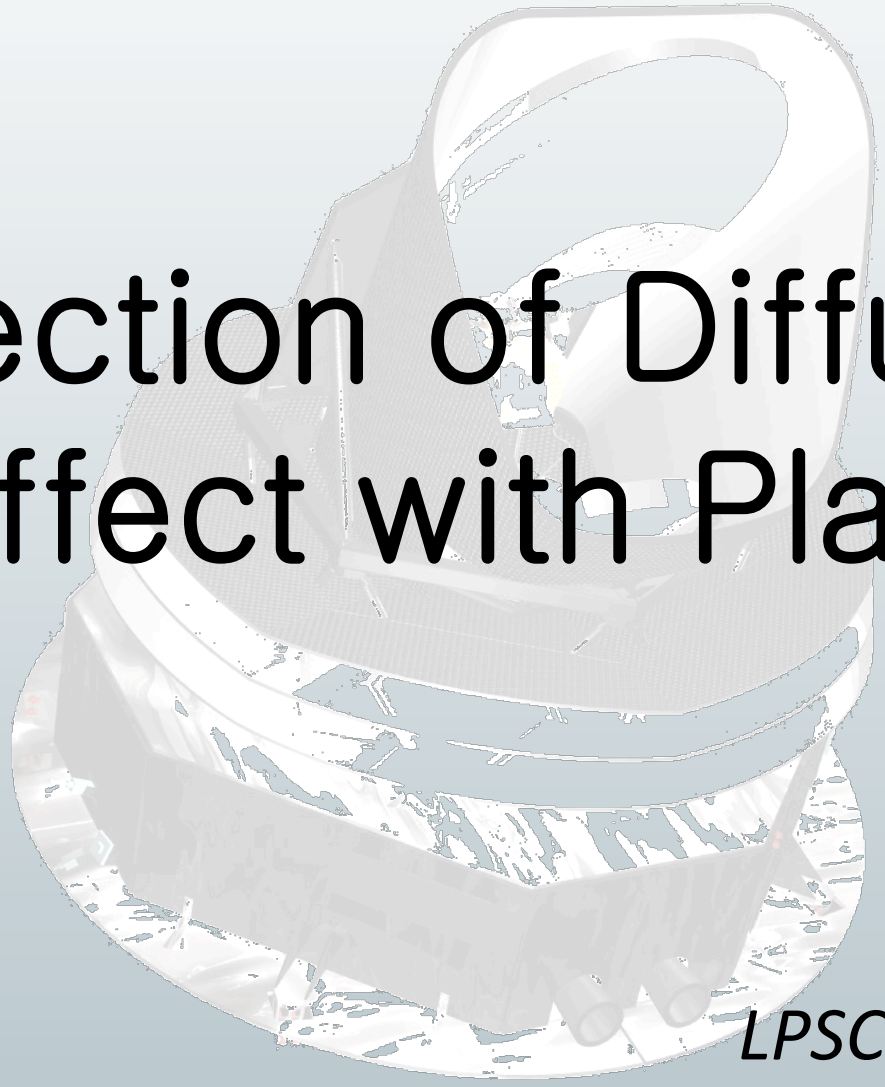


Detection of Diffuse SZ effect with Planck

Barbara Comis

LPSC –Grenoble (France)

On behalf of the **Planck collaboration**

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.

X name "The talk"

Outline

Planck intermediate results. VIII. Filaments between interacting clusters, Planck Collaboration, A&A 550, A134 (2013)

- Diffuse SZ: missing baryons, structure formation model
- Cluster pairs, candidates selection criteria
- Joint SZ/X-ray analysis (ROSAT-Planck): the A399-A401 case
- Comparison with hydrodinamical simulations
- Conclusions

Large-scale sructure formation

half the baryons in the nearby Universe should be contained in the “cosmic web”:

$$Y = \int_{\Omega} y d\Omega \propto \frac{\int n_e T_e dV}{D_A^{\,2}} \qquad S_X = \frac{1}{4\pi(1+z)^4} \int n_e^{\,2} \Lambda_{ee} d\ell$$

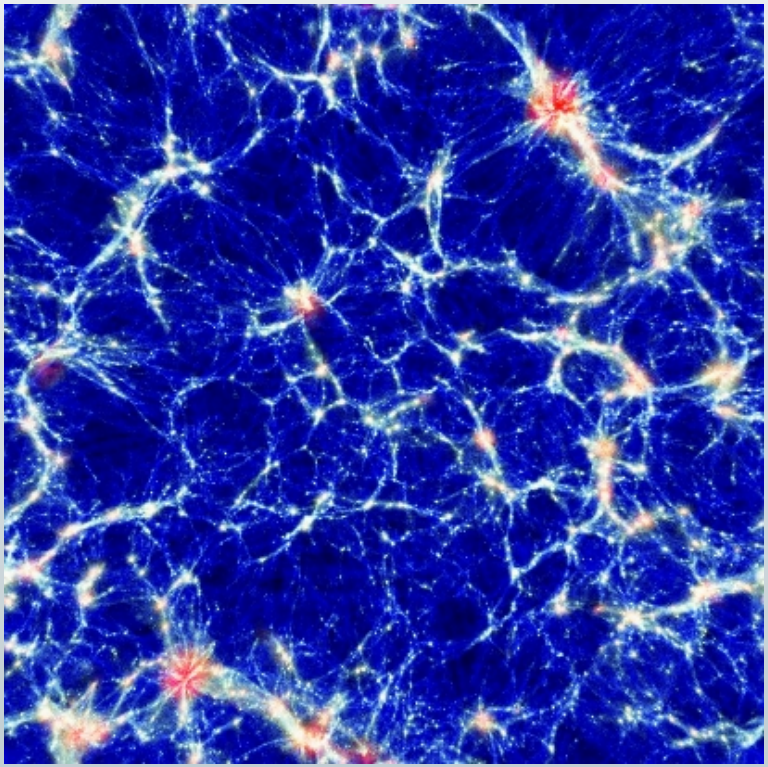


Image courtesy of Klaus Dolag [Universitäts-Sternwarte München, Ludwig-Maximilians-Universität München,]

$$T_e \sim 10^{5-7} K$$

$$n_e \sim 10^{-4} cm^{-3} \longrightarrow y \sim 10^{-6}$$

$$\Delta \lesssim 100$$

Planck: test of the current paradigm of cosmic structure growth via the **thermal Sunyaev-Zel’dovich effect**

→ SZ power spectrum
(yesterday talk by J. F. Macias-Perez)

