"Astrophysics with E-LOFAR"

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Reionization & 21cm observations

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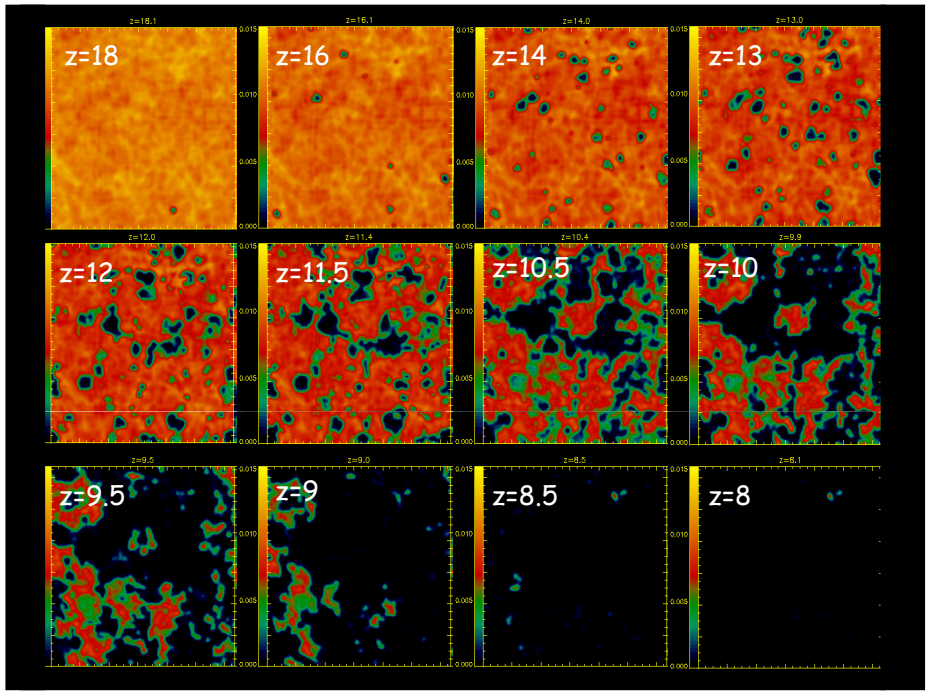
& the LOFAR EoR Team

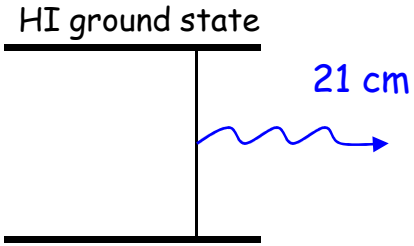
Simulations of reionization

(BC, Stoehr & White 2003; BC, Ferrara & White 2003; BC et al. 2006)



Predictions for 21cm signal

21cm line diagnostic

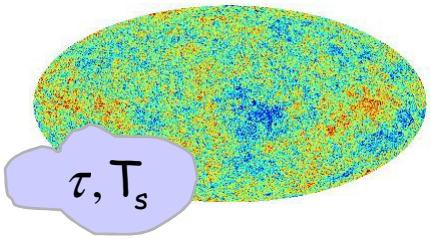


Ideal probe of neutral H at high-z
different observed frqs. → different z

Differential brightness temperature:

$$\delta T_b \approx \frac{T_s - T_{CMB}}{1+z}\tau \propto (1 - T_{CMB}/T_s)$$

spin temperature



$T_{CMB} = T_s \Rightarrow$ no signal

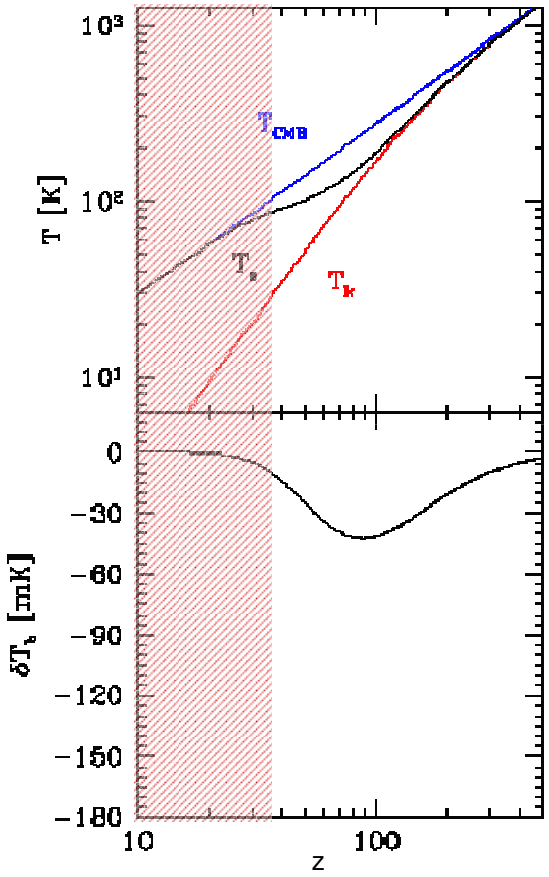
$T_{CMB} > T_s \Rightarrow$ absorption

$T_s > T_{CMB} \Rightarrow$ emission

kinetic temperature of the gas

$$T_s = \frac{T_{CMB} + (y_\alpha + y_c)T_k}{1 + y_\alpha + y_c}$$

Lya scattering & heating



- In the absence of decoupling mechanisms, other than collisions, 21cm line will not be visible at z<20

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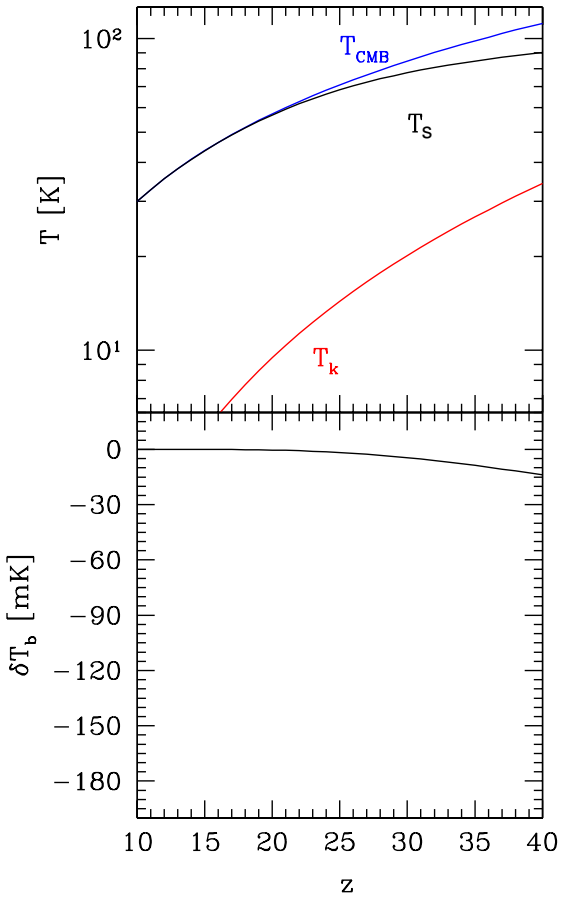

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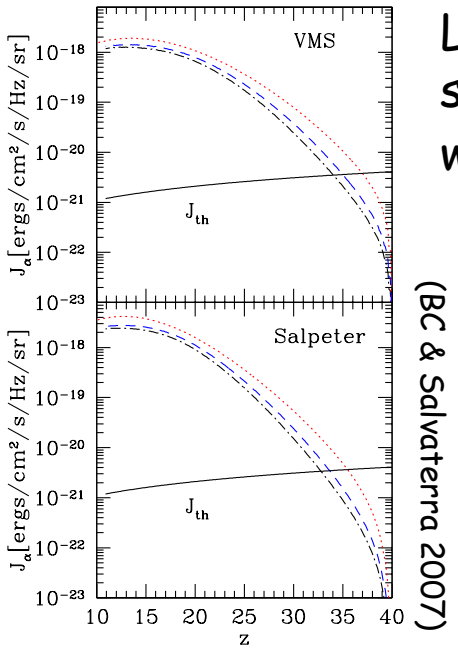
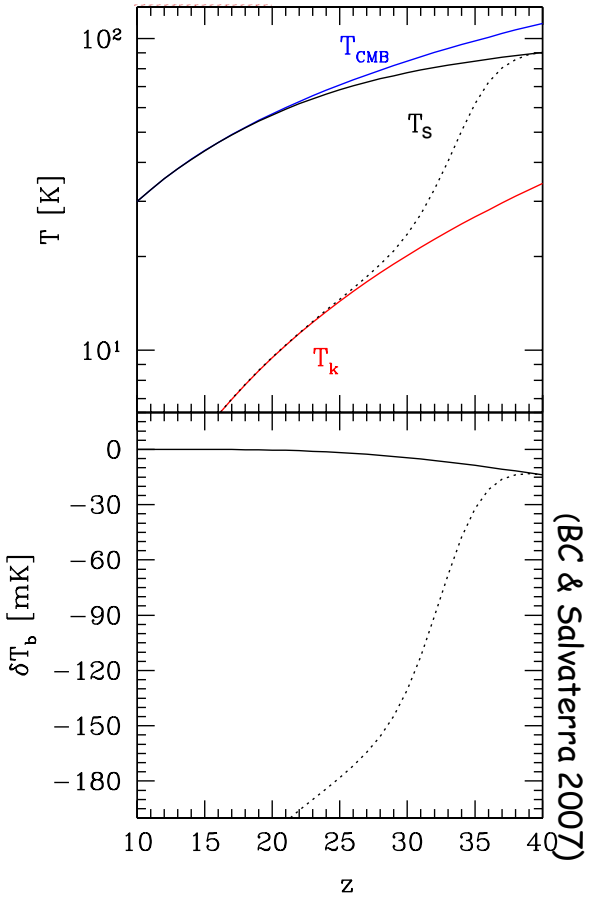


