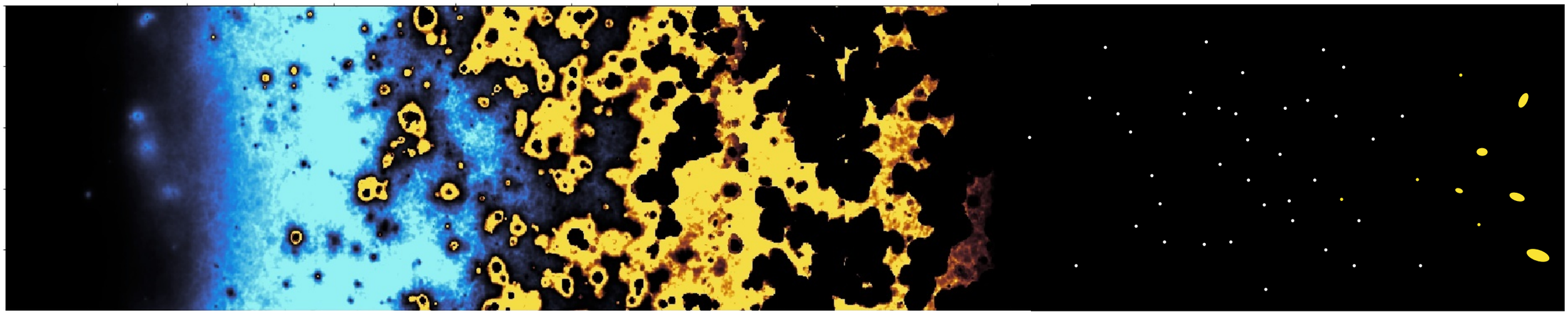
Predicting the 21cm signal at cosmic dawn

… and forecast results for SKA-LOW

Aurel Schneider — University of Zurich

SKA science

z = 25 → 15 → 6 → 0



SKA: an all purpose telescope !

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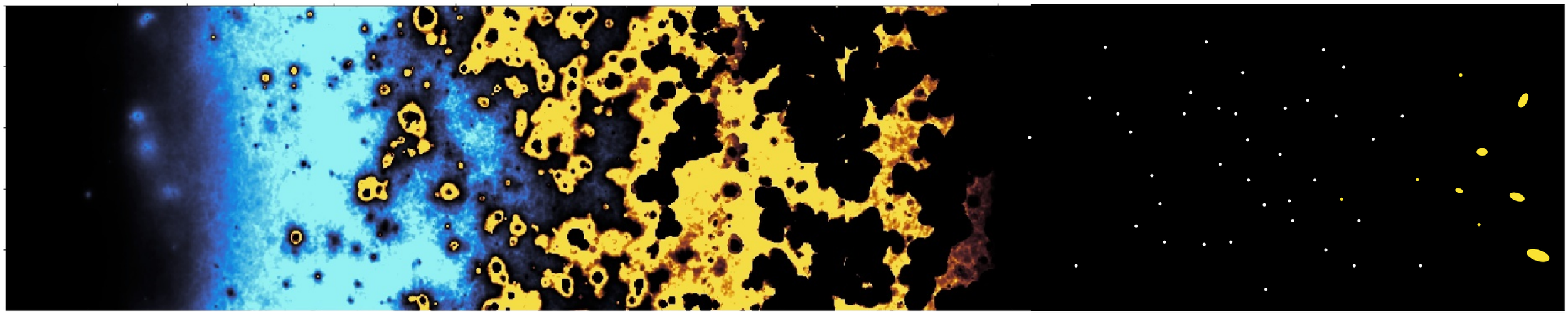


SKA: an all purpose telescope !

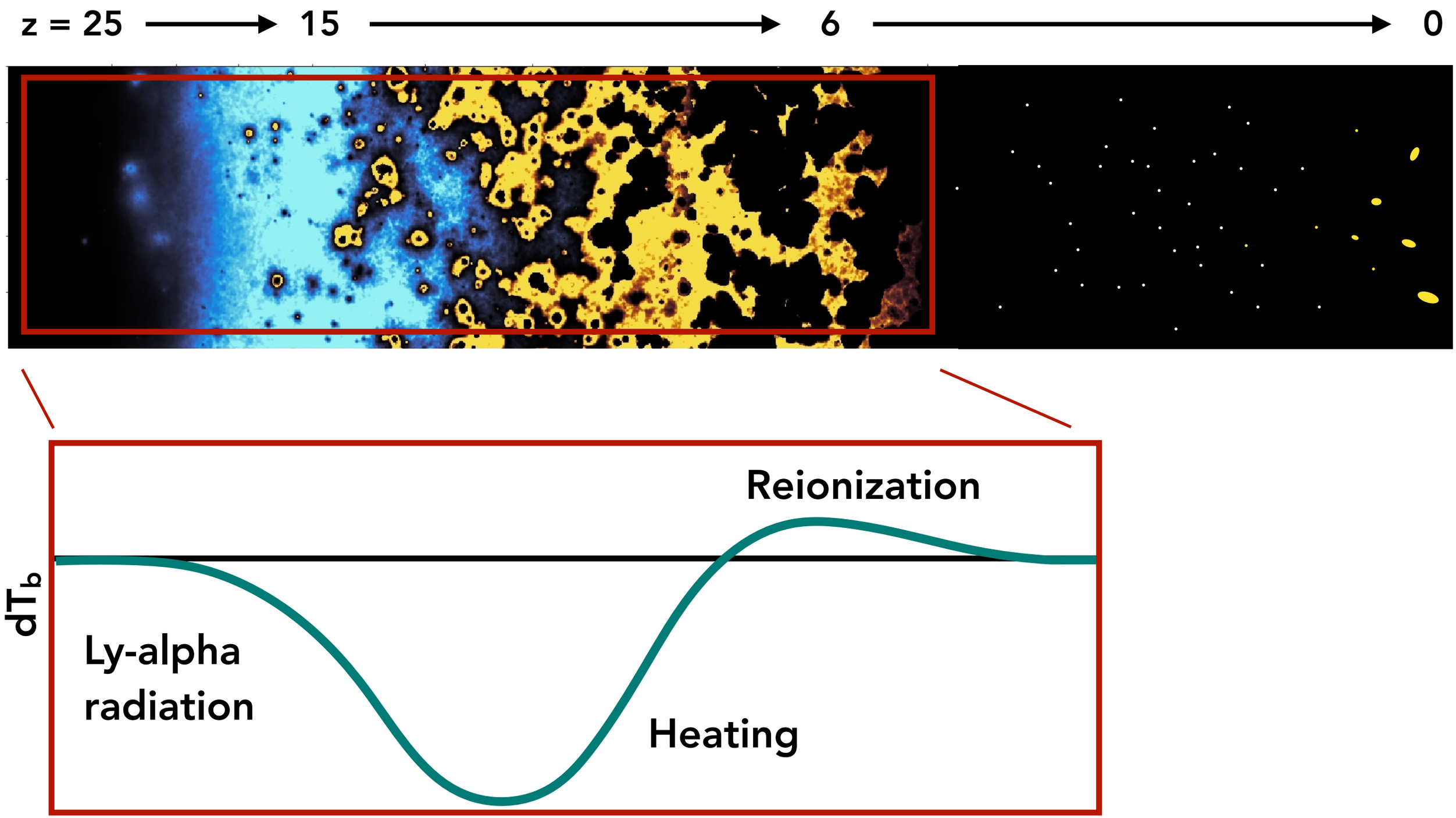
Intensity mapping

Individual galaxies

Weak lensing

Galaxy clustering

SKA science



Epoch of Reionization

Science Working Group

The Square Kilometre Array (SKA) is a global enterprise to build the largest scientific instrument on Earth, both in physical scale and in terms of the volume of data it will generate. Consisting of two telescope arrays located respectively in Australia and South Africa and managed from the SKA Organisation headquarters in the UK, the SKA promises to revolutionise our understanding of the universe. The science case for the SKA has the potential to appeal to users well beyond the radio astronomy community, spanning across a wide range of areas of physics, cosmology and astrophysics. Science working groups (SWGs) and Focus Groups (FGs) covering all these areas have been set up to further evolve the SKA science case, providing a conduit for interaction between the SKA Organisation science team and the astronomical community. This banner provides a summary of the Epoch of Reionizatio Science Working Group.