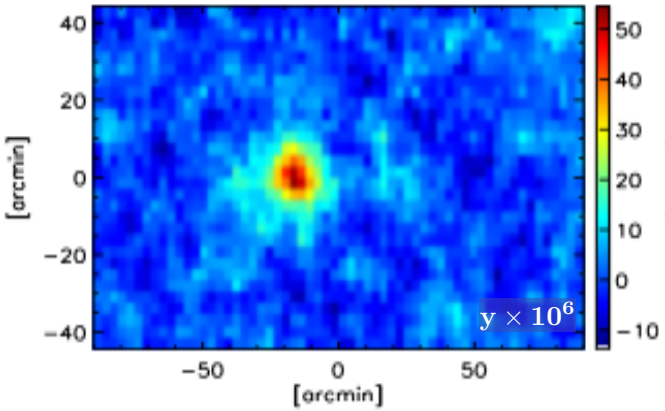
→ SZ from the inter-cluster medium

Cluster pairs

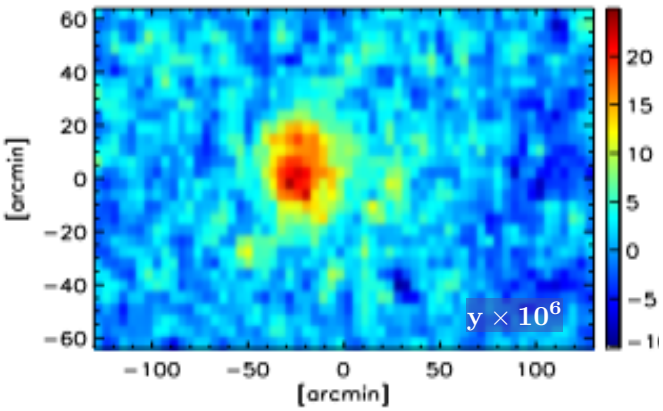
→ **$\Delta z < 0.01$ & $10' < \theta_{12} < 120'$** @ MCXC

+ SNR > 5
+ $\theta_{12} > 30'$

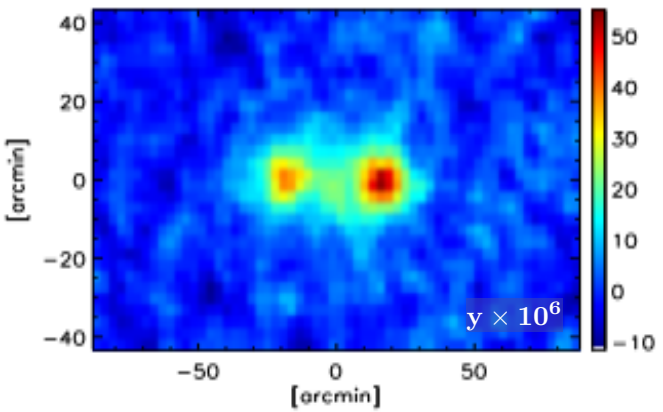
A2029-A2033: $\Delta z=0.005$, $\theta_{12}=36.6'$



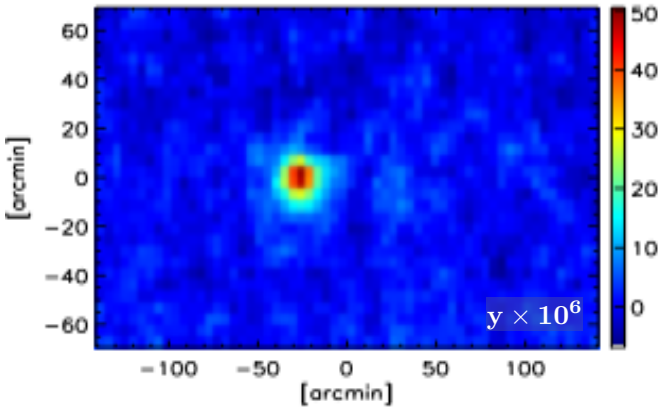
A2147-A2152: $\Delta z=0.002$, $\theta_{12}=52.9'$



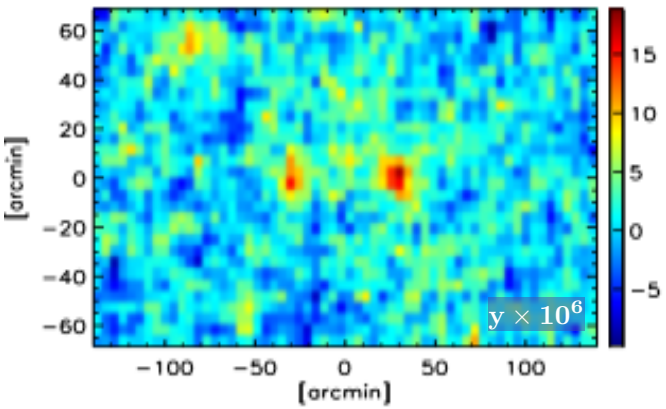
A399-A401: $\Delta z=0.002$, $\theta_{12}=35.8'$



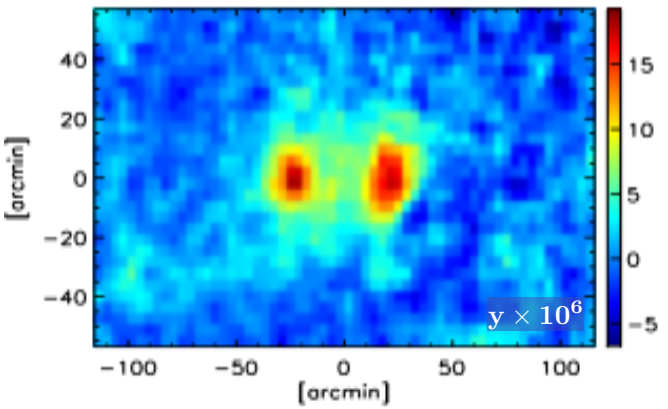
A2256-A2271: $\Delta z=0.0003$, $\theta_{12}=57.3'$



MKW3s-A2063: $\Delta z=0.009$, $\theta_{12}=56.8'$



A3391-A3395: $\Delta z=0.008$, $\theta_{12}=47'$



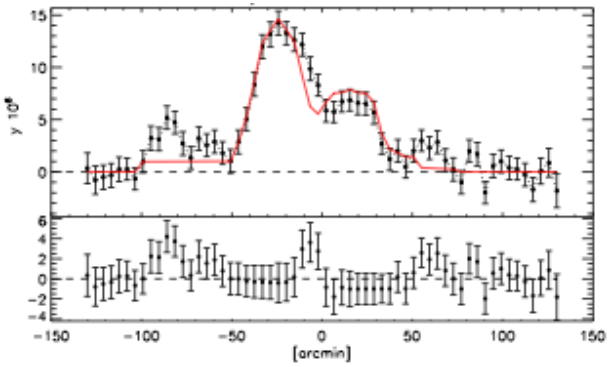
@7.18'' ($\theta_{pix}=5\theta_{12}/60$)

Cluster pairs

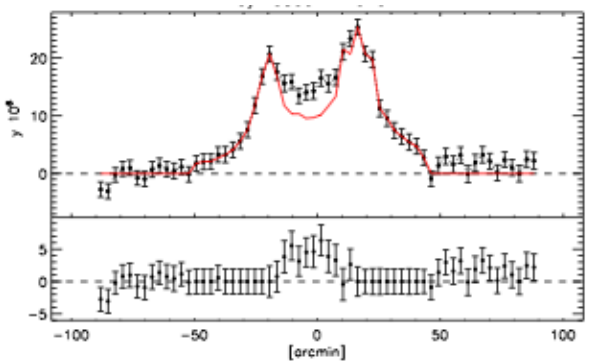
→ **$\Delta z < 0.01$ & $10' < \theta_{12} < 120'$** @ MCXC