Lya background from metal-free stars with Salpeter IMF or VMS with M=300Msun

(BC & Salvaterra 2007)

Lya scattering & heating



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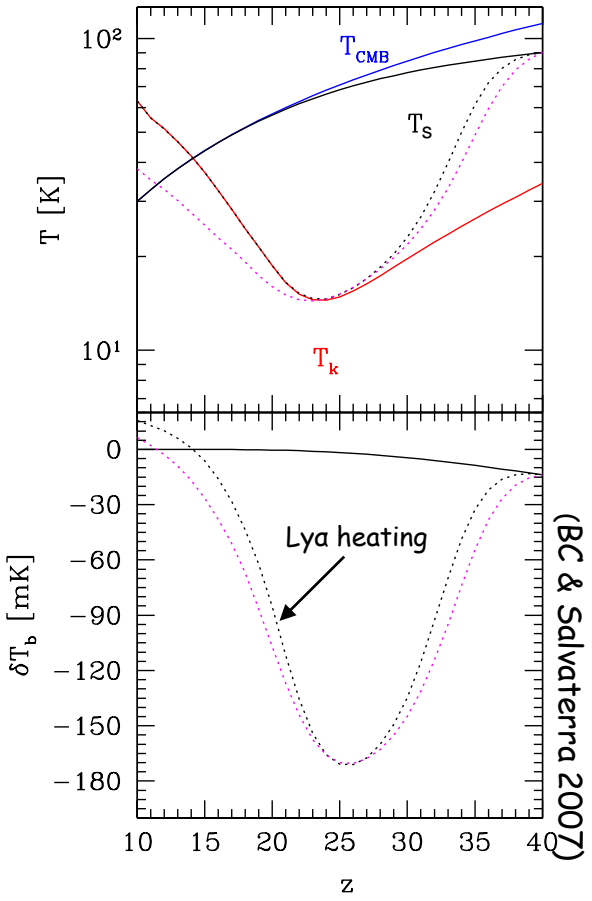
Lya scattering & heating



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- Lya photon scattering decouples T_S from T_{CMB} → 21cm line can be observed

- Lya photon scattering heats the gas → 21cm line can be observed in emission

Lya heating is effective for $z \leq 15$

Metal-free stars, Salpeter IMF

Very massive metal-free stars

CRASHalpha

: continuum radiation (H, He)

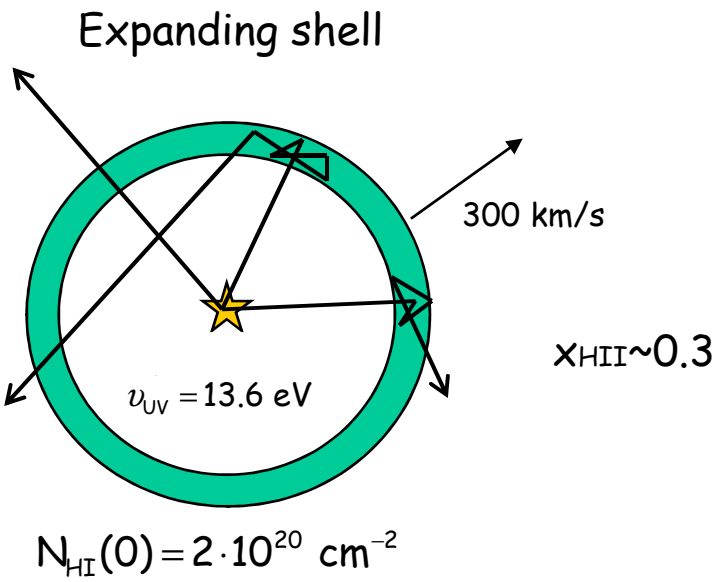
(BC et al. 2001; Maselli, Ferrara & BC 2003; Maselli, BC & Kanekar 2008)