When did the first generations of galaxies form? What were their properties? How did they interact with each other? What is the structure of the intergalactic medium during the first billion years? What is the thermal and ionization history of the baryons?

The footprint of these processes is imprinted in the Hydrogen gas the major constituent of the intergalactic medium) and can be probed by observations of its hyperfine spectral line transition (occurring at the rest frequency of 21-cm). We plan to use the SKA to carry out the deepest observations of the diffuse neutral Hydrogen gas to trace the evolution of cosmic structure in the $6 < z < 30$ range, unveiling the epoch when the very first luminous structure were born and how their growth ionized the intergalactic medium.

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Goal of the EoR SWG:

We plan to use the SKA to carry out observations of the diffuse neutral Hydrogen gas to trace the evolution of cosmic structure in the $6 < z < 30$ range.

If you want to join, please contact:
Abhirup Datta (abhirup.datta@iiti.ac.in); Andrei Mesinger (andrei.mesinger@sns.it)

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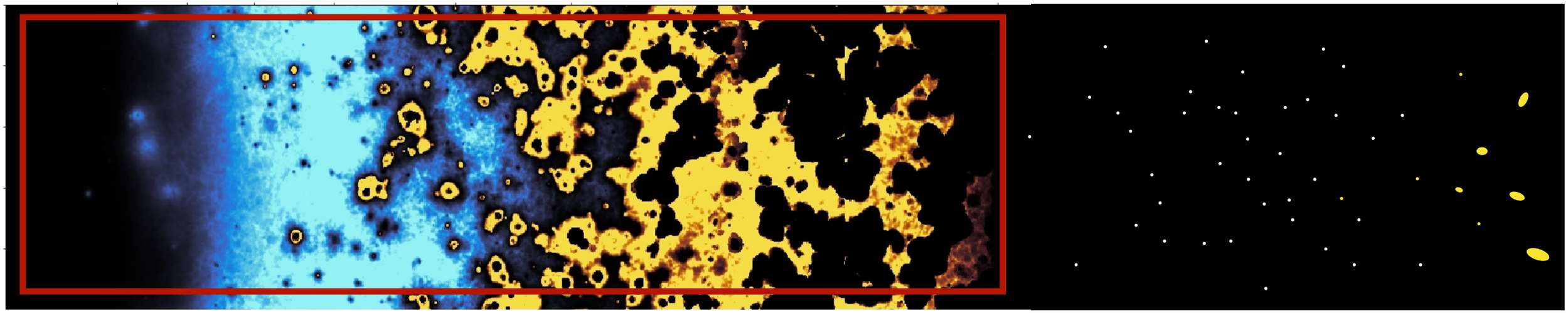

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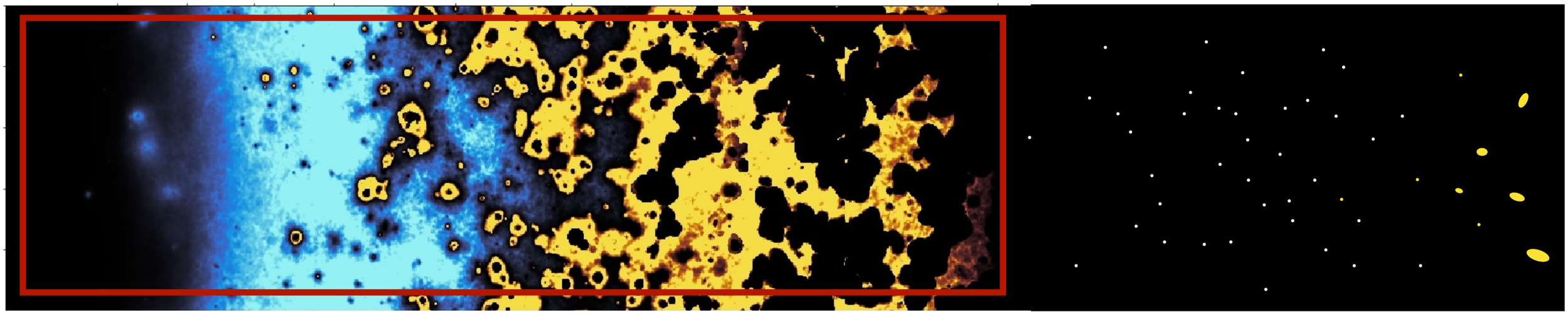


Signal depends on …

… nature of sources.

… abundance and distribution of sources.

… spectral properties of sources.

… cosmological parameters.

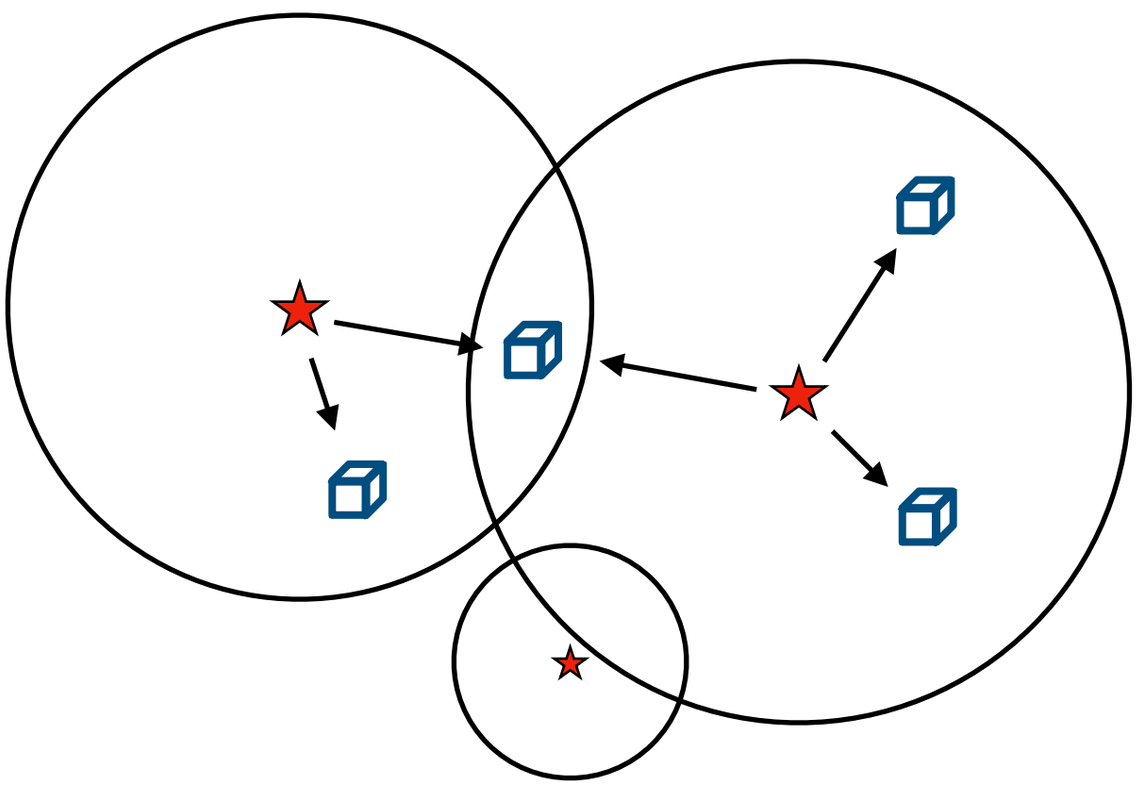
… exotic physics.