+ SNR > 5
+ $\theta_{12} > 30'$

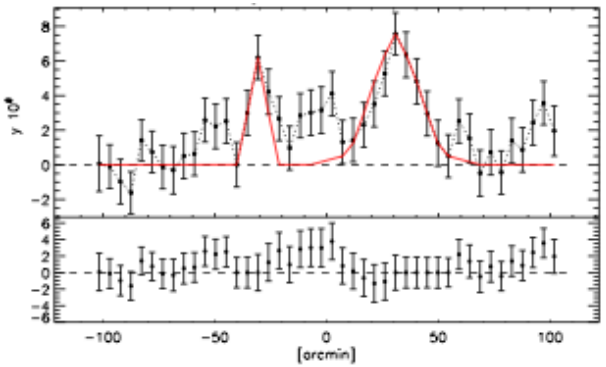
A2147-A2152: Δz=0.002, θ_{12}=52.9'



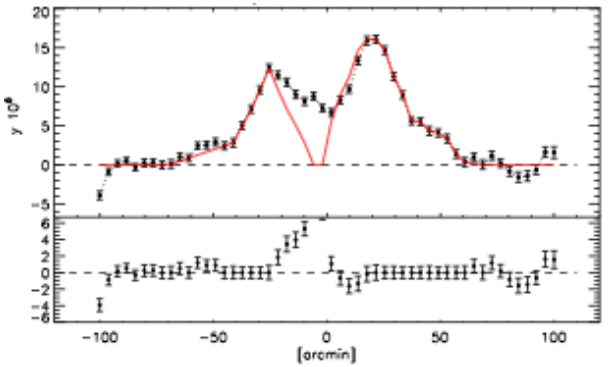
A399-A401: Δz=0.002, θ_{12}=35.8'



MKW3s-A2063: Δz=0.009, θ_{12}=56.8'

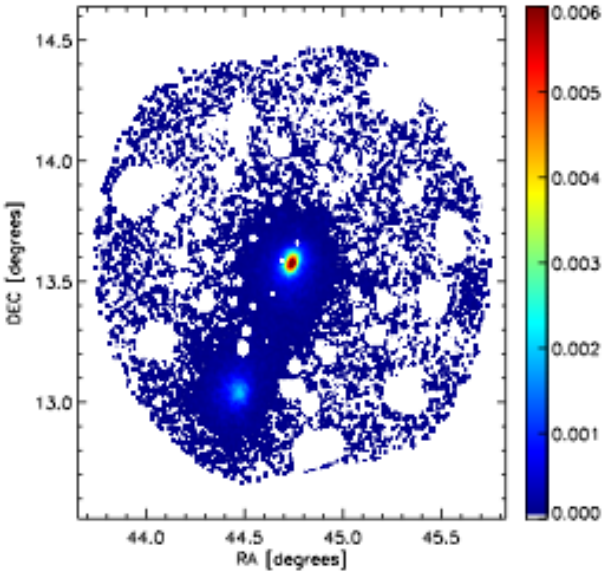


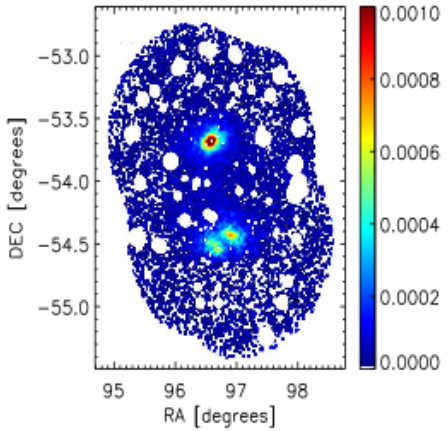
A3391-A3395: Δz=0.008, θ_{12}=47'



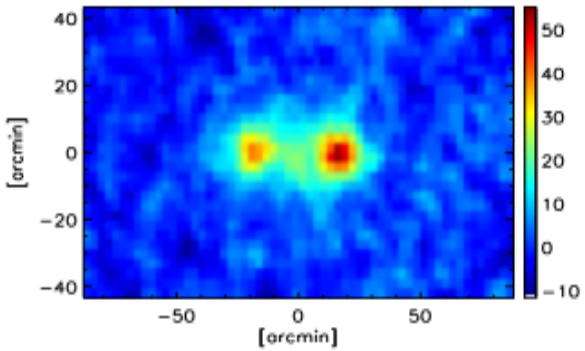
Cluster pairs

ROSAT + Planck

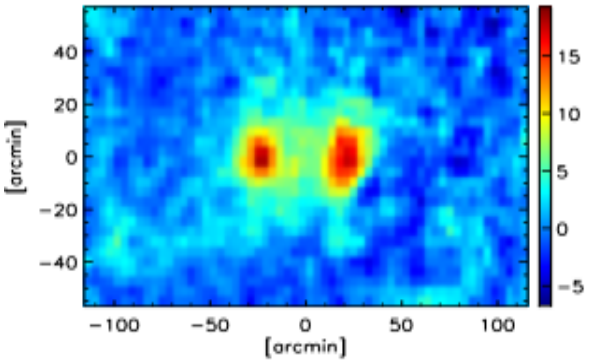




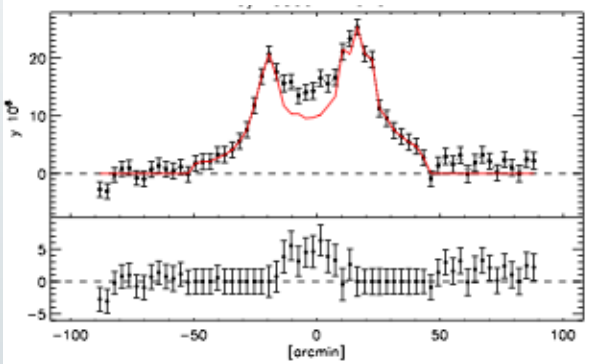
A399-A401



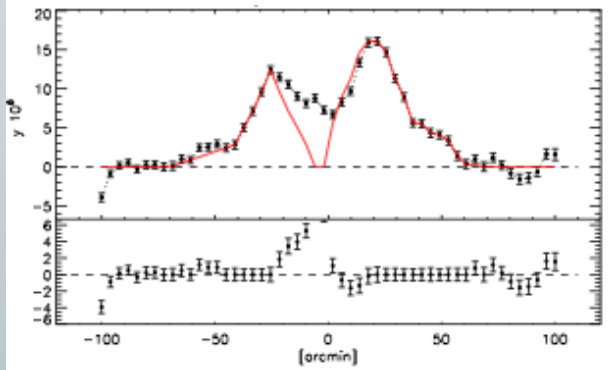
A3391-A3395



A399-A401

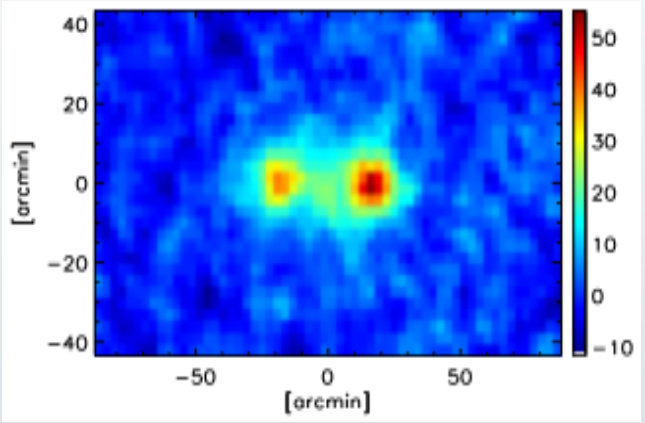


A3391-A3395



Signal modeling

A399-A401 (Planck)