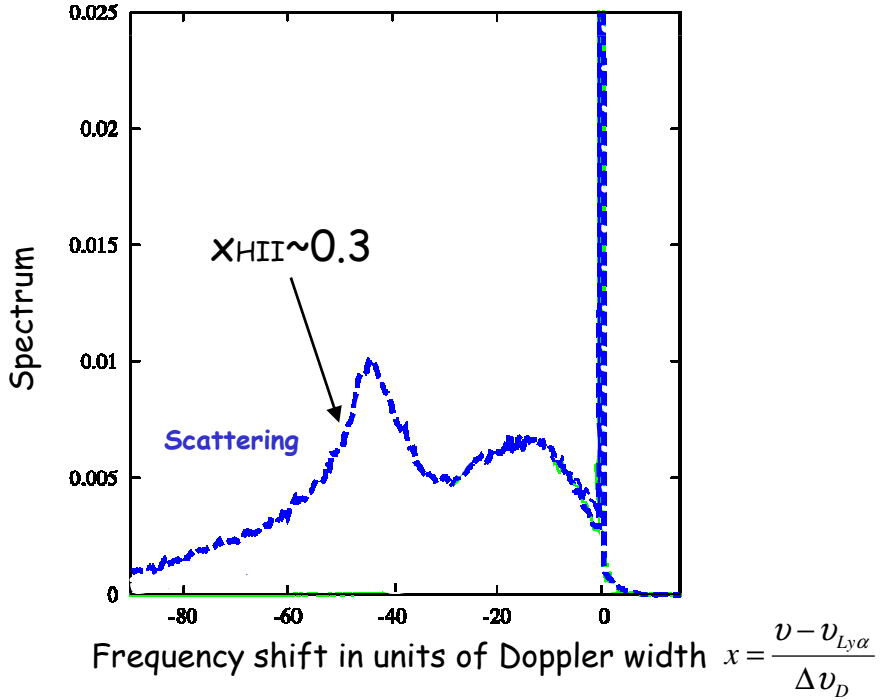
MCLyalpha: Lyalpha scattering

(Verhamme, Schaerer & Maselli 2006)

CRASHalpha: continuum radiation + scattering

(Pierleoni, Maselli & BC 2008)





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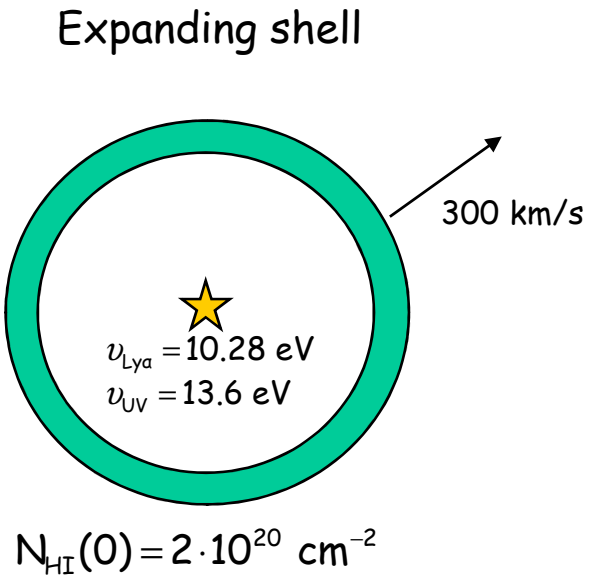