→ **Very large parameter space = fast methods required !**

Modelling the EoR

Fast methods to predict the power spectrum (plus maps) based on 1d radiative transfer around sources.

Halo (source) model approach

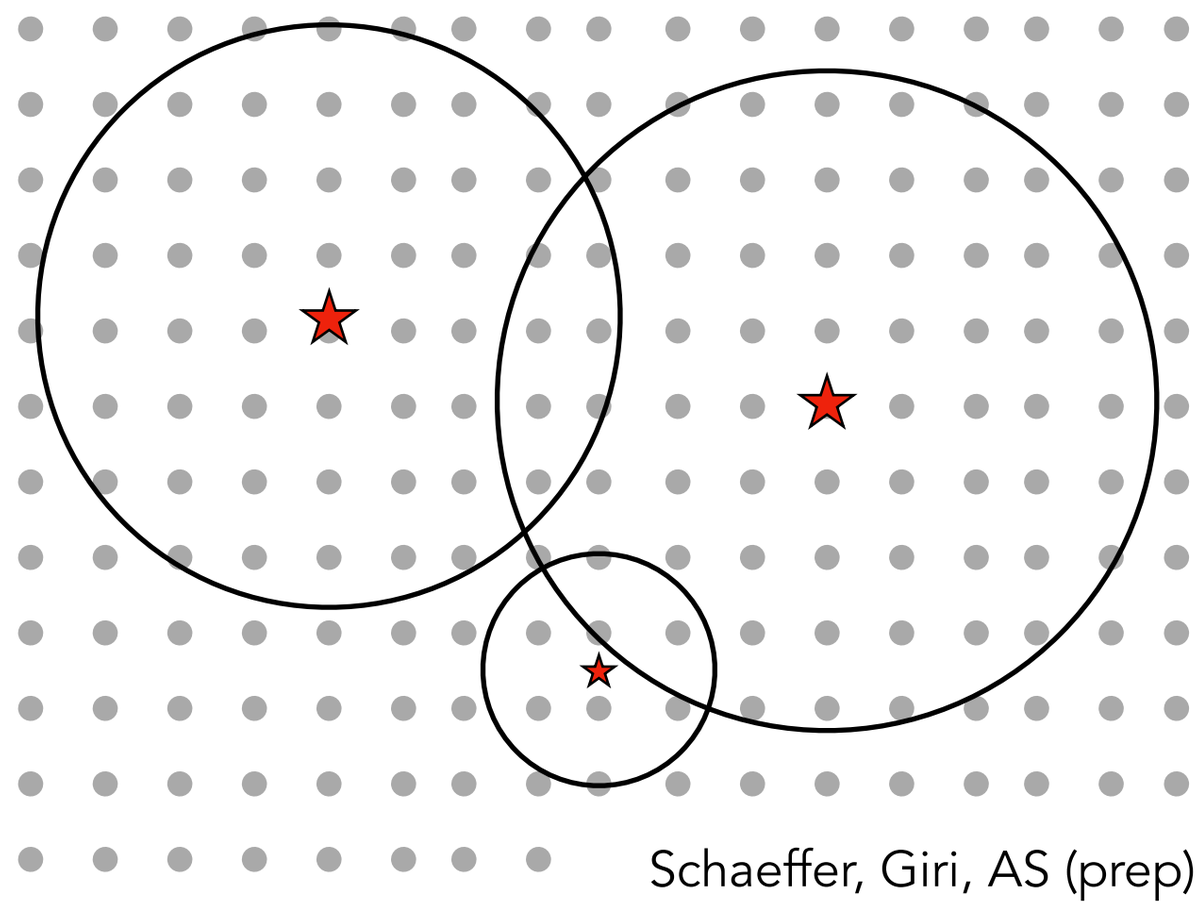


AS, Giri, Mirocha (2021)

Modelling the EoR

Fast methods to predict the power spectrum (plus maps) based on 1d radiative transfer around sources.

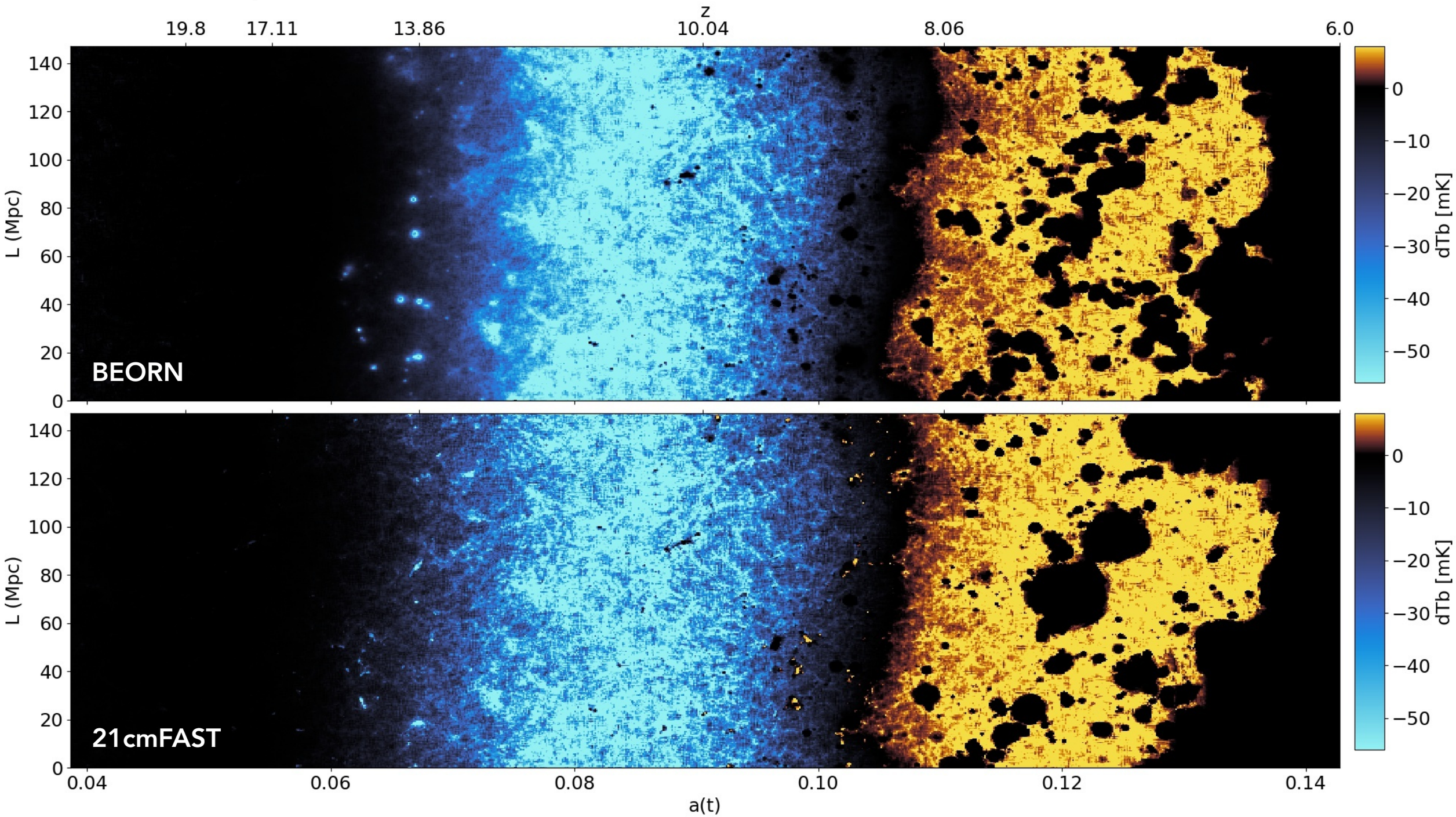
Flux-on-grid approach (BEORN)