Isothermal β-model

$$n_e(r) = n_{e0}\left(1 + \frac{r^2}{r_c^2}\right)^{\frac{-3\beta}{2}}$$

2D-fit: X + SZ

GNFW

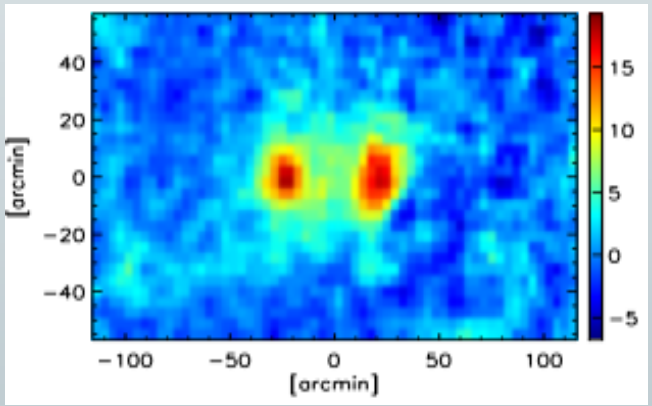
$$P(x) = \frac{P_0}{(c_{500}x)^{\gamma}\left[1 + (c_{500}x)^{\alpha}\right]^{(\beta-\gamma)/\alpha}}$$

$$P(r) = P_{500}P(x) \qquad x = r/R_{500}$$

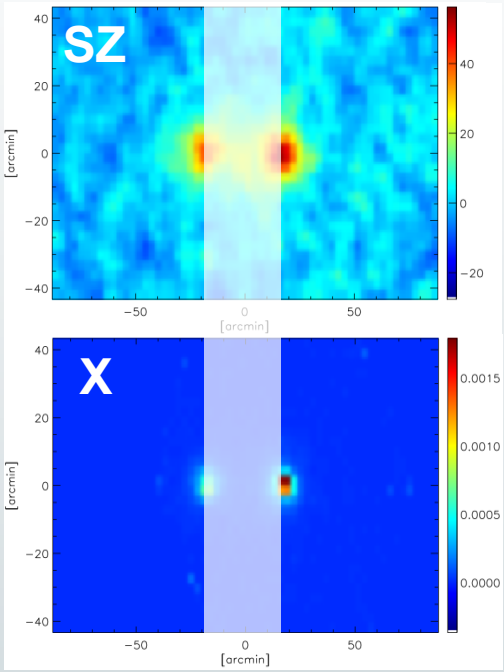
1) $\beta = 3.5$

2) $\begin{matrix} c_{500} \\ \alpha \\ \gamma \end{matrix} \equiv A10$

A3391-A3391 (Planck)



SZ/X signal modeling



Isothermal β-model 2D-fit: X + SZ

$$n_e(r) = n_{e0}\left(1+\frac{r^2}{r_c^2}\right)^{\frac{-3\beta}{2}} \quad + \quad T_e\ [\mathrm{S\&P\ (2004)}]$$

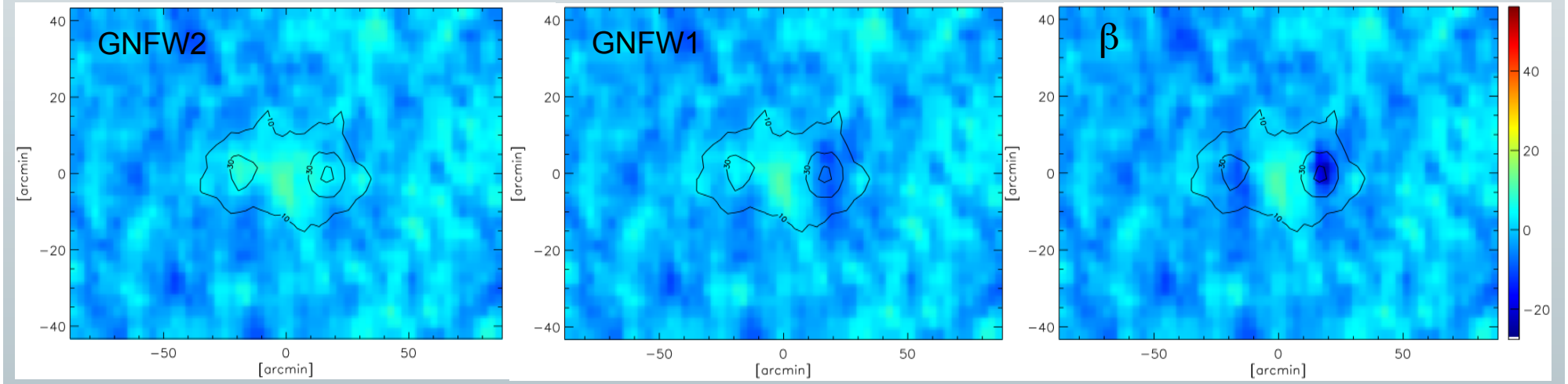
GNFW

$$P(x) = \frac{P_0}{(c_{500}x)^{\gamma}\left[1+(c_{500}x)^{\alpha}\right]^{(\beta-\gamma)/\alpha}}$$

$$P(r) = P_{500}P(x) \qquad x = r/R_{500}$$

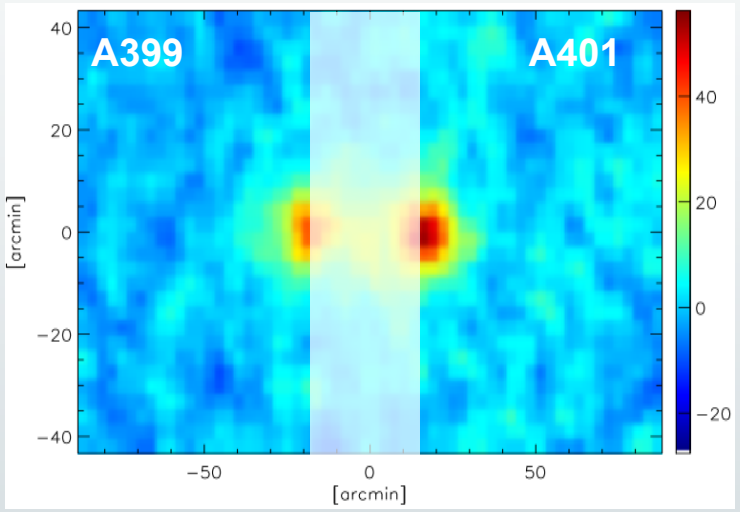
1) $\beta = 3.5$, T_e [S&P (2004)]