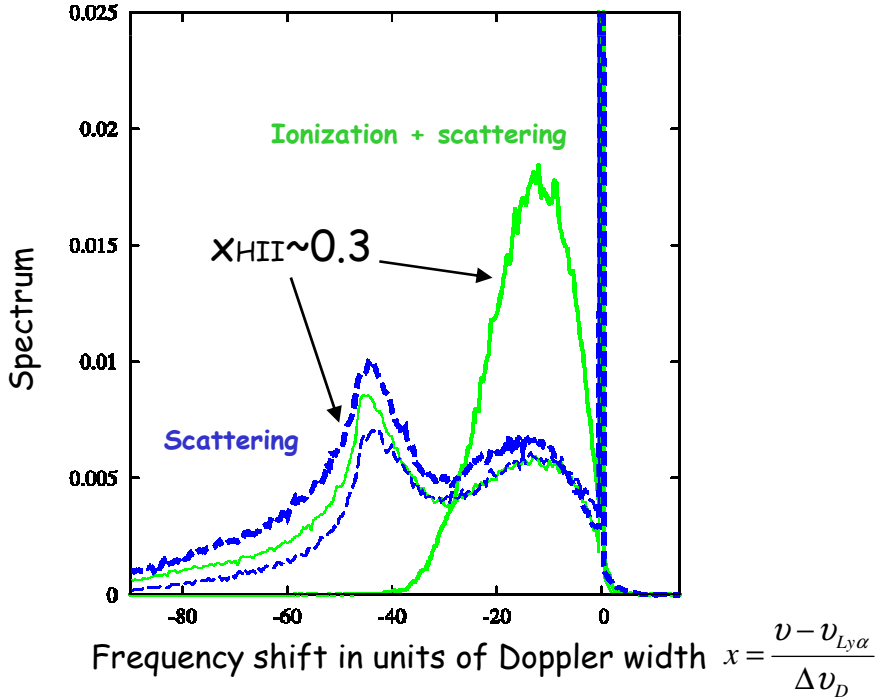

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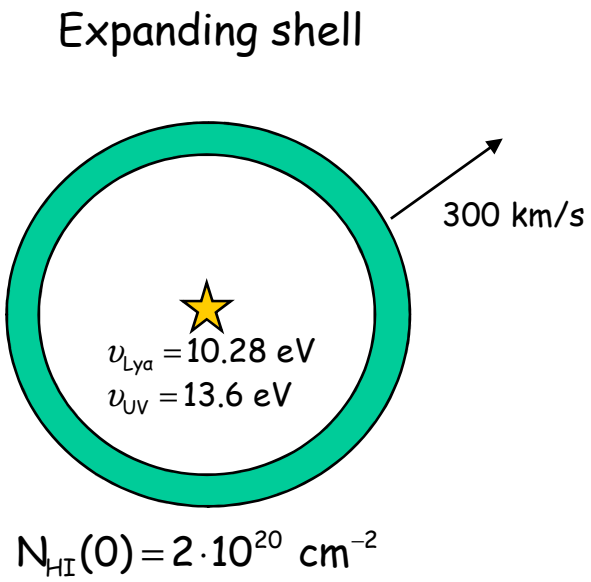
