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THE COSMOLOGICAL FREE-FREE SIGNAL FROM GALAXY GROUPS AND CLUSTER

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ABSTRACT:

using analytical model and cosmological N-body simulations, we study the free-free radio emission from ionized gas in clusters and groups of galaxies. The results obtained with the simulations are compared with analytical predictions based on the mass function and scaling relations. Earlier works based on analytical models have shown that the average free-free signal from small haloes (galaxies or smaller) during and after the reionization time could be detected with future experiments as a distortion of the CMB spectrum at low frequencies (ν< 5 GHz). We focus on the period after the reionization time (from redshift z=0 up to z=7) and on haloes that are more massive than the previous works (groups and clusters). We show how the average signal from haloes with $M > 10^{13}\ h^{-1}\ M_{*}$ is less than 10% the signal from the more abundant and colder smaller mass haloes. However the individual signal from the massive haloes could be detected with the future experiments opening the door for a new window to study the intracluster medium.

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FREE-FREE EMISSION free electron moves and interacts in the +ion Coulombian field emitting radiation

$T \geq 10^4$ Temperture of the hot plasma ► emission in the radio band **1 – 10 GHz**, weakly dependent on the frequencies range in the Rayleigh -Jeans limit

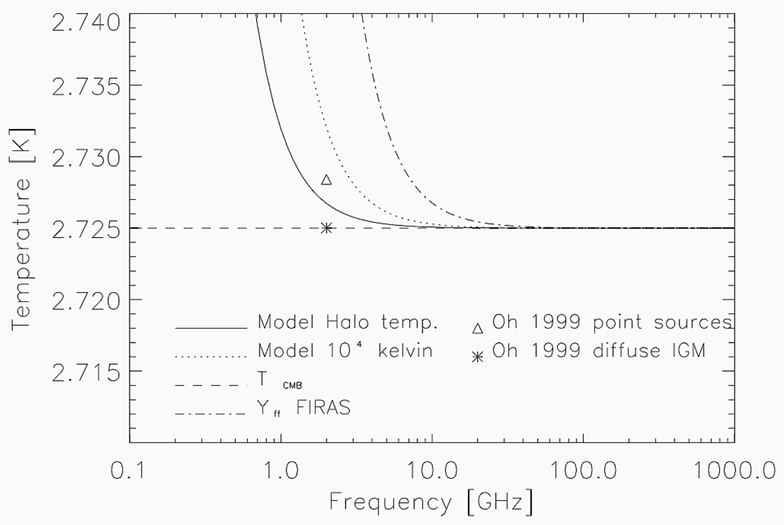
EMISSION $\epsilon_\nu \propto \frac{n_e^2}{T^{1/2}}$ [erg cm^{-3} sec^{-1} Hz^{-1} sr^{-1}] ► **LUMINOSITY** $L_{\rm ff}$ from a SINGLE halo with $10^8 M_\odot \leq M \leq 10^{16} M_\odot$ ► **BRIGHTNESS** $S_{\rm ff} = \frac{L_{\rm ff}}{D_{\rm L}^2}$ [Jansky]

HALO MASS FUNCTION: # of haloes forming per mass and per redshift intervals (Sheth & Tormen 1999)

$$\int_z \int_M \frac{dN(M,z)}{dMdVol} dMdVol \times S_{\rm ff}$$ **BRIGHTNESS OF THE SKY**

Completely ionized haloes during and after the reionization epoch $0 < z \leq 7$

1



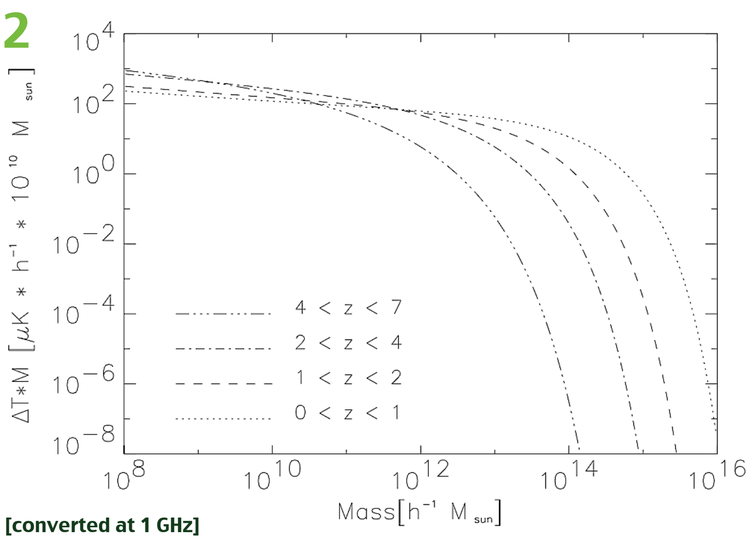
Measureable distortion on the CMB temperature [Kelvin]

The effect is computed using both the virial T of the haloes (depending on their masses) (continuous line) and the ionizing T of 10^4 Kelvin (dotted lines)

Is reported the actual constrain of the free-free distortion (Bersanelli et al1994)

The data points are from Oh 1999, an analytical study of the free-free emission both from haloes and diffuse IGM.

