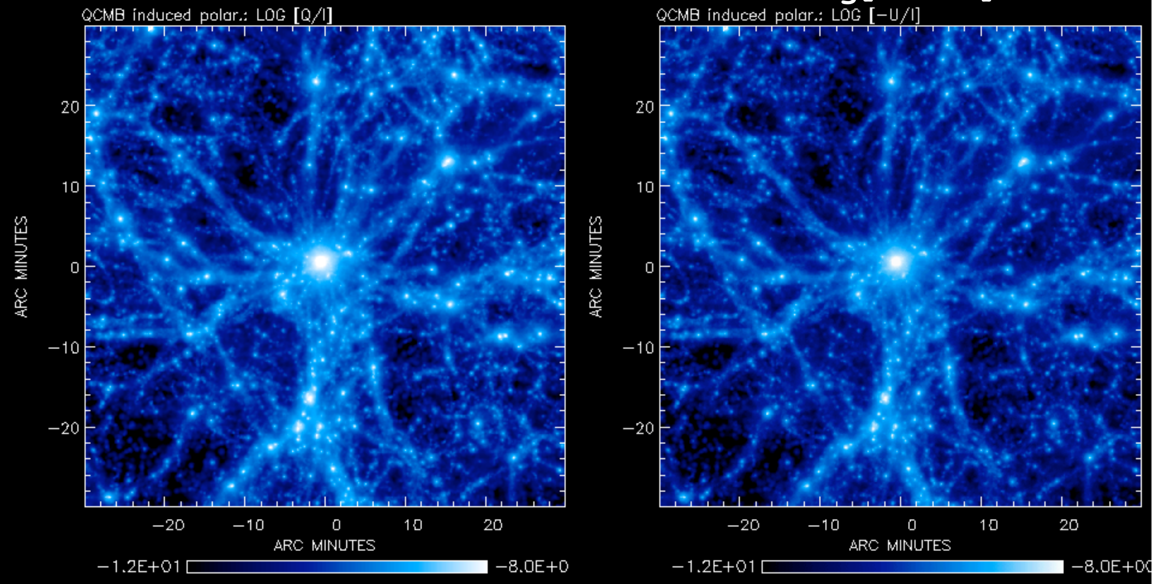
$$\tan(2\phi) = \frac{U}{Q}.$$

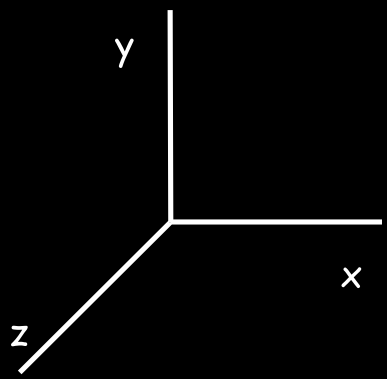
Line-of-sight integration:

U/I \propto ne_T QCMB

Q/I \propto ne_T QCMB

log[Q/I]   log[-U/I]





High-resolution polarisation maps:

CMB quadropole induces linear polarisation:

$$\tan(2\phi) = \frac{U}{Q}.$$

Line-of-sight integration:

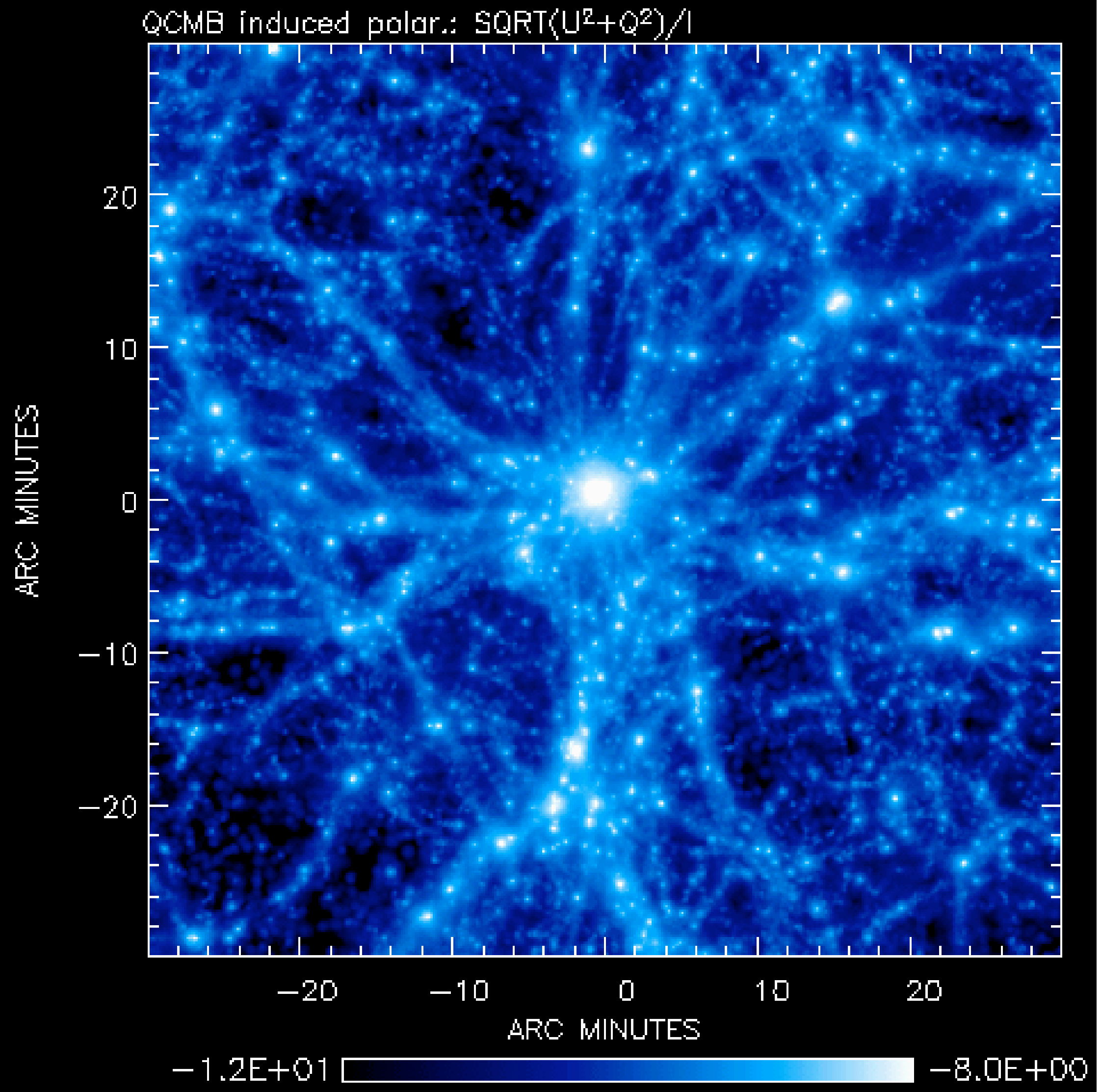
U/I \propto ne_T QCMB

Q/I \propto ne_T QCMB

$$p = \frac{\sqrt{Q^2 + U^2}}{I}$$

Max degree of polarization:

max(p) = 7.8e-8



High-resolution polarisation maps:

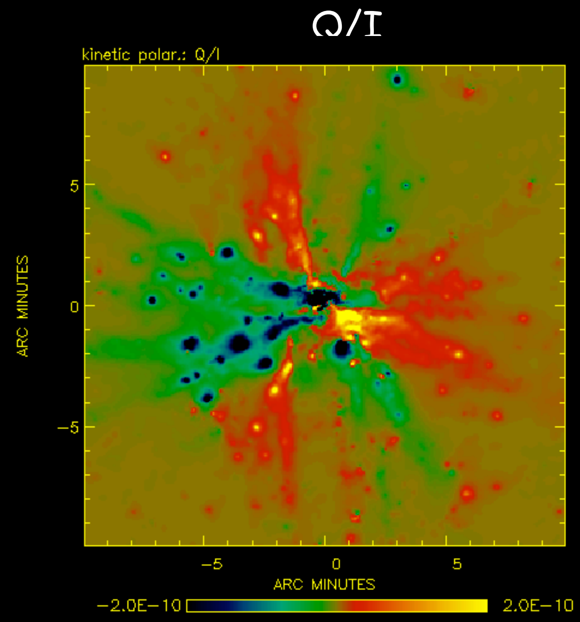
Gas transverse velocity (kinetic) induces linear polarisation:

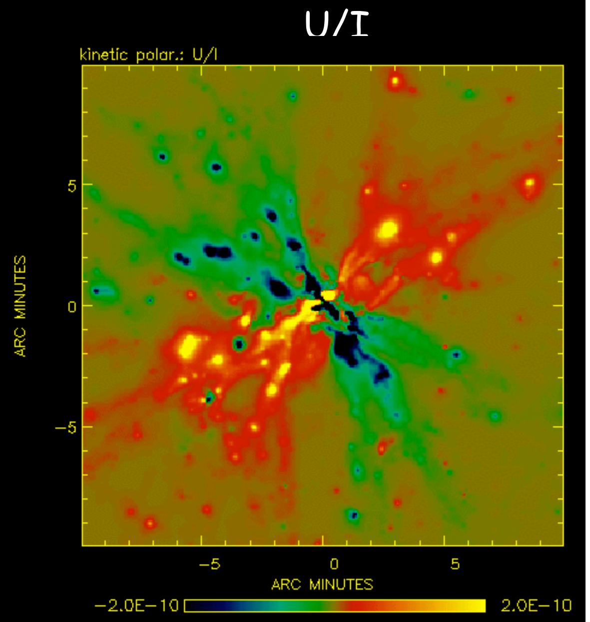
$$\tan(2\phi) = \frac{U}{Q}.$$

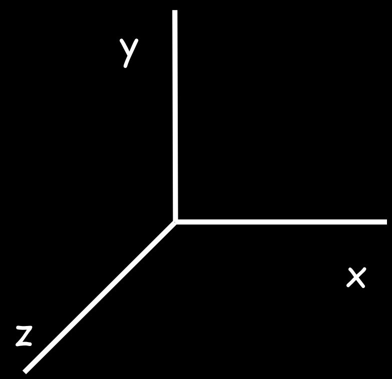
Line-of-sight integration:

$$dQ = -0.1 I_{0\nu} \sigma_T f(x_\nu) n_e \beta_t^2 \cos(2\chi)\, dZ$$

$$dU = -0.1 I_{0\nu} \sigma_T f(x_\nu) n_e \beta_t^2 \sin(2\chi)\, dZ$$







High-resolution polarisation maps:

Gas transverse velocity (kineti
induces linear polarisation:

$$\tan(2\phi) = \frac{U}{Q}.$$

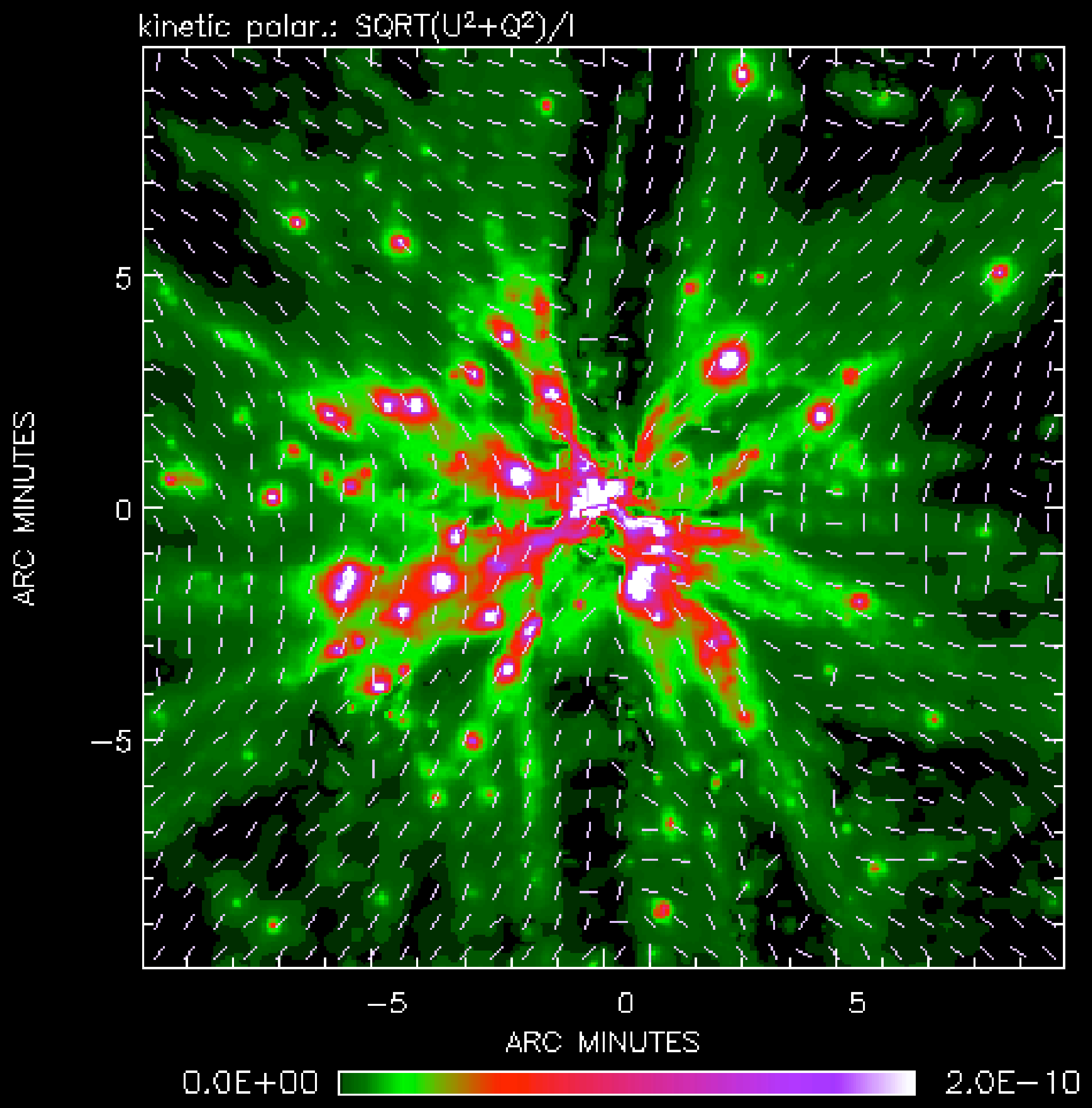
Line-of-sight integration:

$$\mathrm{d}Q = -0.1 I_{0\nu}\sigma_{\mathrm{T}} f(x_\nu) n_e \beta_t^2 \cos(2\chi)\,\mathrm{d}Z$$