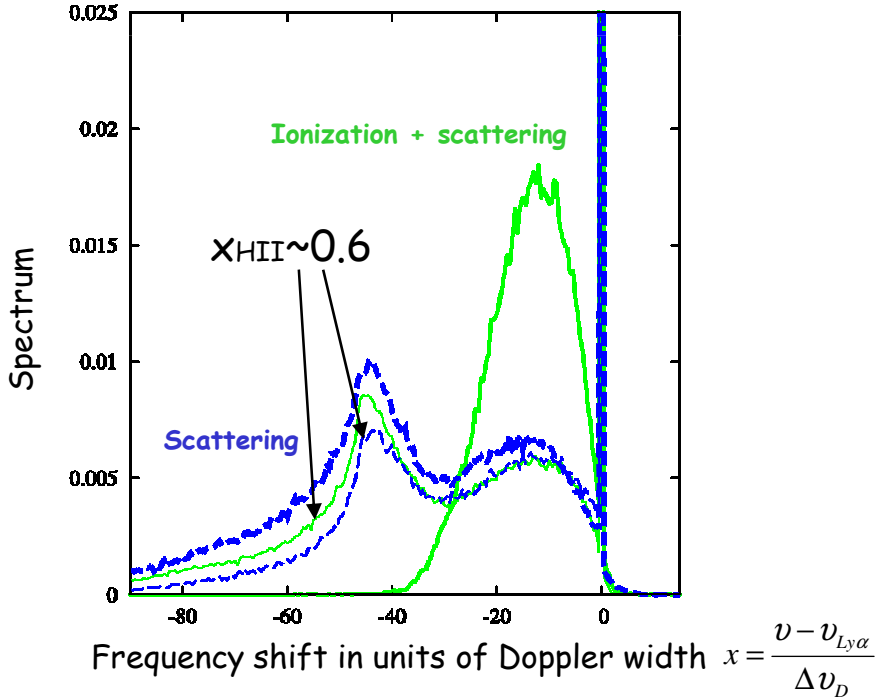
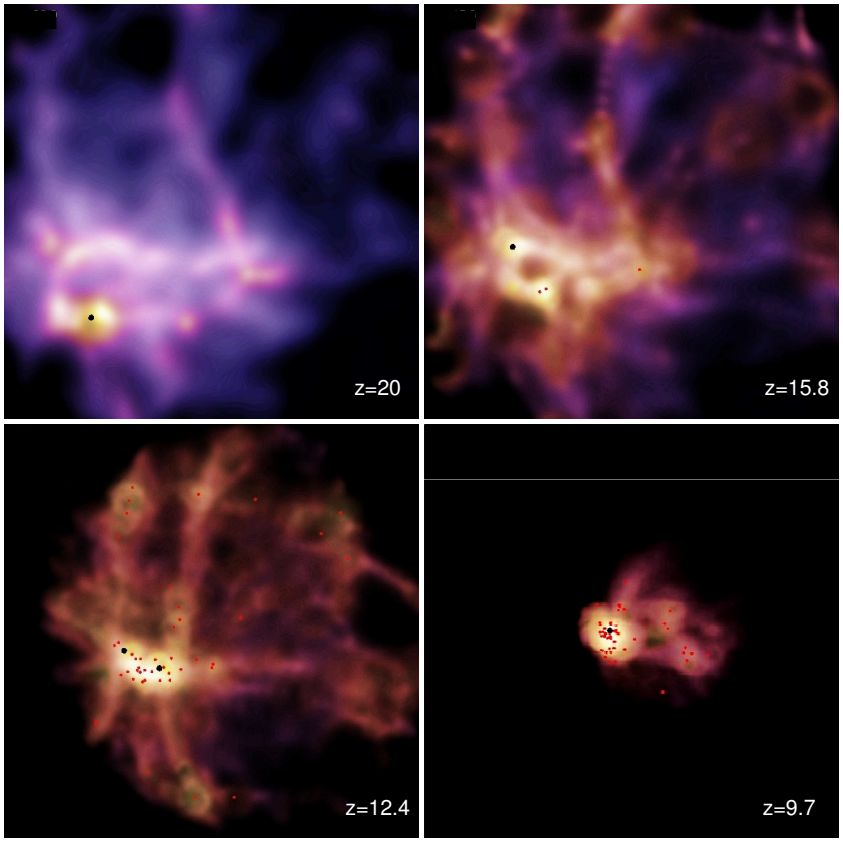




X-ray heating

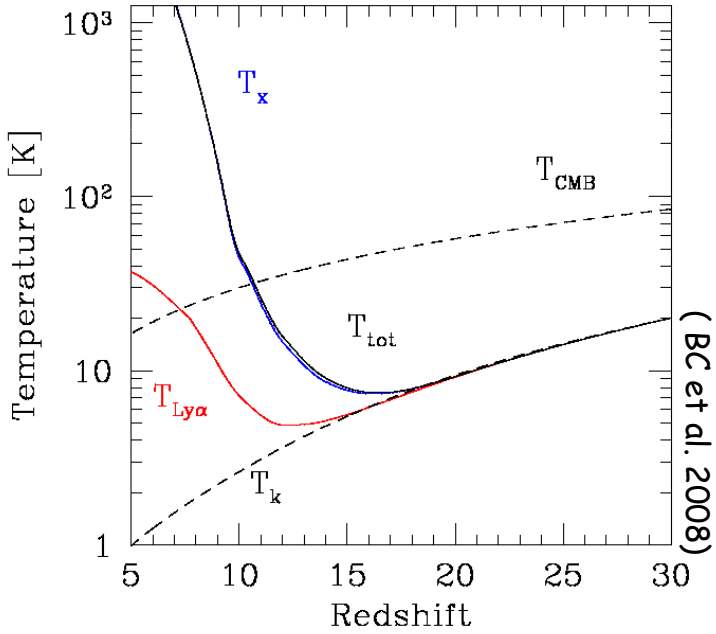


200 kpc com.

