

Constraining cosmology with the 21-cm signal during reionization



NORDITA
The Nordic Institute for Theoretical Physics



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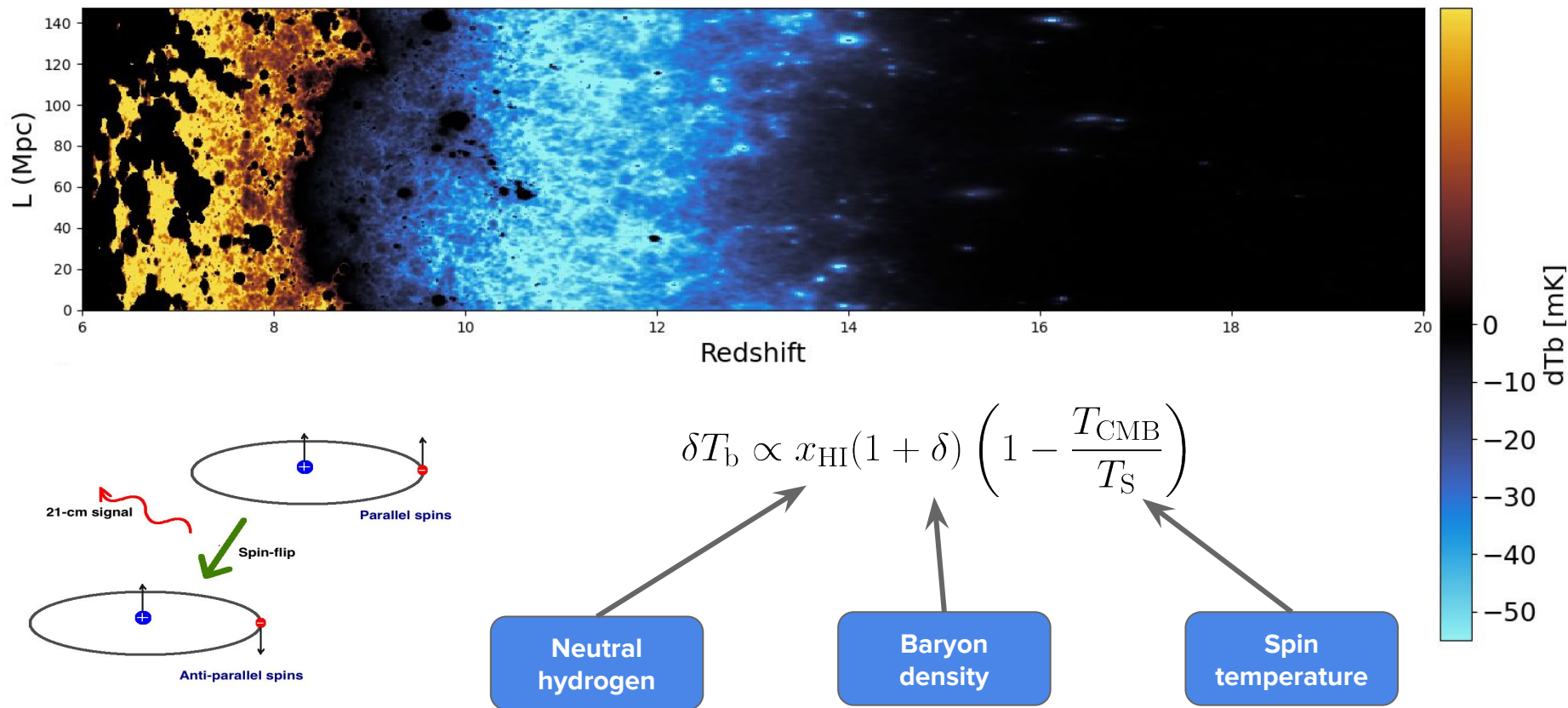


**Stockholm
University**

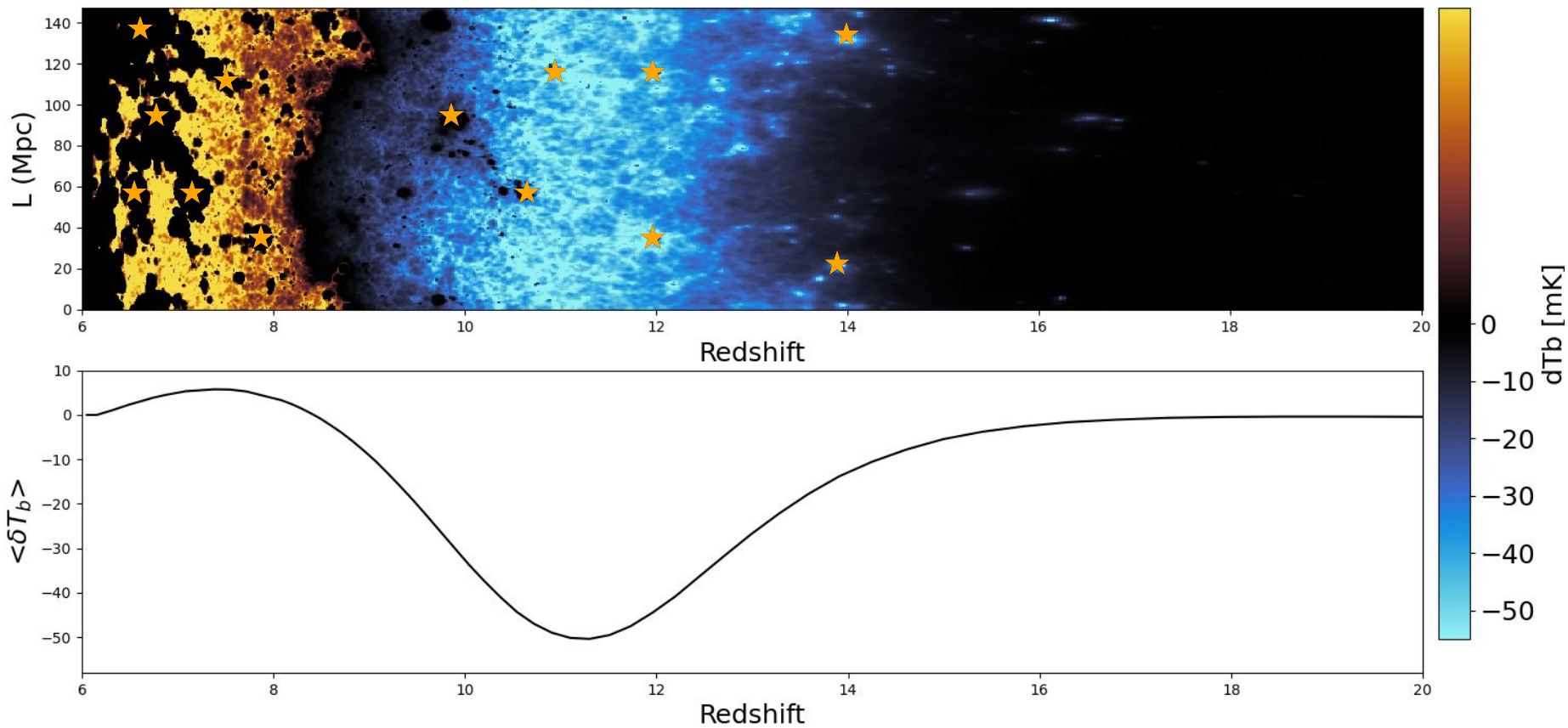
Stockholm Reionization (StoRe)
Garret Mellema (Professor)
Ivelin Georgiev (PhD student)
Olof Nebrin (PhD student)
Karin Kjellgren (Master's student)

