Mapping the kinetic Sunyaev-Zel'dovich effect with kinetic inductance detectors in MACS J0717.5+3745

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Marco DP – Feb 22, 2016

Abstract ---

".. but its observation is challenging both in term of sensitivity requirement and control of systematic effects."

also the contaminants should have to be remind here, see CMB.

Introduction --

pag.2

"... and on statistical samples (e.g., Planck Collaboration et al. 2014b) ..."

Also previous attempts of studying kSZ towards clusters to explore velocity field on scales >100 Mpc (aka bulk flows) of Kashlinsky et al. 2008 and Komatsu et al. 2011 using CMB maps produced by WMAP could be cited.

Regarding the new results with Planck data two papers are discussing them: Planck Collaboration et al. 2014 and Atrio-Barandela 2013.

"and constitute a primary choice target"

and constitutes a primary choice target

2. Sunyaev-Zel'dovich observations and data reduction ----------

2.1. The Sunyaev-Zel'dovich effect

pag.3

"The parameters \sigma_T is the Thomson cross section"

The parameter ...

"The coefficients f(\nu, T_e) and g(\nu, T_e, v_z) are computed ..."

It sounds strange (at least to me) to recall them as coefficients.

You could write, as example:

The functions f(\nu, T_e) and g(\nu, T_e, v_z) are integrated over NIKA bands and the values are listed in Table 1 for a few electronic gas temperature values.

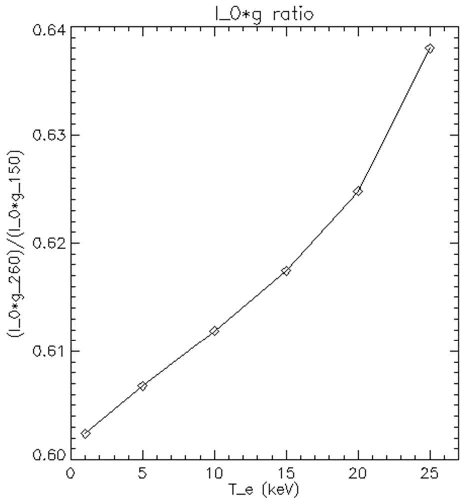
Moreover in Table 1 "the coefficients .. account for the atmospheric absorption" this means that in the columns are not listed I_0*f or I_0*g (at the two bands) but I_0*f*t and I_0*g*t, with t referring to the atmo transmission to show clearly that they are not exactly the members in eq.3.

Regarding Table 1, I would like to understand clearly what is reported.

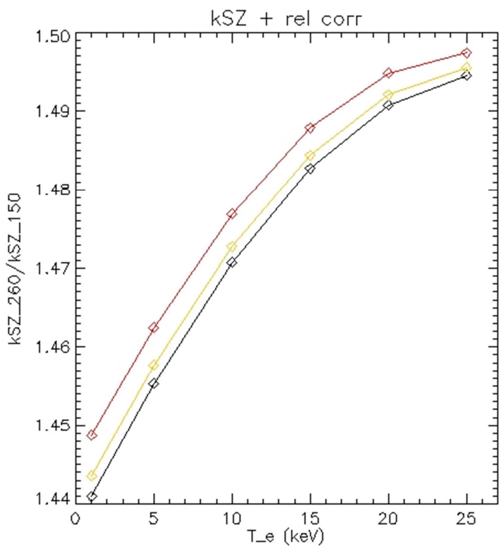
T_e (keV)	$I_0\ f$(260 GHz)	$I_0\ f$(150 GHz)	$I_0\ g$(260 GHz)	$I_0\ g$(150 GHz)
1	3.76	-11.63	7.47	12.40
5	3.31	-11.34	7.30	12.03
10	2.83	-11.00	7.11	11.62
15	2.43	-10.71	6.94	11.24
20	2.06	-10.38	6.81	10.90
25	1.76	-10.17	6.75	10.58

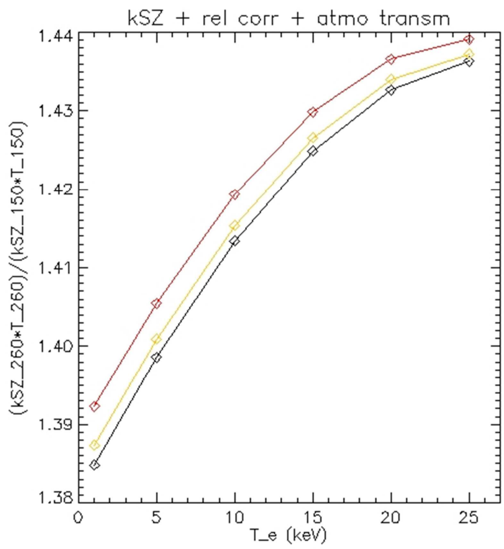
I am focusing only on the kSZ component: I_0*g.

The ratio of the 260 and 150 GHz values are plotted in the following figure.



I expect that the 2 NIKA bands (150 and 260 GHz) should have an almost similar kSZ contribution, with the 260 GHz band a bit higher.
Assuming the filters with a gaussian profile (FWHMs of 40 and 50 GHz, respectively) I have estimated the ratio I_0*g@260/I_0*g@150 for the same electronic temperature values and for 3 values of the gas velocity.
The ratios are plotted in the following left figure with velocity equal to 500 km/s (black), 1000 km/s (yellow) and 2000 km/s (red).
The ratios including the atmospheric transmission are plotted on the right figure.