$M = 10^{10} M_{\oplus}$

(Pelupessy, Di Matteo, BC 2007)

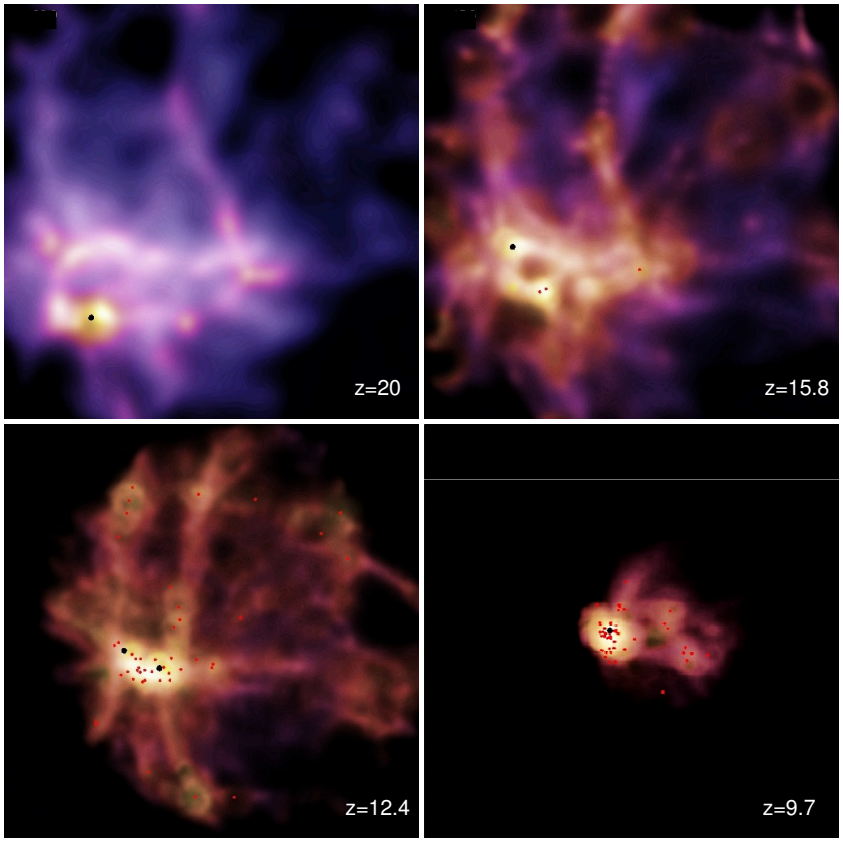
- SPH simulations to study the formation of z~6 QSOs
- Merger of BHs hosted by parent halos and accretion onto them are followed



(BC et al. 2008)

Accretion onto the BHs → X-ray emission
SFR → Lyalpha emission

X-ray heating



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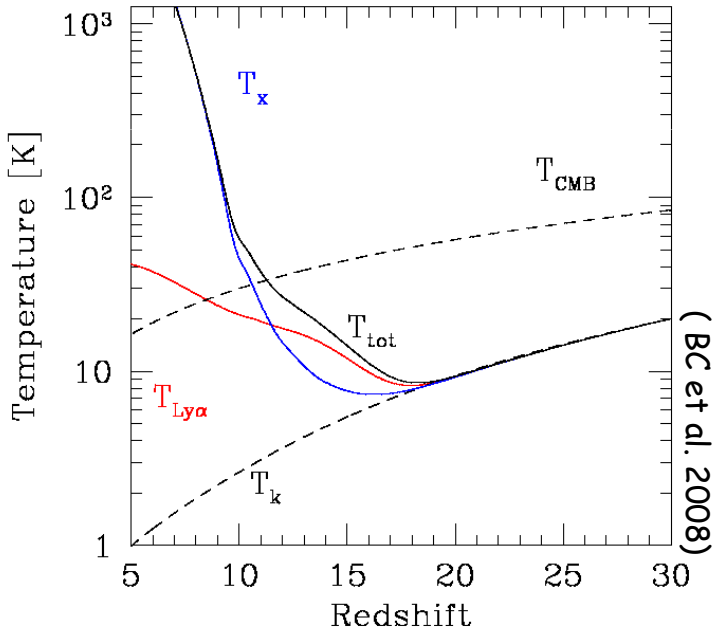

(BC et al. 2008)