Comparison to 21cmFAST

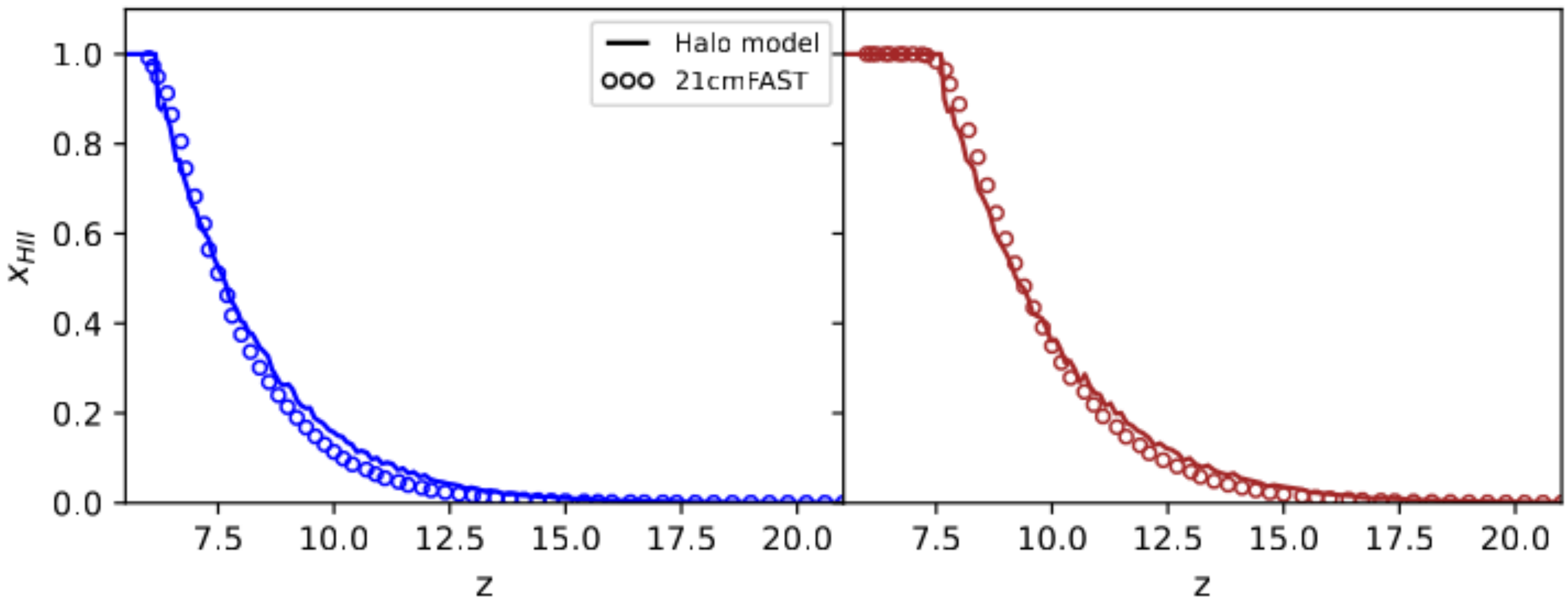
Comparison to 21cmFAST

At the map level (BEORN)



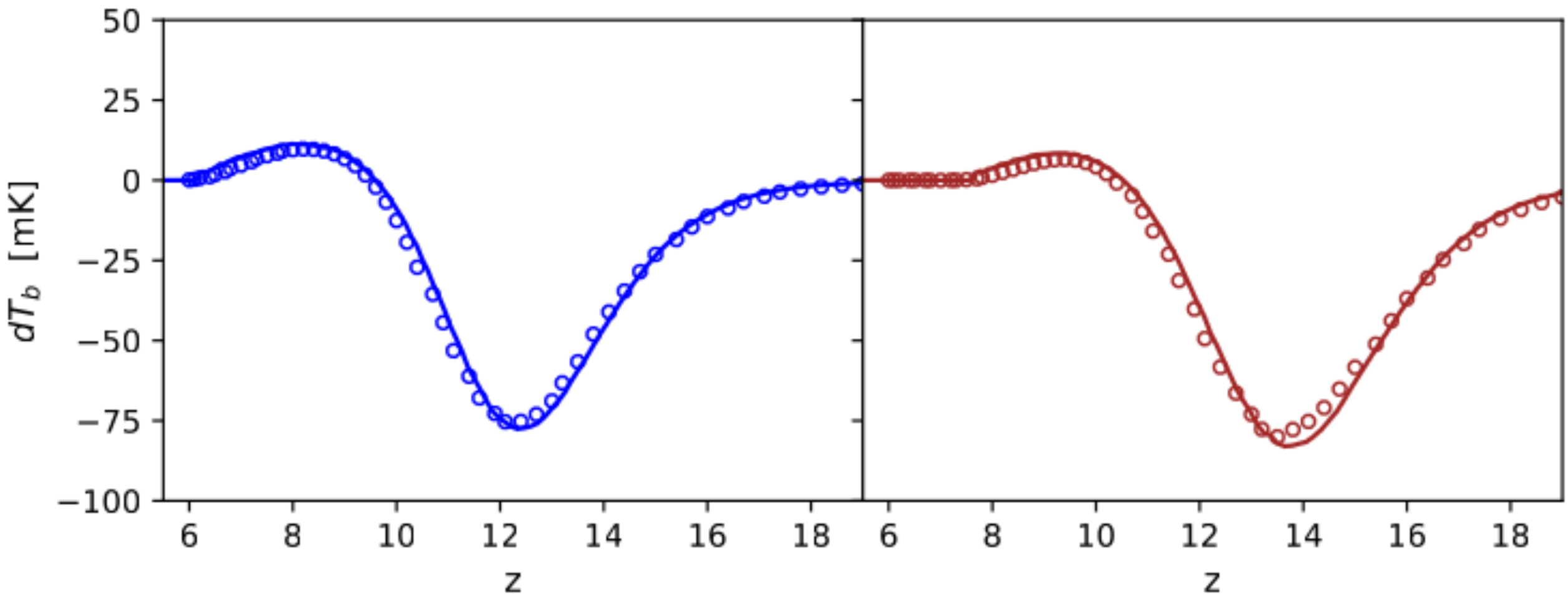
Comparison to 21cmFAST

Global ionisation fraction (HM)