2) c_{500}, α, γ $\equiv A10$

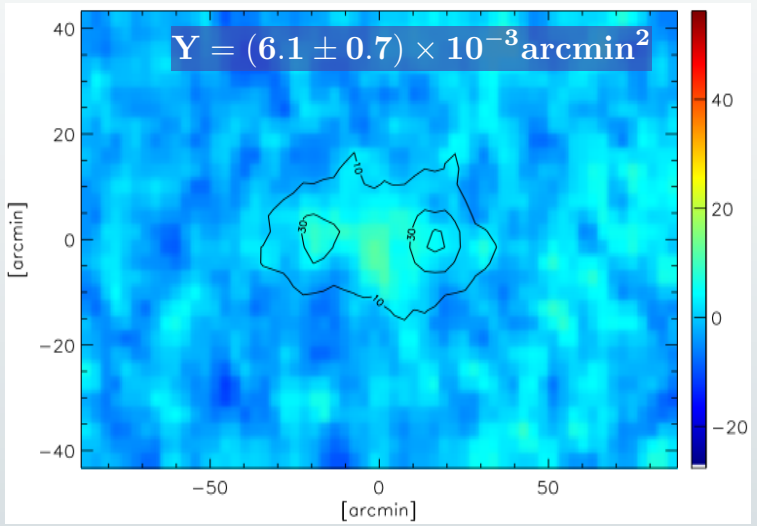


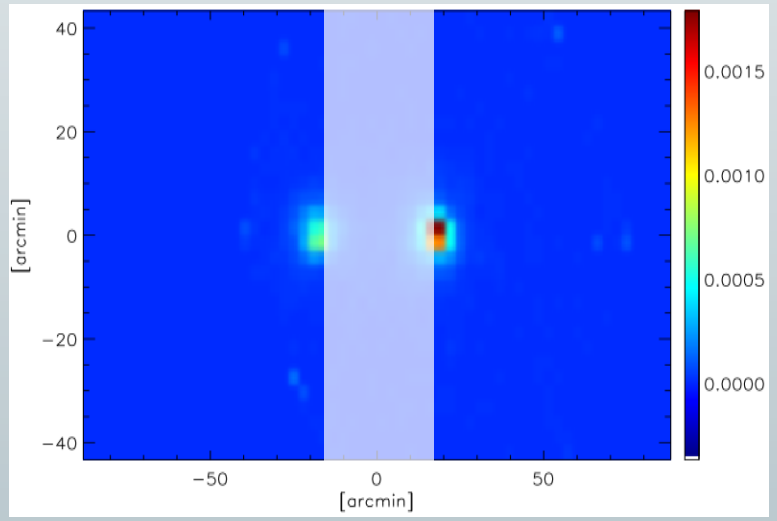
SZ/X signal modeling

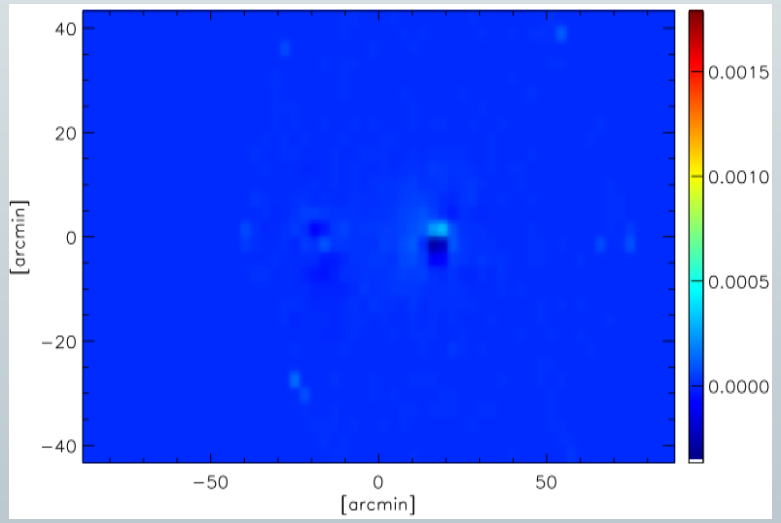
2D-fit: X + SZ



GNFW c_{500} α γ $\equiv A10$

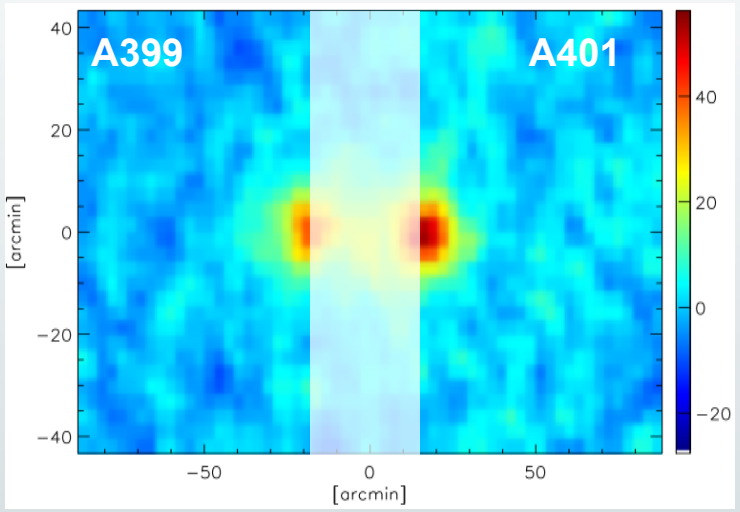




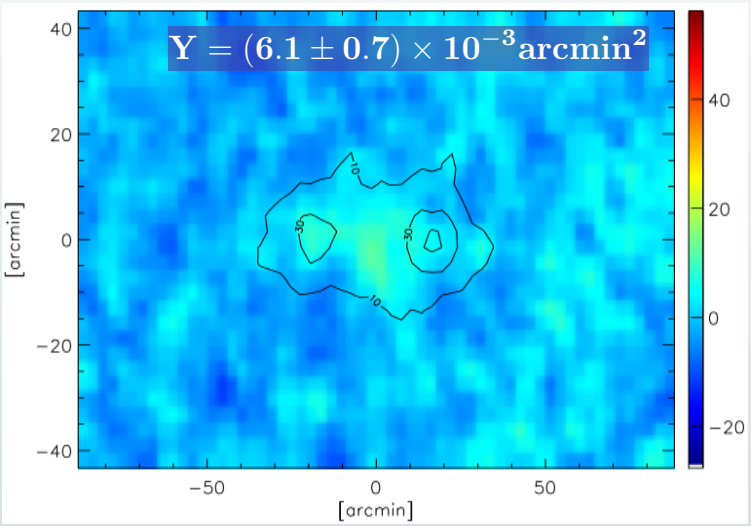


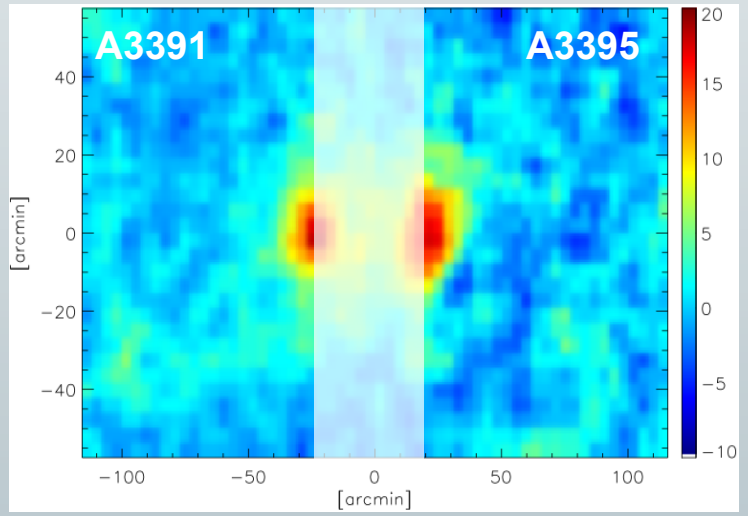
SZ/X signal modeling

2D-fit: X + SZ

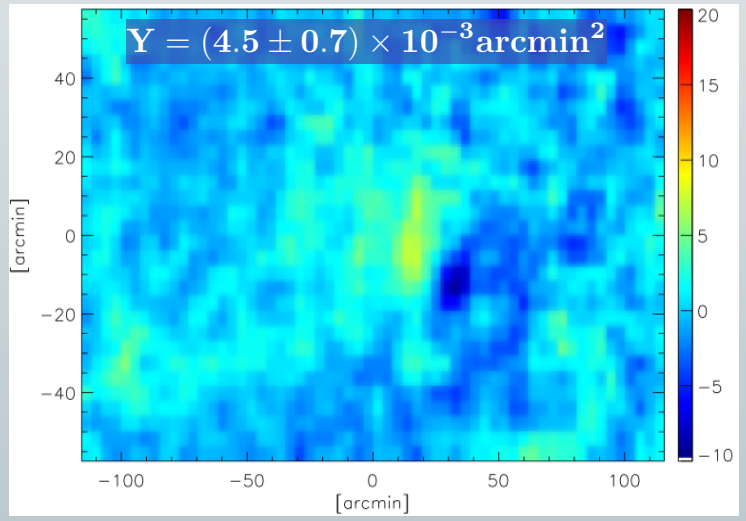


GNFW c_{500} α γ $\equiv A10$

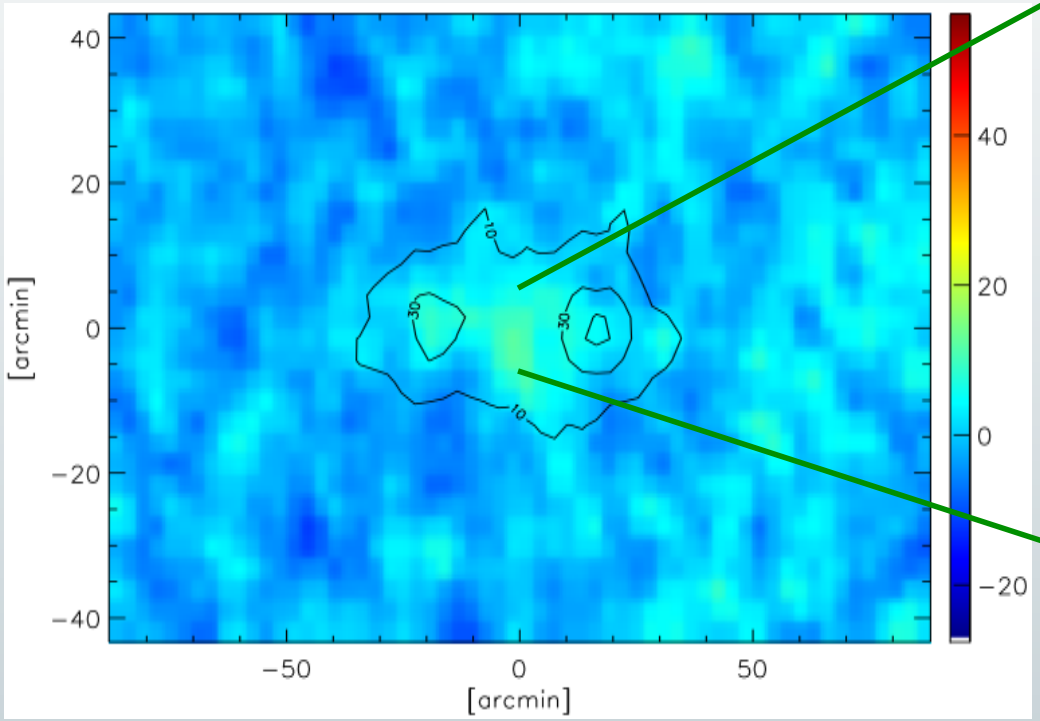