Accretion onto the BHs → X-ray emission
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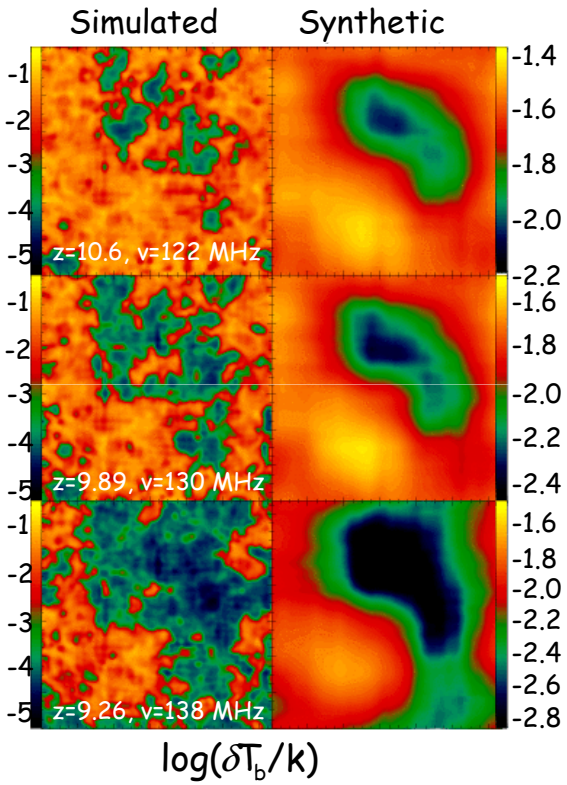
21cm line diagnostic

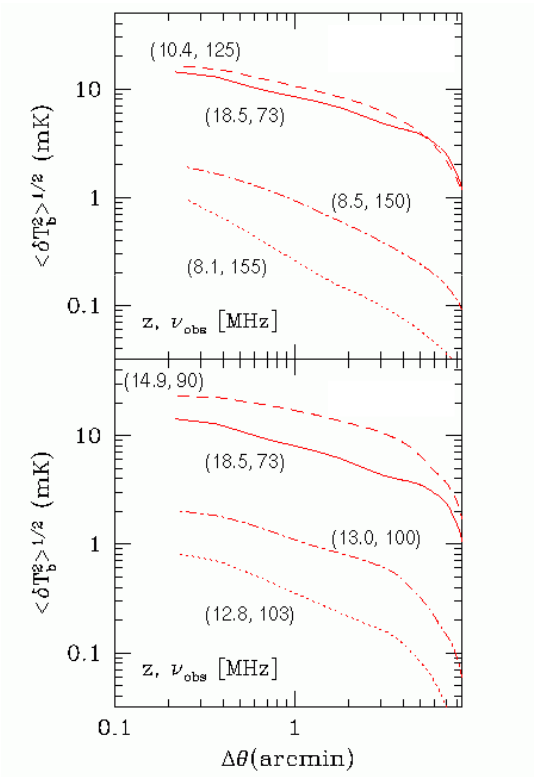
IGM Tomography

(Valdes, BC et al. 2006)



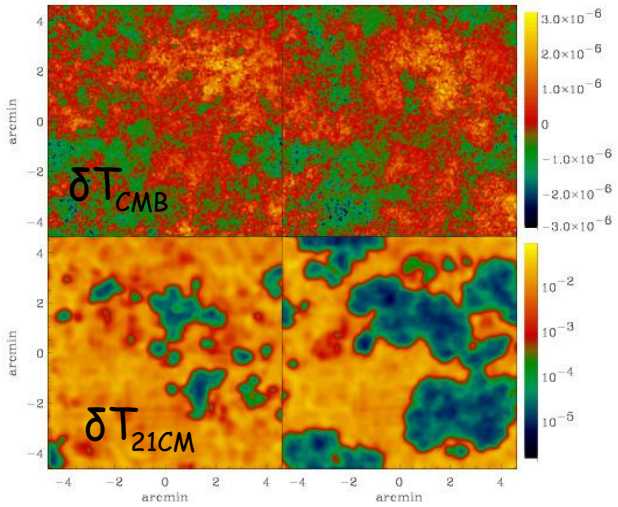
δTb Fluctuations

(BC & Madau 2003)



Correlation 21cm-CMB

(Salvaterra, BC et al. 2005)



Conclusions

- Simulations of cosmic reionization → predictions for 21cm line
- 21cm diagnostic:
  - IGM tomography
  - Brightness temperature fluctuations
  - Combination with other observations, i.e. CMB anisotropies
- Importance of Lyalpha and x-ray photons for observability