02 February 2023

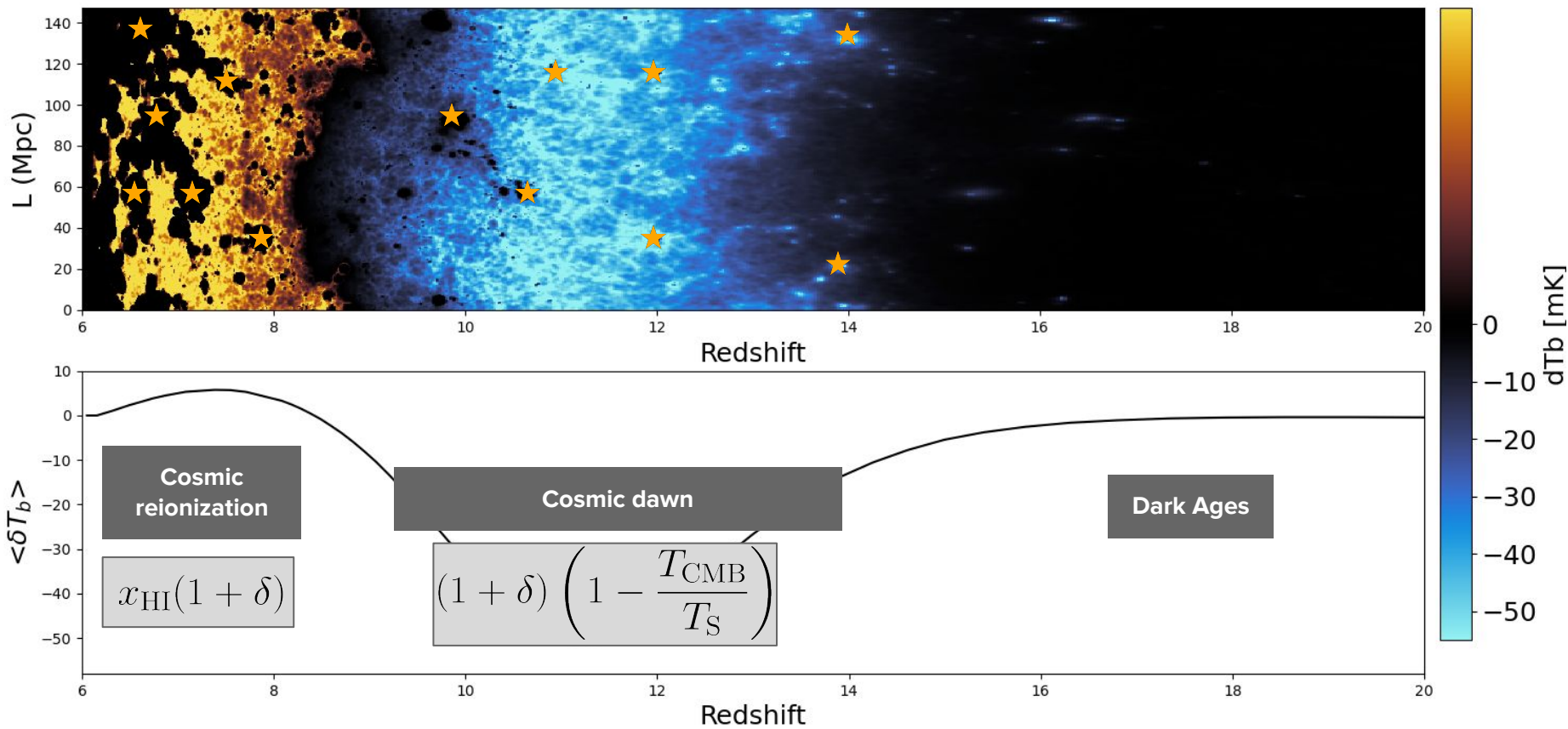
The 21-cm signal will probe the intergalactic medium