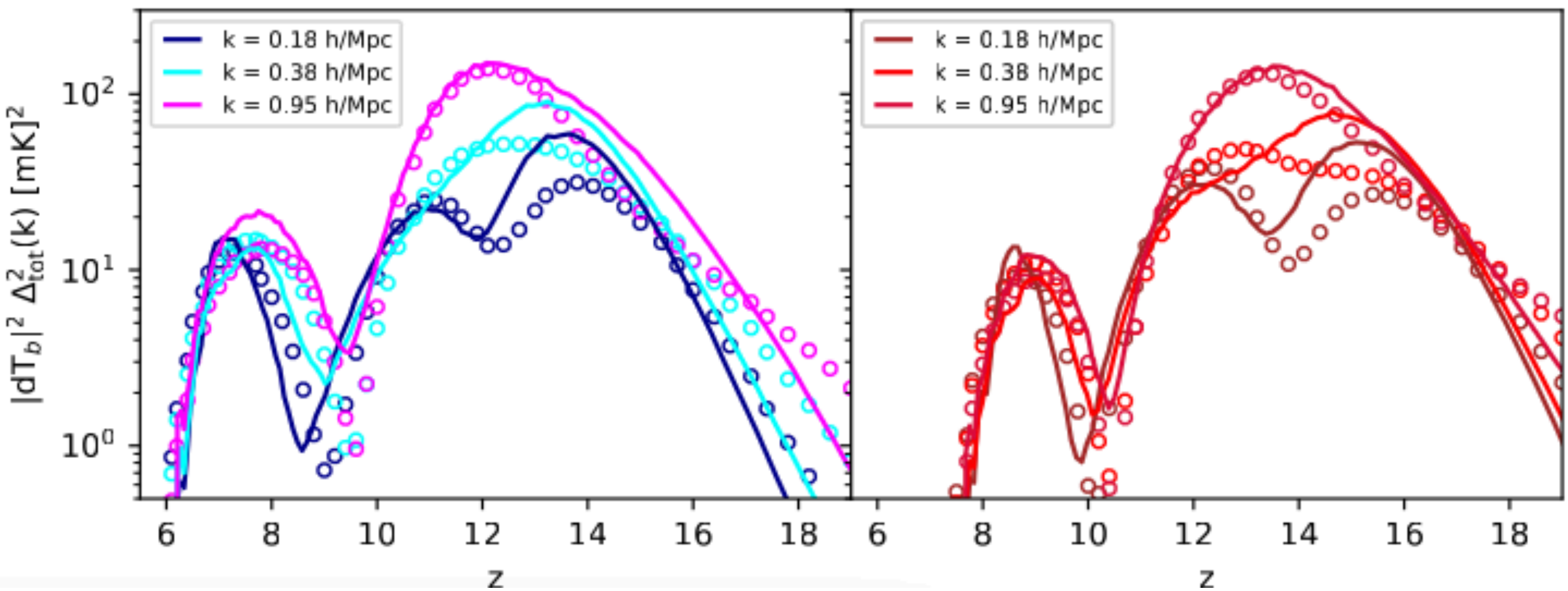
Comparison to 21cmFAST

Global differential brightness temperature (HM)



Comparison to 21cmFAST

Power spectrum (HM)