GNFW c_{500} α γ $\equiv A10$



SZ/X signal modeling



Isothermal filament

$$n_e(r) = \frac{n_e(0)}{\left(1 + (\frac{r}{r_c})^2\right)^{\frac{3}{2}\beta}}$$

$n_{e,0} = (3.72 \pm 0.17) \times 10^{-4} cm^{-3}$

$T_e = (7.08 \pm 0.85)\, keV$

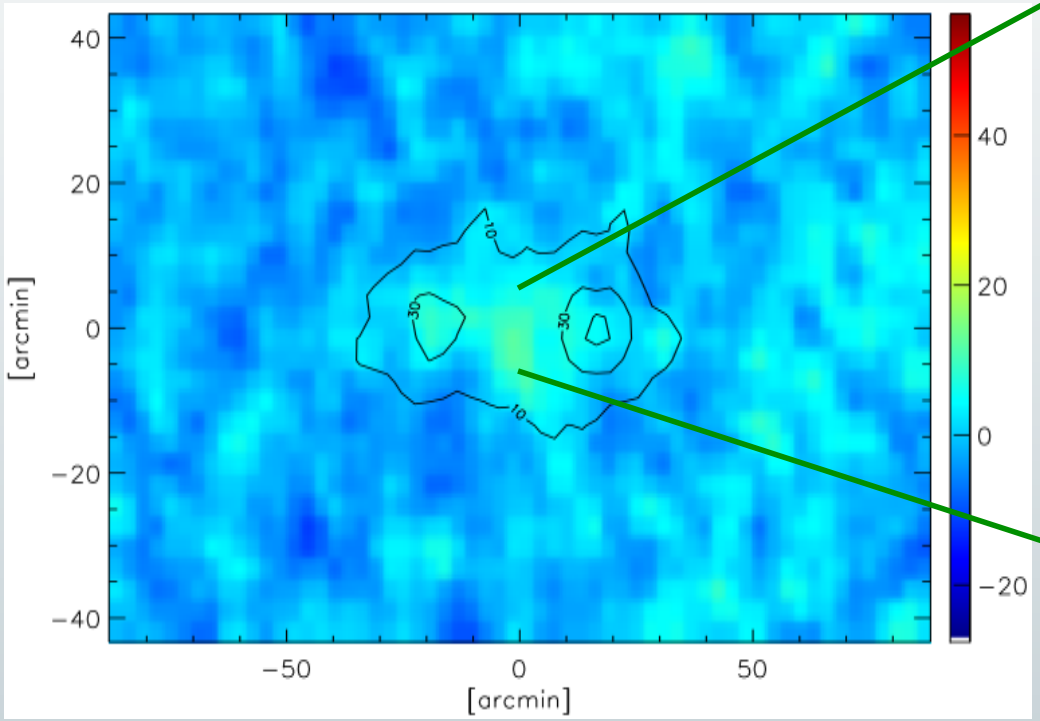
3rd extra cluster

$z \sim 2$

$M_{500} \sim 2.5 \times 10^{15} M_\odot$

→ Not consistent with structure formation model

SZ/X signal modeling



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$T_e = (7.08 \pm 0.85)\, keV$