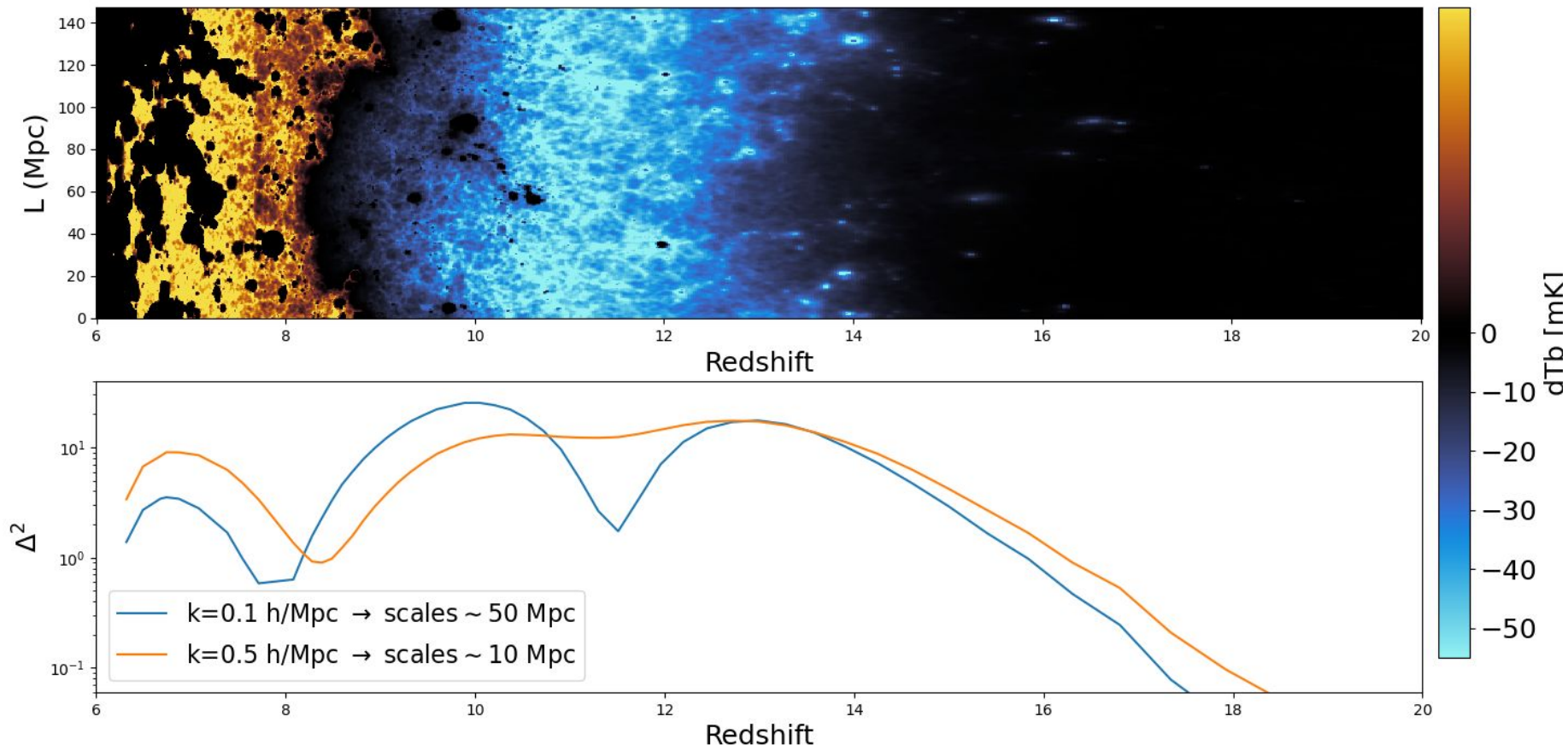
Evolution of the signal is driven by early luminous sources



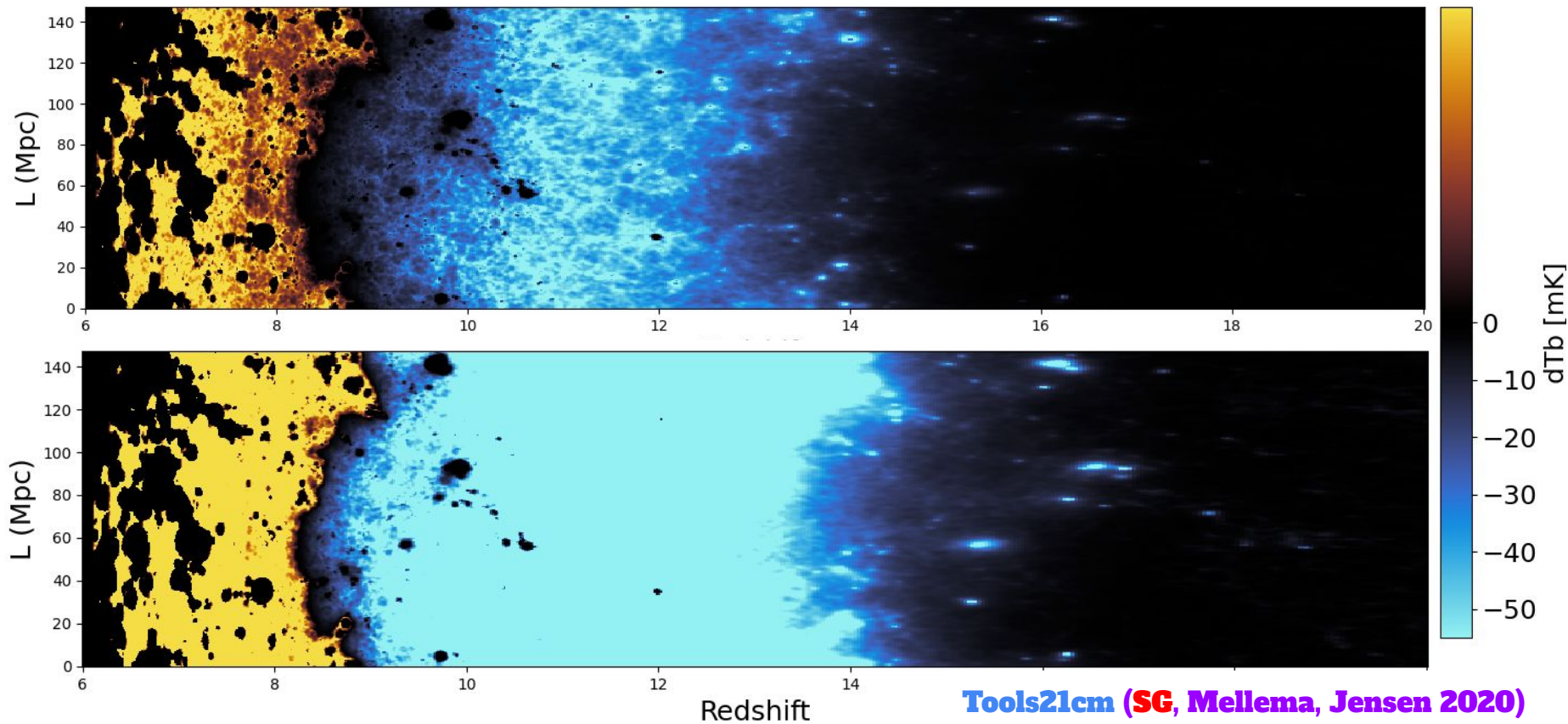
Different epochs seen with the 21-cm signal