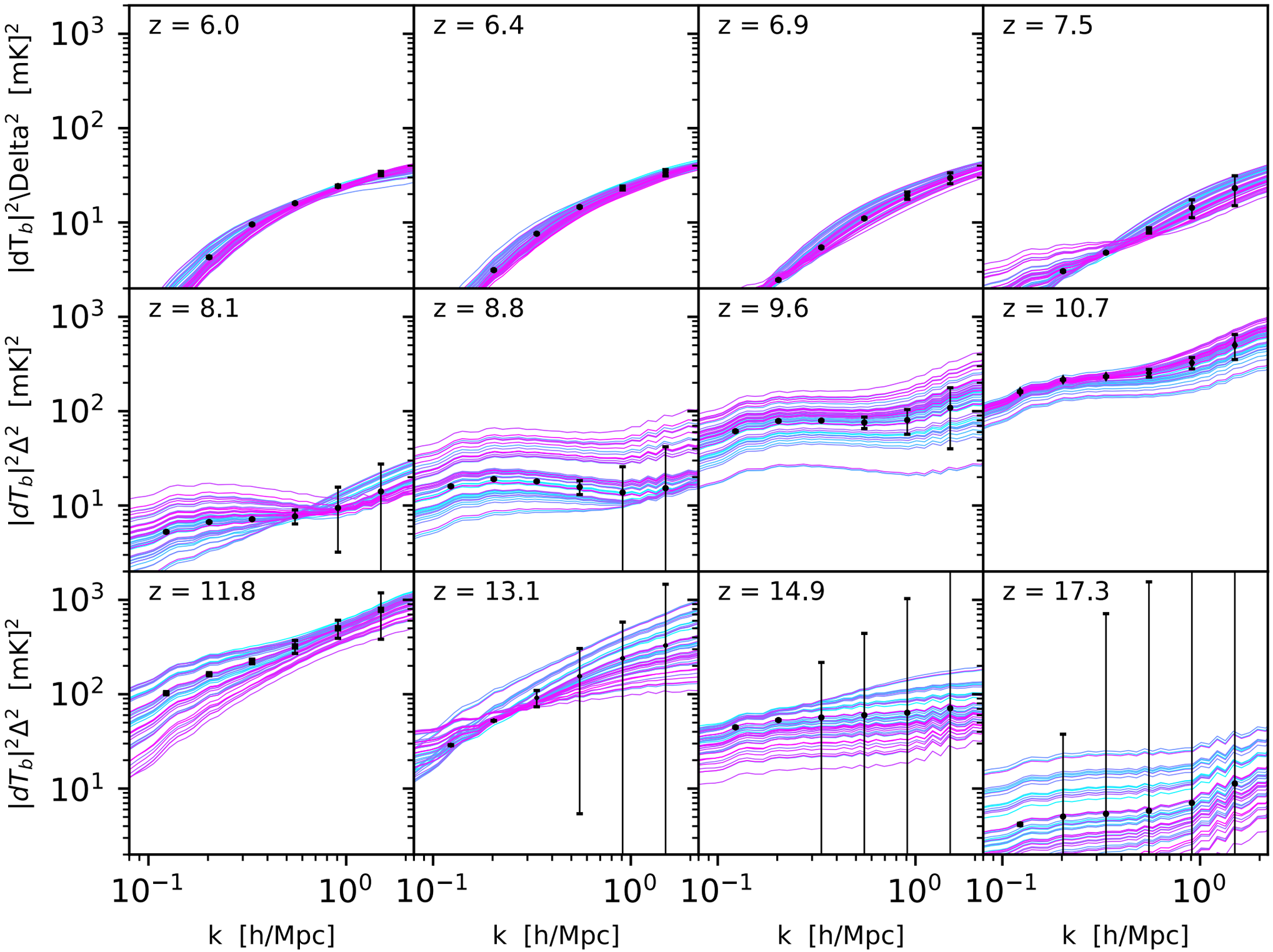


SKA forecast result

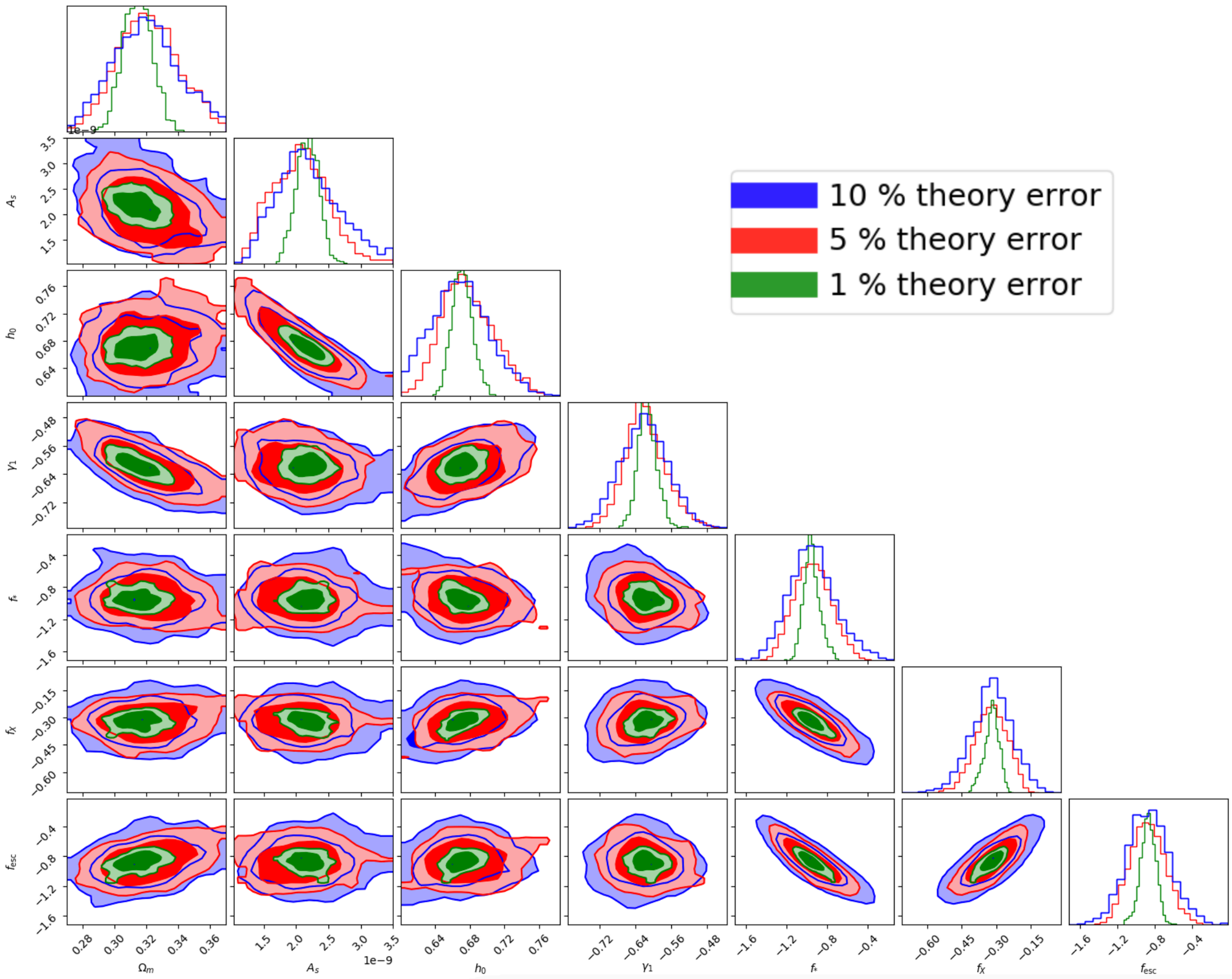
SKA-LOW — 1000h observing time

Including instrumental noise, sample variance, foreground contamination (via scale cuts).

SKA forecast result



SKA forecast result



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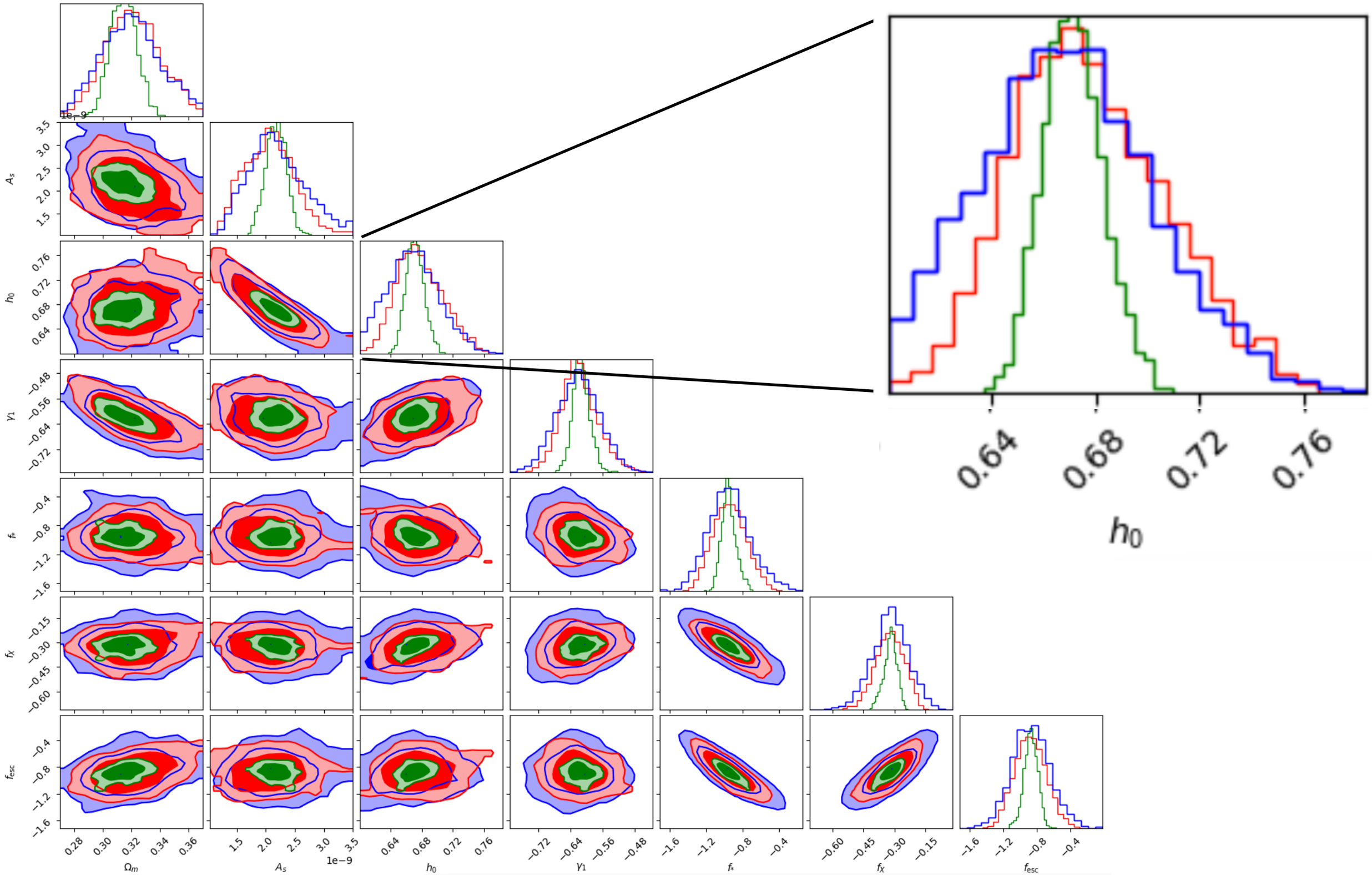

Collaborations within SKACH ?