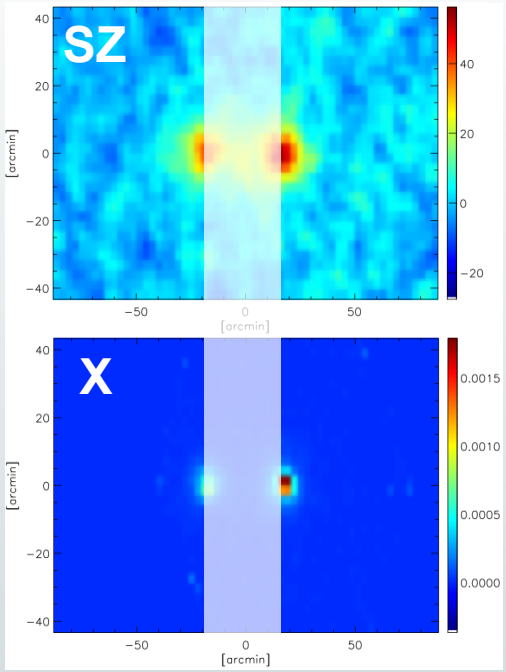
3rd extra cluster

$z \sim 2$

$M_{500} \sim 2.5$ [illegible]

Not co[illegible]t with stru[illegible]re fo[illegible]ion mo[illegible]el

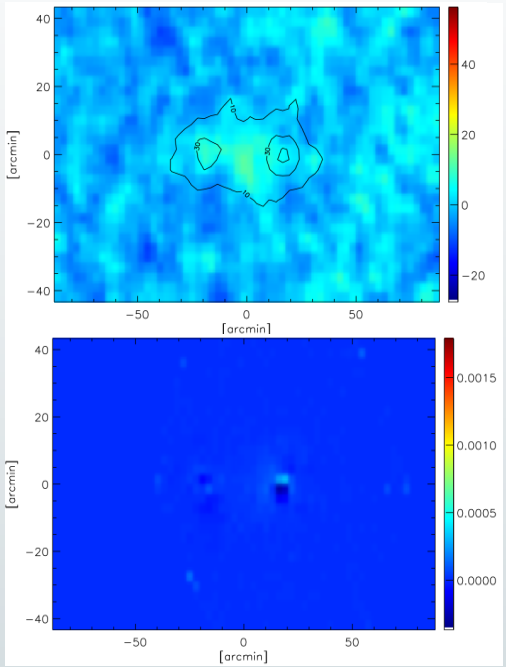
SZ/X signal modeling



$T_e = 5$ keV $T_e = 6.5$ keV

GNFW

c_{500}
$\alpha \equiv A10$
γ



Isothermal filament

$$n_e(r) = \frac{n_e(0)}{\left(1 + (\frac{r}{r_c})^2\right)^{\frac{3}{2}\beta}}$$

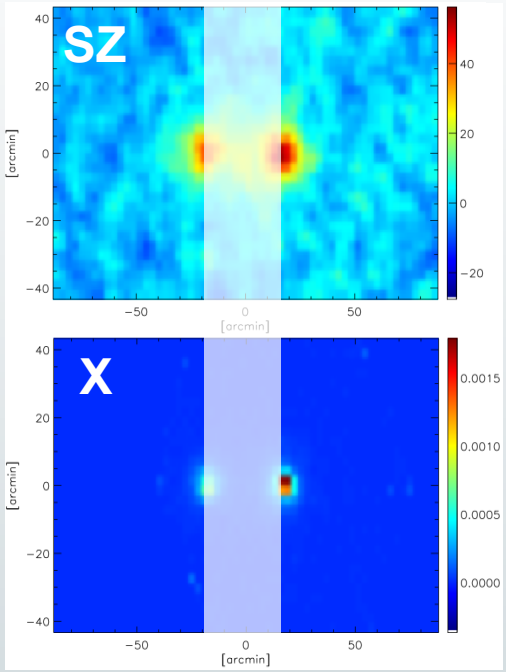
$\beta = 2/3$

$r_c = 10'$

$n_{e,0} = (3.72 \pm 0.17) \times 10^{-4} cm^{-3}$

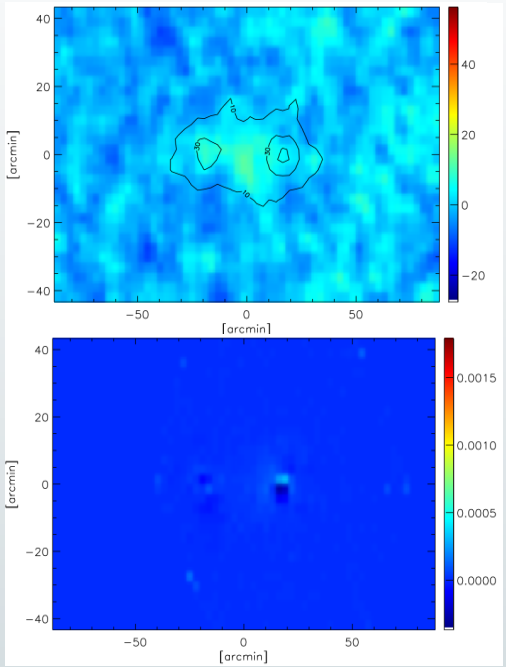
$T_e = (7.08 \pm 0.85)\, keV$

SZ/X signal modeling



GNFW

c_{500}
$\alpha \equiv A10$
γ



Isothermal filament

$$n_e(r) = \frac{n_e(0)}{\left(1 + (\frac{r}{r_c})^2\right)^{\frac{3}{2}\beta}}$$