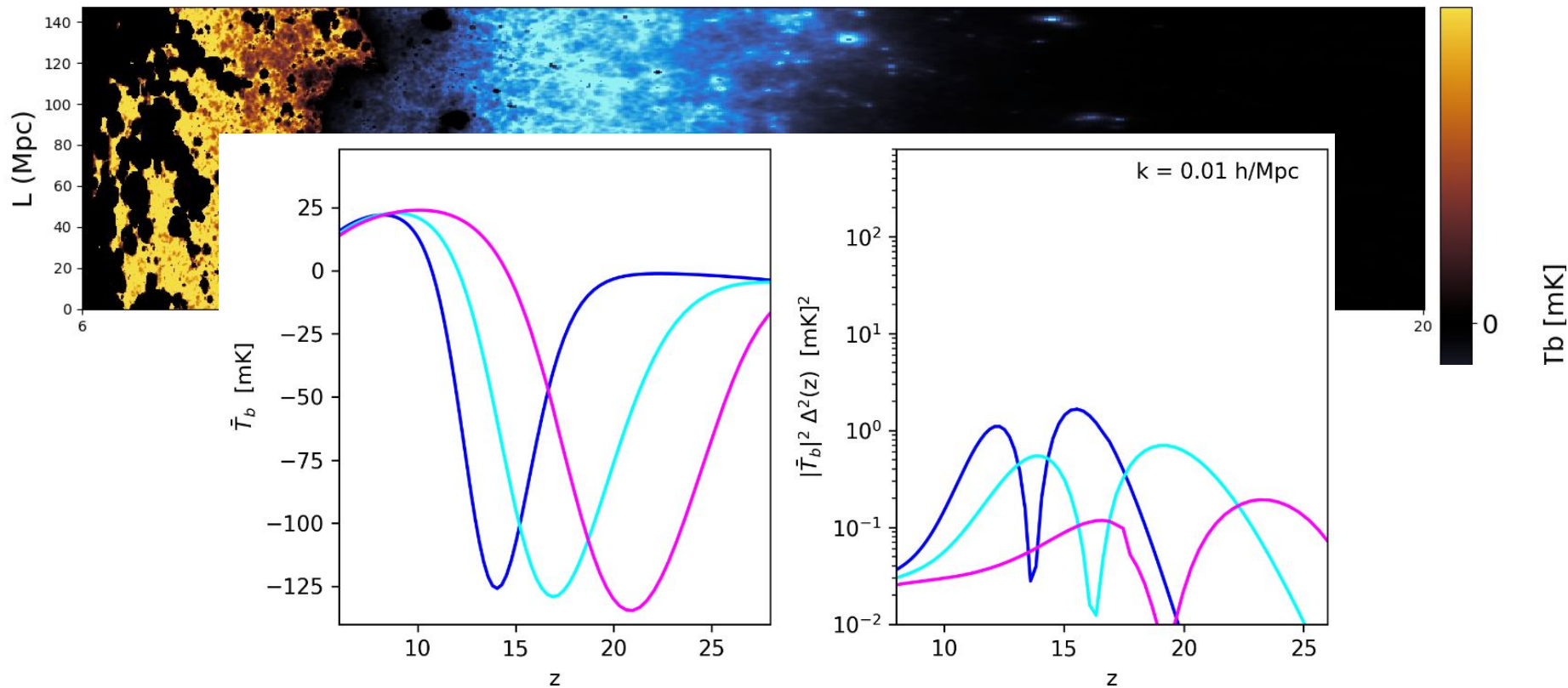
SKA will observe fluctuations



SKA will be able to produce images during reionization

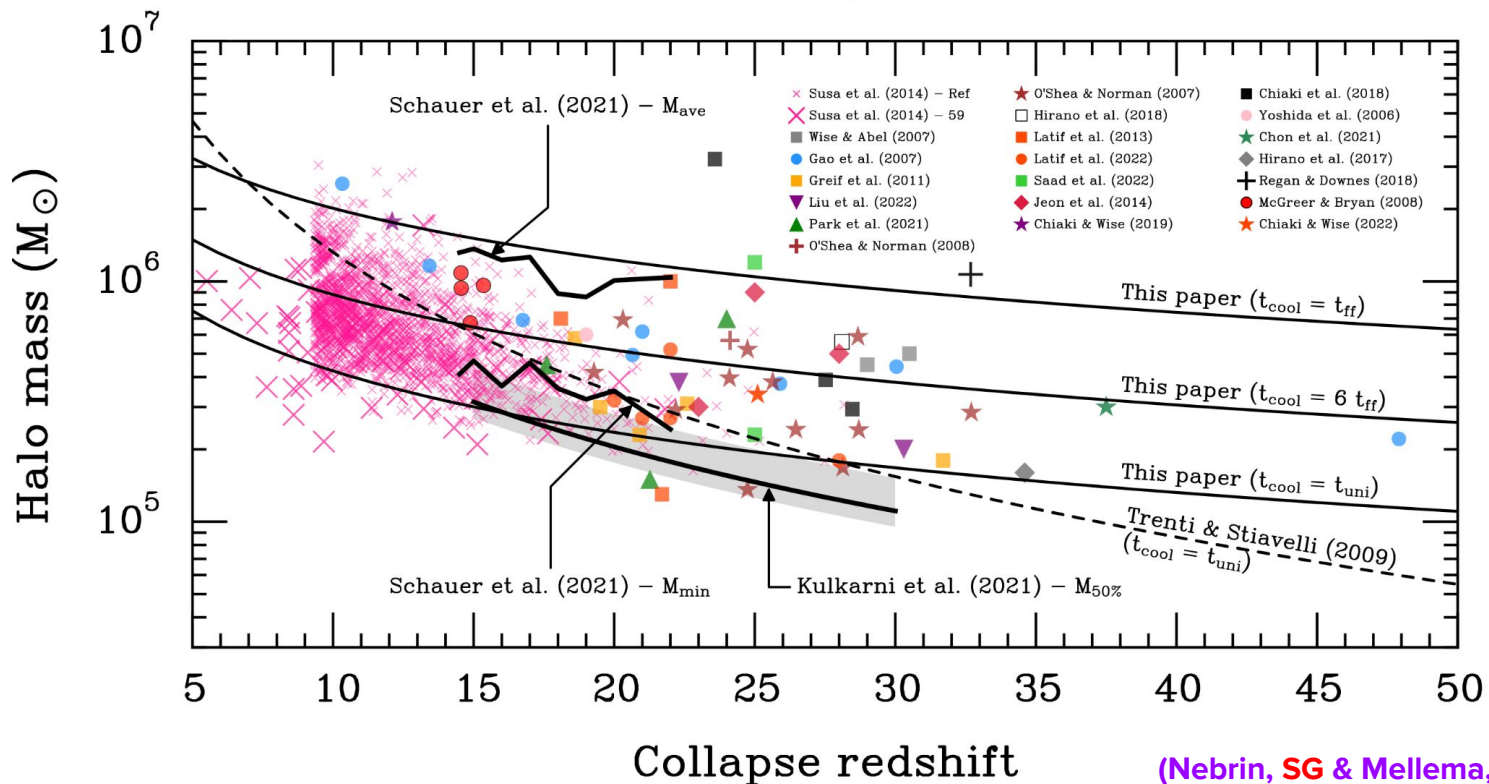