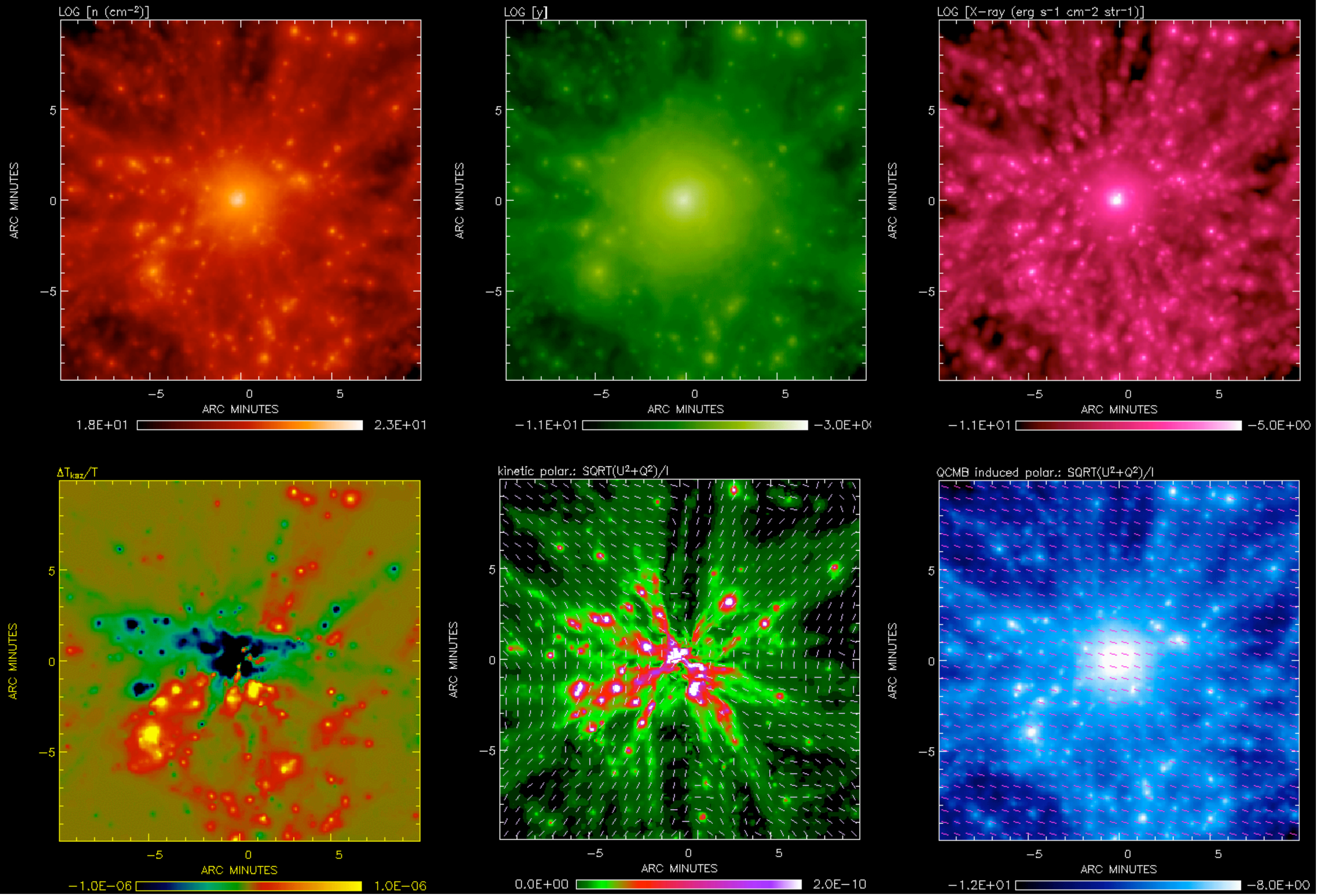
$$\mathrm{d}U = -0.1 I_{0\nu}\sigma_{\mathrm{T}} f(x_\nu) n_e \beta_t^2 \sin(2\chi)\,\mathrm{d}Z$$

Max d $p = \frac{\sqrt{Q^2+U^2}}{I}$ zation:

max(p) = 3.5e-9



High-resolution cluster maps:



Concluding remarks:

Cluster scaling laws from hydrodynamical simulations:

- Radiative gas physics (Cooling and energy feedback) has non negligible impact in cluster scaling relations and the SZ effect.

- The magnitude of these effects is not yet well understood and need to be properly assessed with hydro sims. for preparing and interpreting future SZ/CMB observations.

Hydro maps:

- High-resolution maps are the most powerful tool for studying selection effects of deep surveys (high-angular resolution), complementarity between different observational strategies,…

- High-resolution simulations (with and without extra gas physic) exist!
  - the CLEF run will permit to construct maps with 10 arcsecs
  - higher-resolution cluster simulations exist and new ones are planned!