Improve **modelling precision!**

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Investigate connections to other observables

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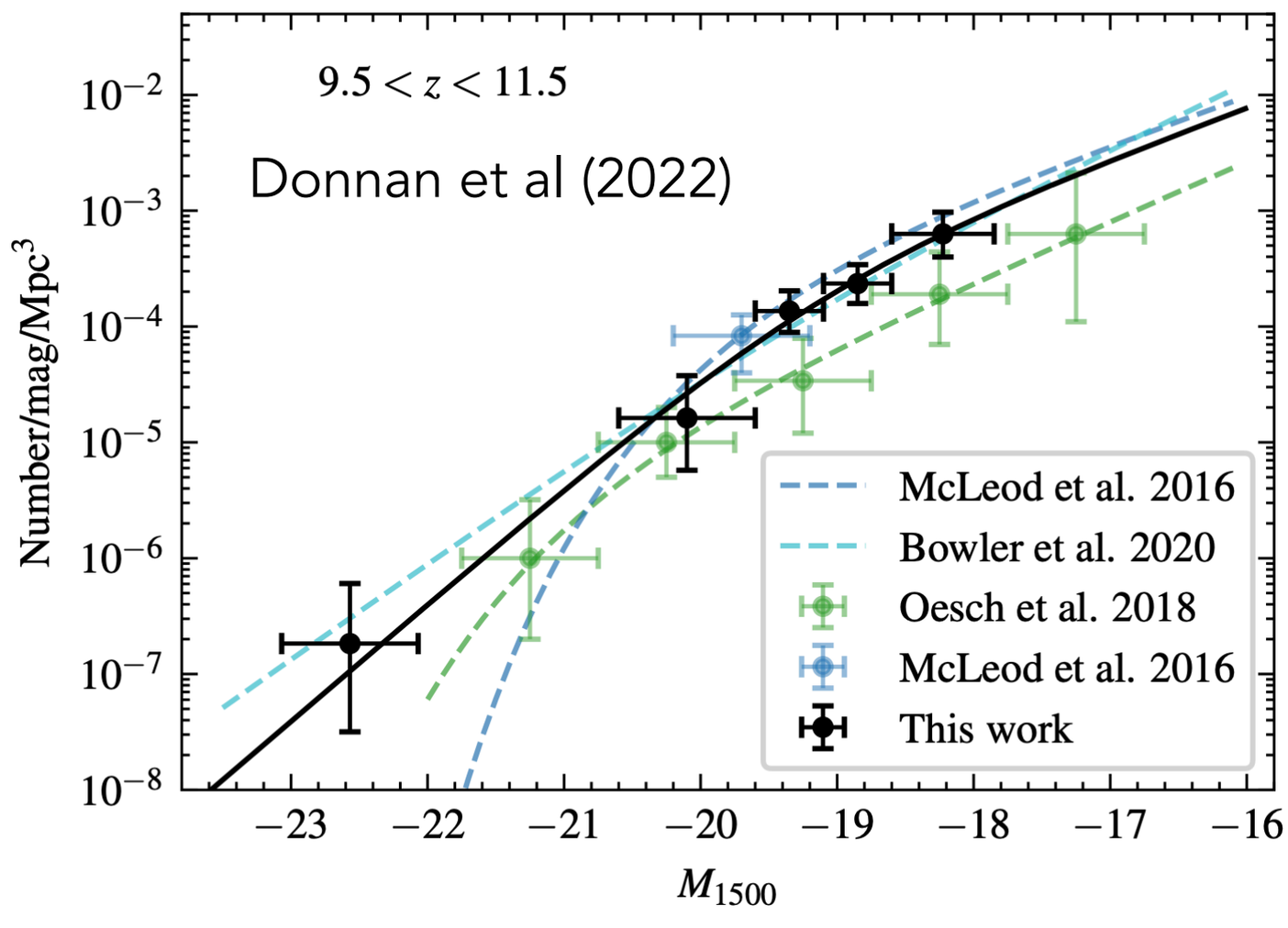
Investigate connections to other observables

Luminosity functions (**JWST**)



Collaborations within SKACH ?

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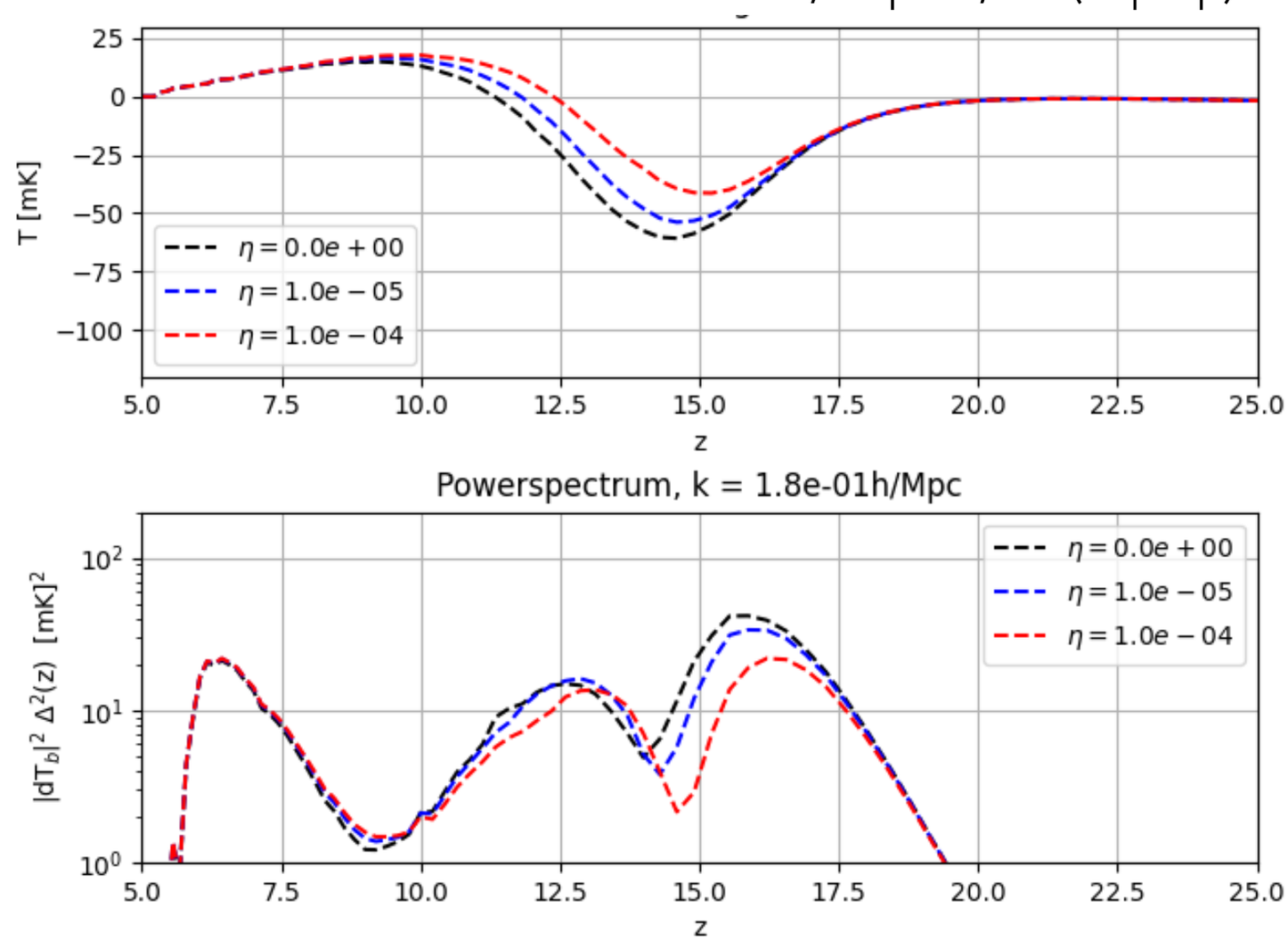
Investigate connections to other observables