The signal will depend on the properties of sources

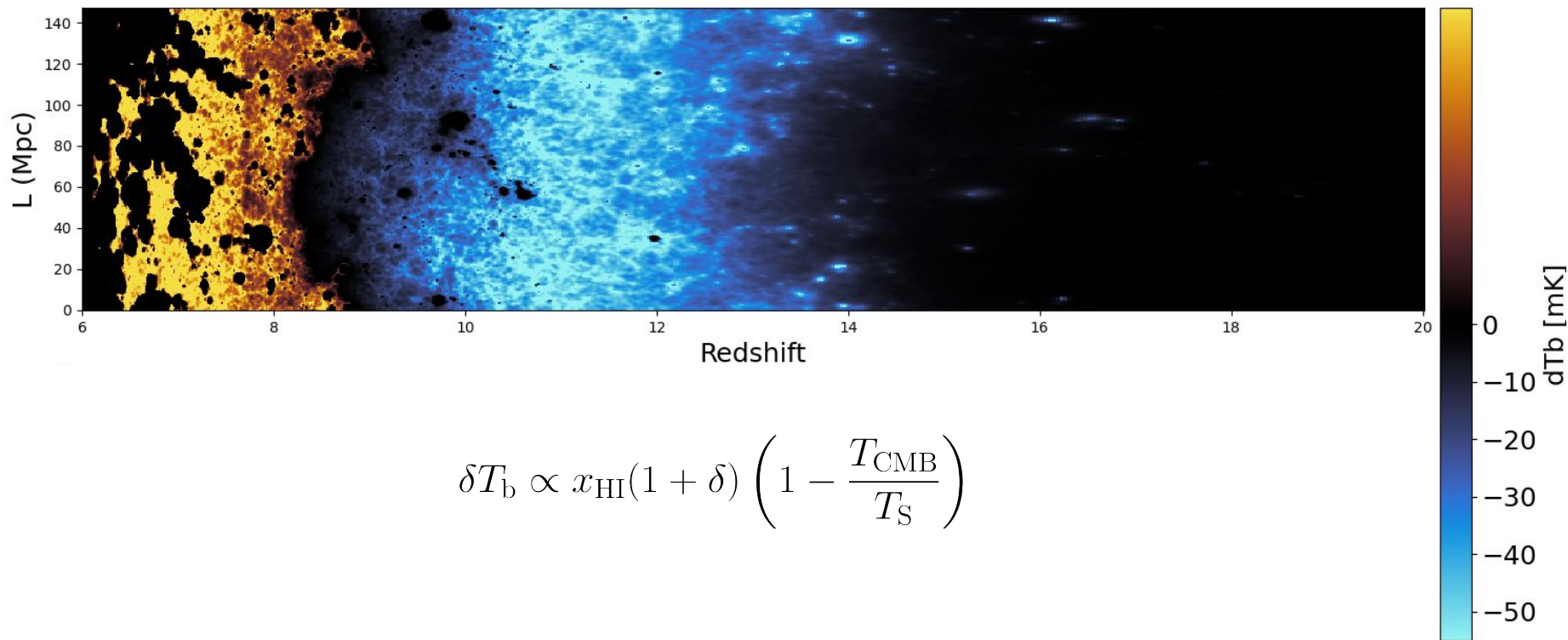


Anaxagoras: modelling the early luminous sources

Minihalo masses at gas collapse: No radiative feedback