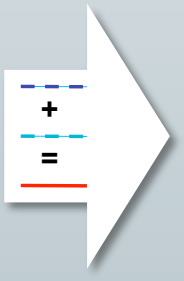
$\beta = 2/3$

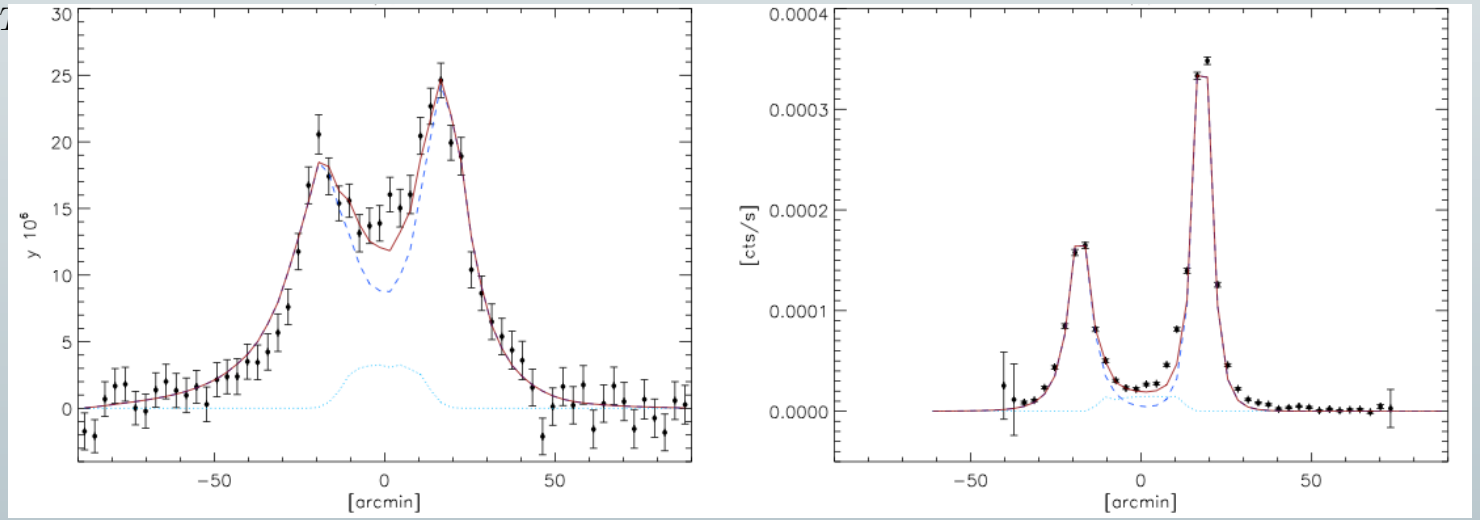
$r_c = 10'$

$n_{e,0} = (3.72 \pm 0.17) \times 10^{-4} cm^{-3}$

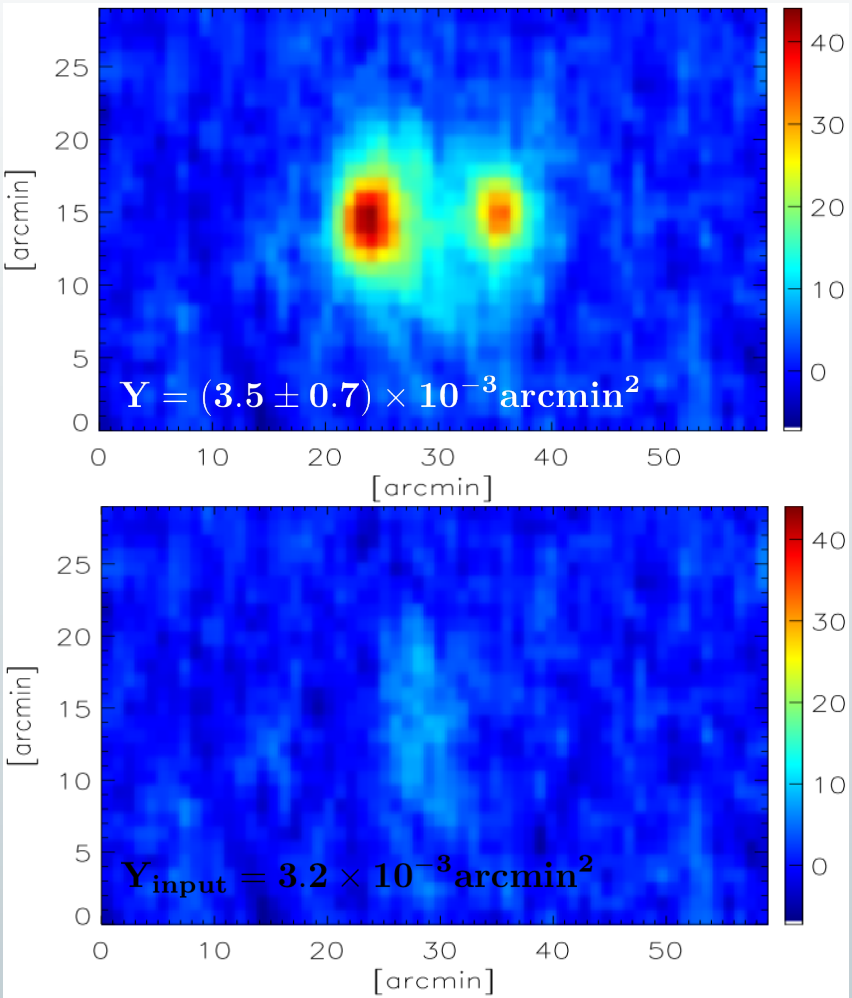
$T_e = (7.08 \pm 0.85)\, keV$

$T_e = 5$ keV

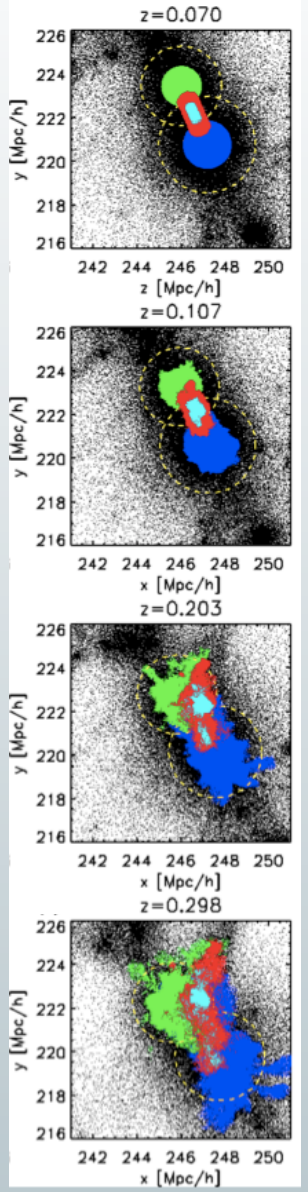




Hydrodynamic simulations



z



0.4 Gyr

1.5 Gyr

2.5 Gyr

- $r < 0.5R_{vir}$
- $r > 0.5R_{vir}$ $d_{cyl} > 1Mpc/h$
- $r > 0.75R_{vir}$ $d_{cyl} > 0.5Mpc/h$

Dolag et al. (2006) + cooling, feedback, UV background

Conclusions

• Planck data: first & high significance detection of inter-cluster SZ signal (A399-A401)

• complementary wavelengths and simulations can be very useful in characterizing the origin and the physical properties of the *inter*-cluster material

→ *Planck data are particularly well suited for stuyding these yet unexplored emissions and components*

- SZ power spectrum *(yesterday talk by J. F. Macias-Perez)*
- New Planck SZ catalogue
  +
- High-resolution follow-up