2



[converted at 1 GHz]

Temperature distortion per mass interval in function of the mass of the halo. Contributions of lower masses are significantly larger than the contributions from more massive haloes. The trend is confirmed for different redshifts.

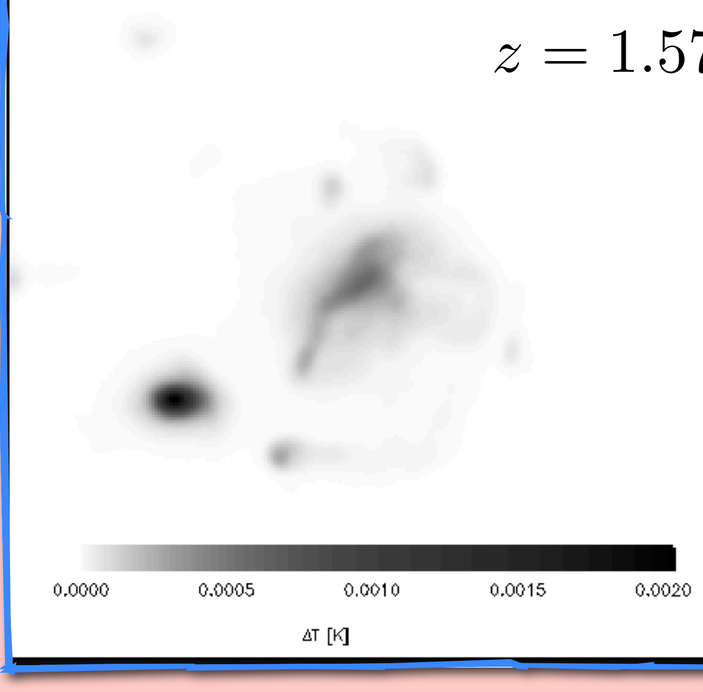
Temperature distortion in function of the redshift, 0< z ≤ 7. Differents ranks of masses are plotted. Lower masses contribute largely than the more massive ones at all redshifts.

SIMULATIONS

4

$M = 6.6 \times 10^{14} M_\odot$

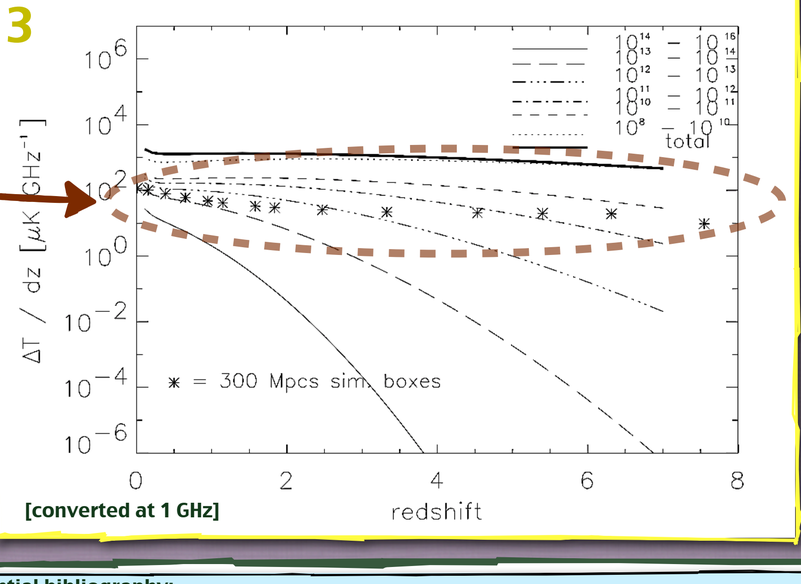
$z = 1.57$



Effect simulated with N-body simulation.
300 h^{-1} Mpc side box evolved in z, filled with 5123 dark matter particles and 5123 gas particle.
In such simulation, only mid-high masses are represented (10^{12}-10^{14} M_*).

Effect of the resolution:
single halo extracted from a 50 h-1 Mpc side simulation. Future experiments could detect the brightess of the single object, open a new window in the cluster study.

3



[converted at 1 GHz]

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