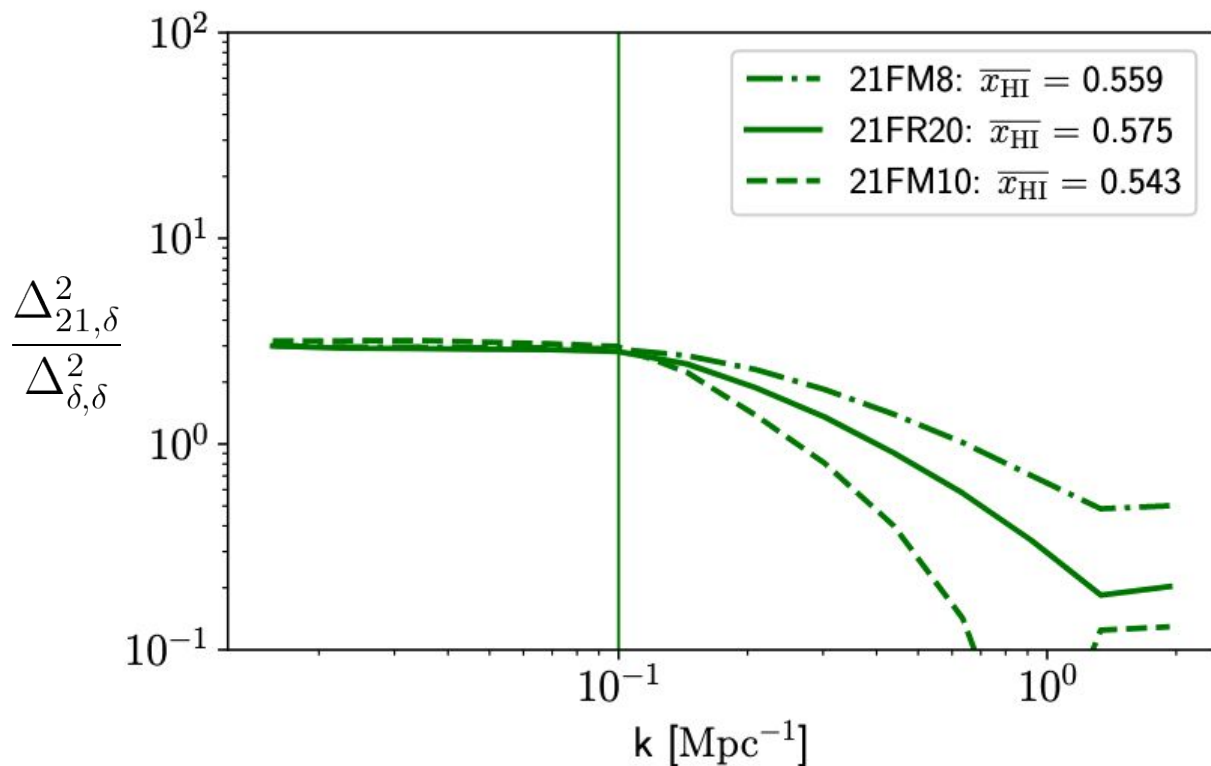


BEORN: Bubbles during Epoch Of Reionization Simulator



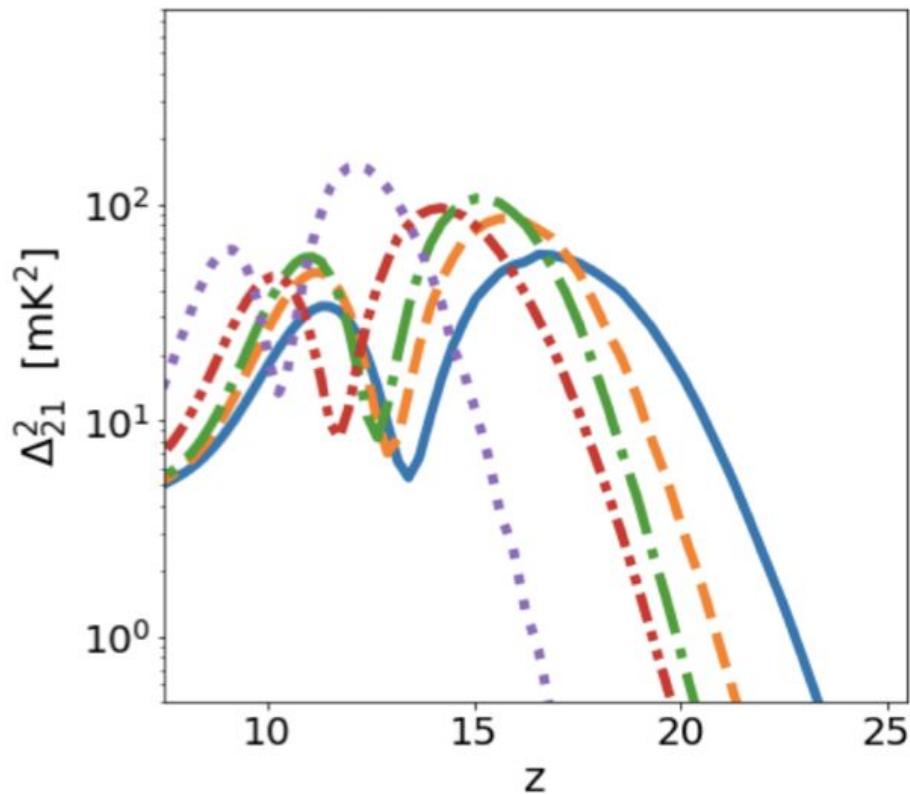
(Schaeffer, SG & Schneider, in prep)

Can we constrain cosmology?