Vecchi, Capelo, AS (in prep)



Black holes (**LISA**)

Changing BH merging

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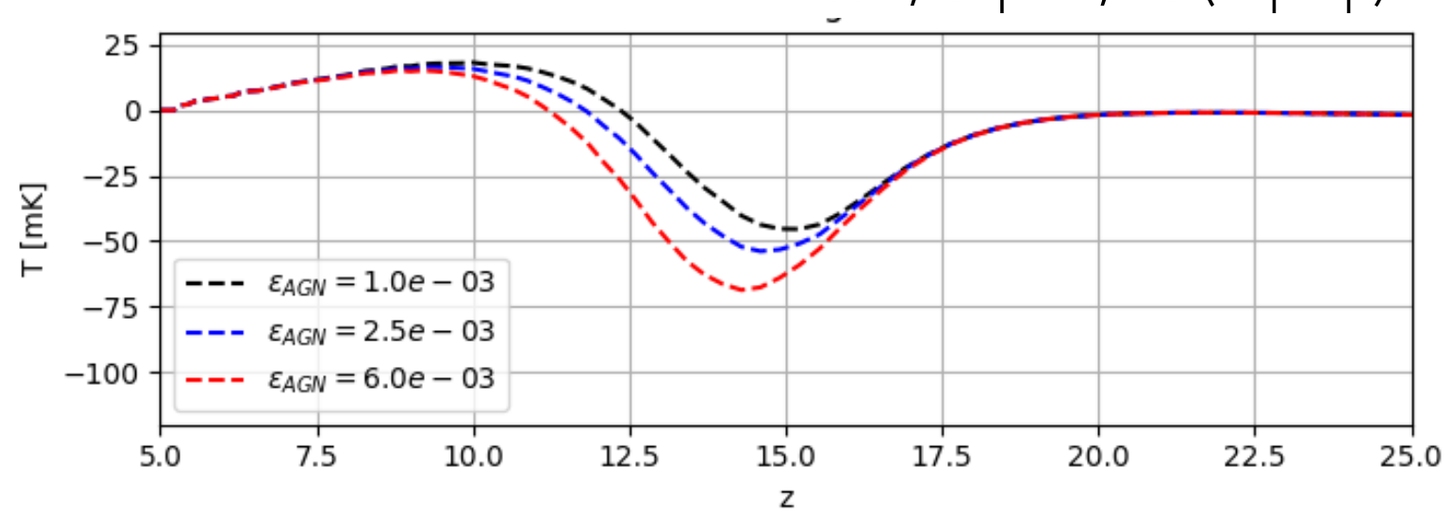
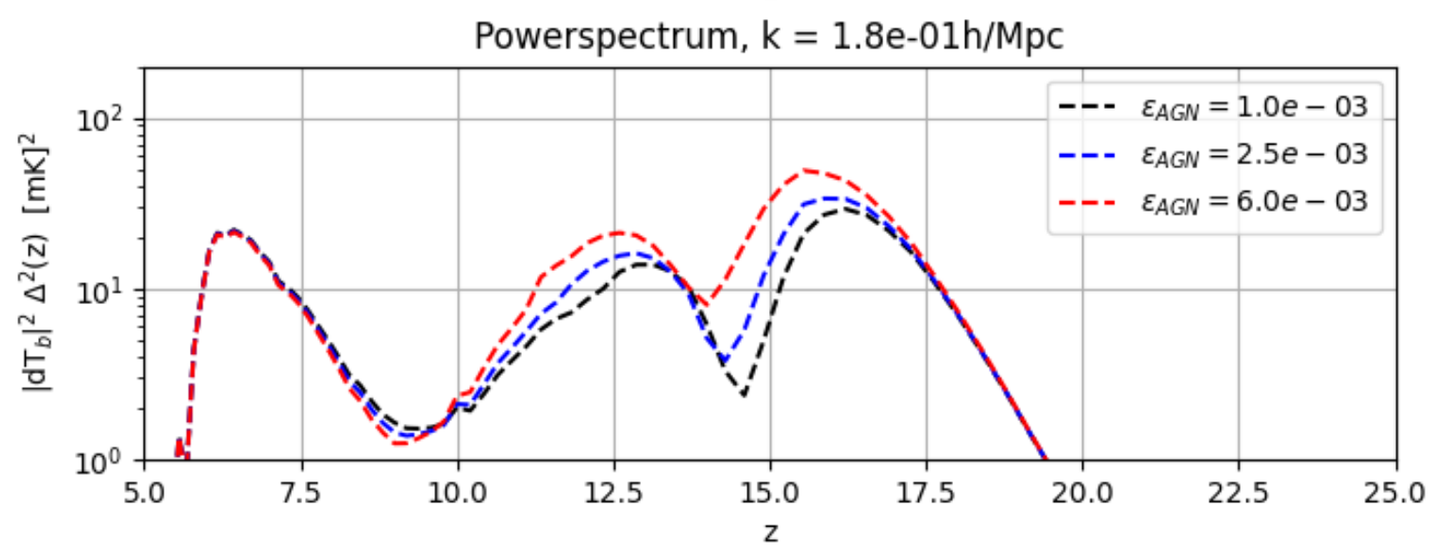
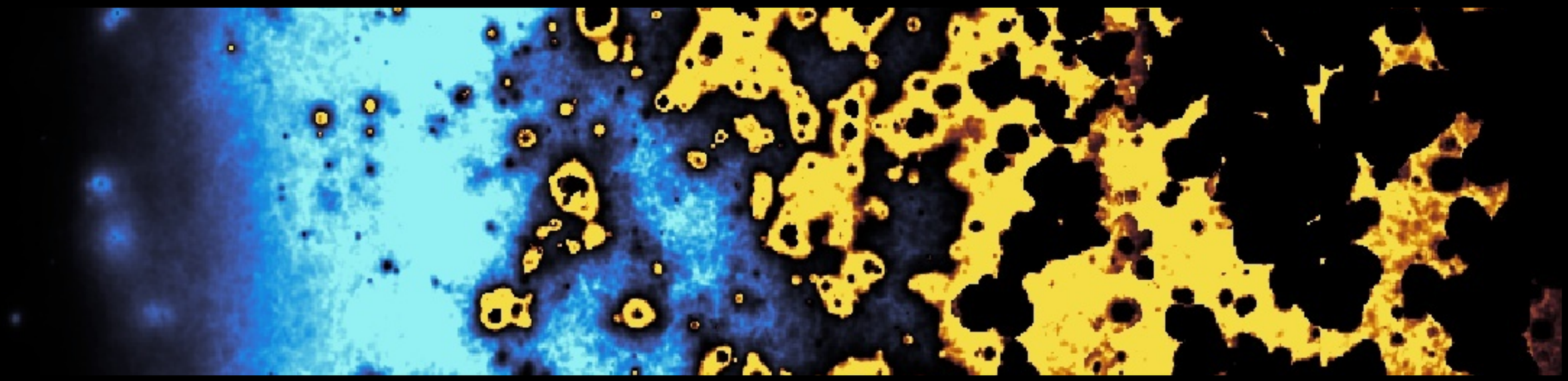




Black holes (**LISA**)

Changing feedback efficiency

Thanks !



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