Starting form a zenith opacity equal to 0.0830000 and 0.113000 at 150 and 260 GHz, I derived the transmission values of 0.895856 and 0.860943, for an elevation of 49 deg.
I would like to recover the factor (almost) 2 that is missing to me in the ratios.
Probably the exact filter transmissions could modify this results.

2.2. NIKA observations and data reduction ---------------------
pag.3

".. and a stable atmosphere."
Is it possible to quantify this statement, as an example, with the standard deviation of opacity? … but this could be only for my interest …

"The pointing center was (R.A., Dec.)"

2000

"the absolute calibration uncertainty are ..."
uncertainties are ...

"However, most of the data were taken between elevations of 35 and 62 degrees, with a mean of 49 degrees, such that we expect this bias to be less than a few percent and we neglect it."
You could remind that the observations were performed around the elevation where the reflector is free of gravity deformations (Gain=1), i.e. around 43 deg for IRAM 30–m telescope (as in Greve 1998).

"The instrumental noise and the atmospheric noise residual are estimated"
residuals

2.3. NIKA raw maps ---
pag.3

"The noise is relatively constant within a radius of 1.5 arcmin around the map centers and increases radially toward the edges. "
Is it due to a lower integration time towards directions far from the center or is it a problem of the filtering procedure on the edge of the map?

pag.4
"... and the choice of this regions has no impact on the results we present"
these regions ...

Anyway in Figure 4, the average brightness measured by NIKA in the 22 arcsec radius regions with center coordinates given in table 2 are plotted.
The data values could be different by moving the centers and/or varying the integration radius.

3.4. Construction of a mask for point sources --------------------
pag.6

Were the masks, shown in Fig.2, applied on the 22 arcsec smoothed maps or on the map before that smoothing?
In the first case, due to the fact that several point source masks have a dimension smaller than 22 arcsec the smoothed source contribution could not fully masked (TBC).

4. X-ray data reduction --
pag.6

I agree that XMM X-ray data could be useful also to better constraint the center of regions A-D.

5.2. Reconstruction of the kinetic signal toward sub clusters ------------
pag.6

“We first consider the mean surface brightness measured in the four regions provided in table 2 and shown in figure 1.”
Are you taking the mean value inside the circular regions shown in Figure 1? What values for the aperture did you assumed?

“… if we consider only the tSZ effect, we see from the red constraint (the overall tSZ plus kSZ constraint) that some signal is detected thanks to the 150 GHz band, …”
This statement is not clear to me.

5.3. Mapping of the kSZ and tSZ signal --------------------------
Pag.8

"The results of section 5.2 provide quantitative illustration of our constraints, but they directly depend on the choice of the region coordinates …"
I think that the values are also depending on the aperture size.
In Ma et al. the region C is larger than the others: did you considered larger aperture?

"Before combining the two data sets, we convolve the NIKA maps to the same angular resolution, i.e., 22 arcsec."
But this has already been done in Figure 1, or not?

6.1. Physical modeling of the gas distribution of MACS J0717.5+3745 ------------------
Pag.10

"The line of sight gas velocity of each clump is also assumed to be a constant."
You are assuming that each clump has their own bulk velocity.

Eq.9
I think that a sky direction on the modelled maps has to be included in eq.9 by sky coordinates (\theta & \phi) or sky pixels (i & j). The 4 sums have different sky apertures with, possibly, overlaps. Each i-clump has a different sky aperture, A_i.

"The integrals line of sight integrations are …"

6.2. Fitting algorithm --
Pag.11

"Therefore, we fix the slopes to \beta^(i) = 2, …"
I would like to set a lower value for \beta (e.g. 2/3) leaving, as you write, the freedom to match the clump to a lower core radius value.

At the beginning of pag.11 it is written:
"Pixels that are potentially contaminated by point source residuals are masked so that they do not contribute the likelihood."
I am worried that when you mask a "large" contaminant source (e.g. galaxy F) the best fit profile of the closest clump (region C) could be "deformed", due to missing values, leaving unwanted residuals.
Did you tried to do the MCMC fit without the mask too?

6.3. Constraints on the velocity -------------------------------
Pag.11

"The 260 GHz map is also mostly consistent with noise…"
Apparently in Fig.6 (top right map) the residuals fully match the data pattern; at least in this version…

6.4. Comparison to previous results and limitations

It should be useful to produce the map of the ratio y_tsz/y_ksz where, under the usual assumptions, could map the ratio of T_e and l.o.s. velocity to try to constraint the degeneracy between \tau and \beta.
At the moment the T_e and l.o.s. velocity ratios, as derived by Sievers and this work, are not consistent towards the two sub clusters B and C, see the following table.

	Sievers et al. 2013		NIKA this work	
Sub cluster	T_e (keV)	l.o.s. vel (km/s)	T_e (keV) *	l.o.s. vel (km/s)
B	11.4±0.5	3450±900	8.0	4303(+1084-902)
C	19.9(+1.5-1.4)	-550(+1350-1400)	14.0	-1559(+510-441)

(*) by Chandra