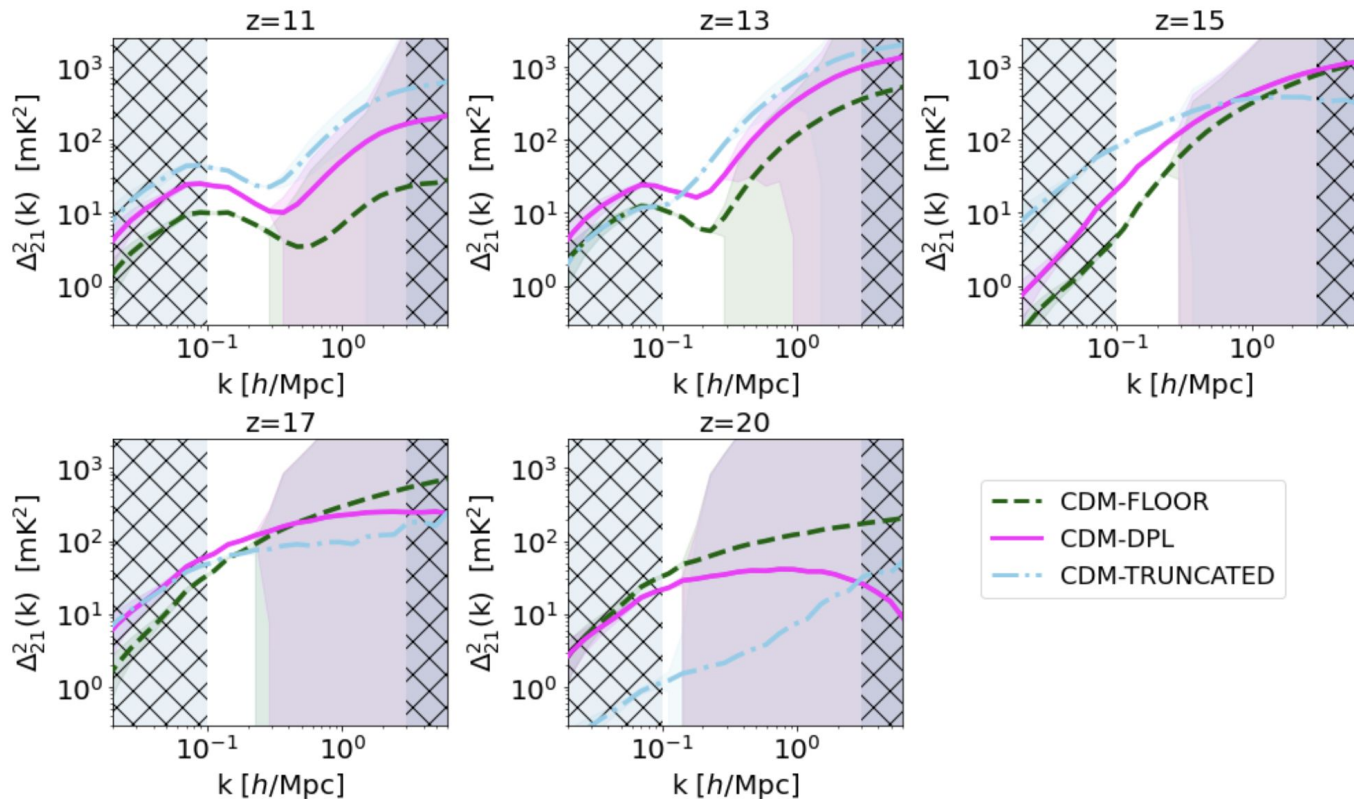
$$\begin{aligned} \delta_{21} &= b \delta \\ \Rightarrow b &= \frac{\langle \delta_{21}, \delta \rangle}{\langle \delta, \delta \rangle} = \frac{\Delta_{21,\delta}^2}{\Delta_{\delta,\delta}^2} \end{aligned}$$

The 21-cm signal is sensitive to cosmological parameters



(SG & Schneider 2022)

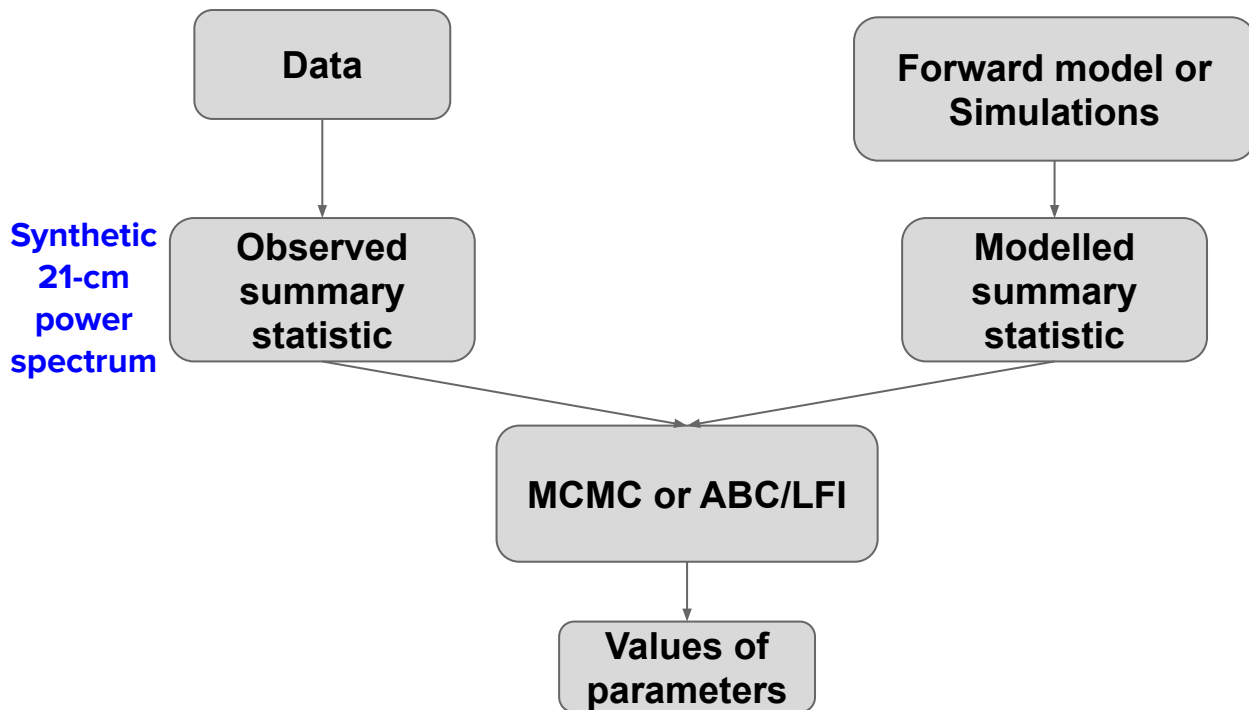
Mock SKA observation created with **Tools21cm**



SG, Mellema &
Jensen (2020)

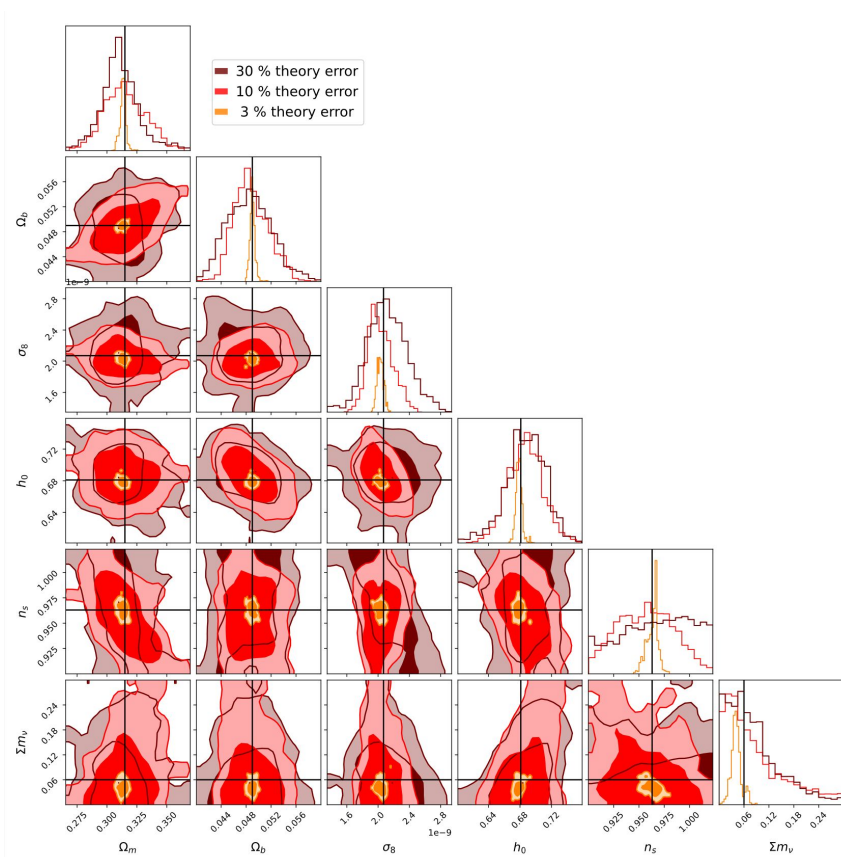
(**SG** & Schneider 2022)

Inference from 21-cm observations

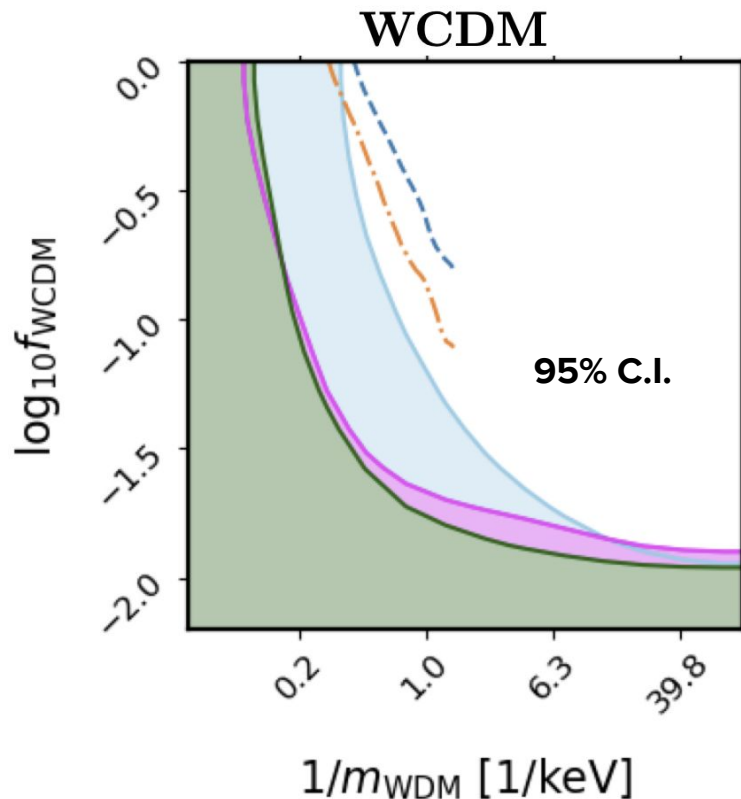


(Schneider, **SG**, Mirocha 2021;
SG & Schneider 2022;
Schneider, **SG**, Schaeffer, in prep)

Constraining cosmological parameters



Constraints on cold + warm DM



$f \sim 1 : m_{\text{WDM}} \gtrsim 15 \text{ keV}$ (FLOOR, DPL),
 $\gtrsim 4 \text{ keV}$ (TRUNCATED)
CDM + hot relic : $f \lesssim 1\%$ (FLOOR, DPL, TRUNCATED)

(SG & Schneider 2022)

TRUNCATED

DPL

FLOOR

--- SDSS (Baur+2017)

--- SDSS+XQ+HR (Baur+2017)

Summary

- SKA observations of the epoch of reionization and cosmic dawn can **constrain cosmological parameters**
 - Help understand or resolve the S_8 and H_0 tension
 - Rule out $\Sigma m_\nu = 0$
- SKA observations of the epoch of reionization and cosmic dawn can **constrain dark matter models**
 - Improve the constraints on non-cold dark matter models by ~ 4 times compared to the current ones