ultracompact minihaloからの21cm線シグナル

Nagoya Univ.　FURUGORI, Kunihiko

Collaborator : ABE,　Katsuya　TASHIRO, Hiroyuki　TANAKA, Toshiyuki

HASHIMOTO, Daiki　HASEGAWA, Kenji(Nagoya Univ.)

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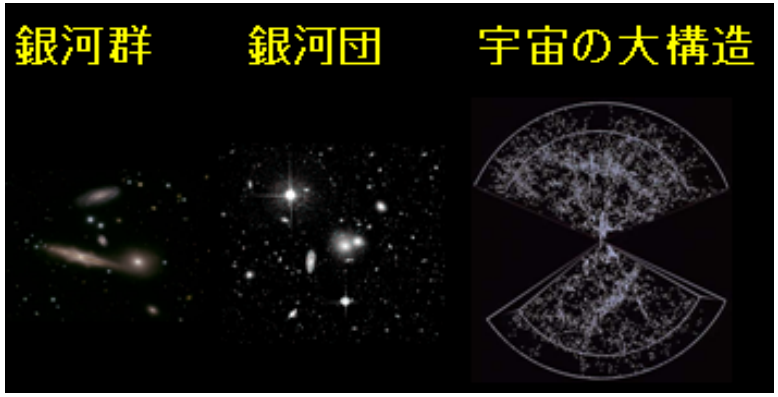
1.Introduction 3 pages

2.Method and Result 5 pages

3.Summary 1 pages

1.What's primordial perturbation?



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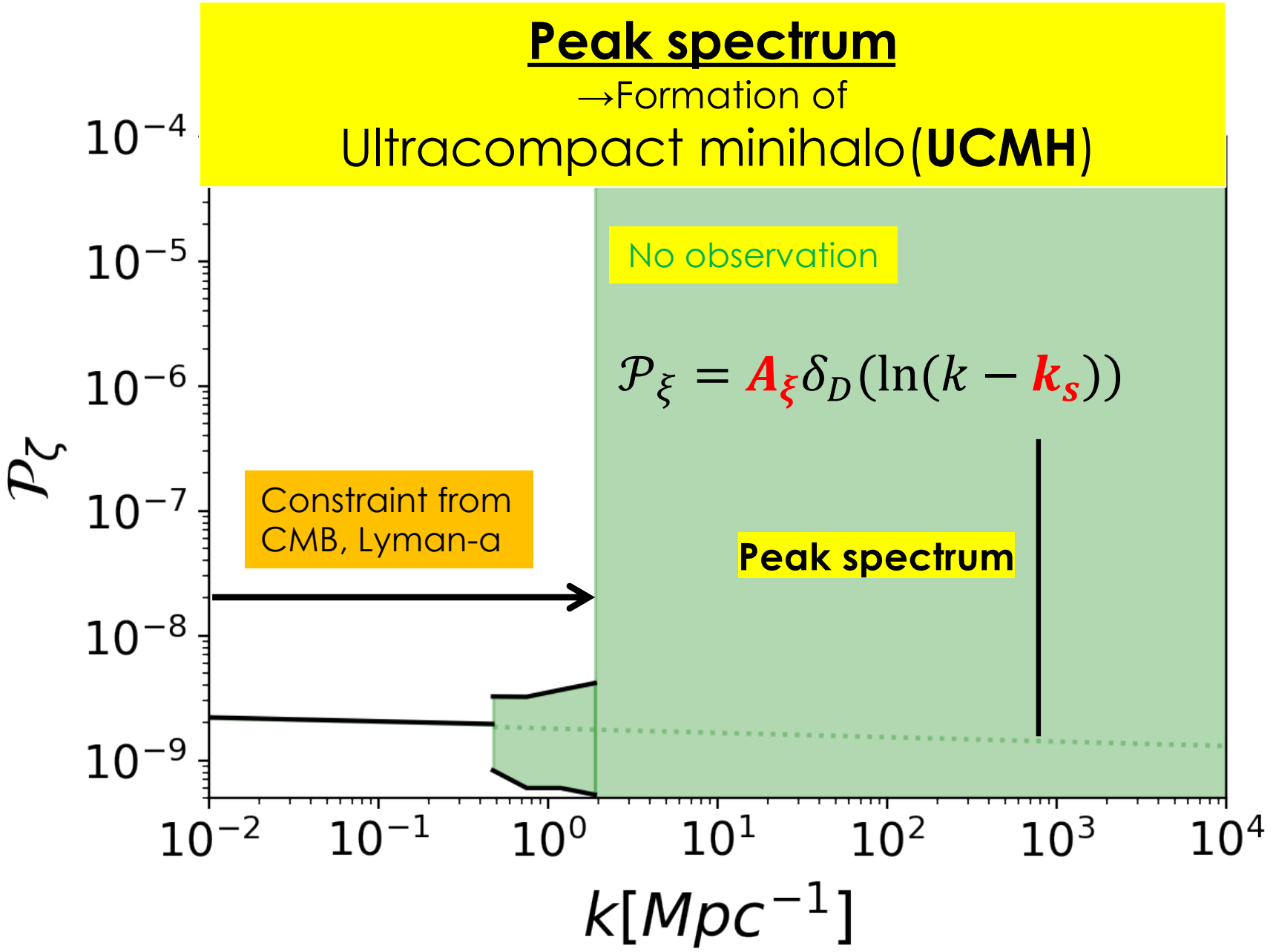
structure

Density contrast

Collapsed criteria

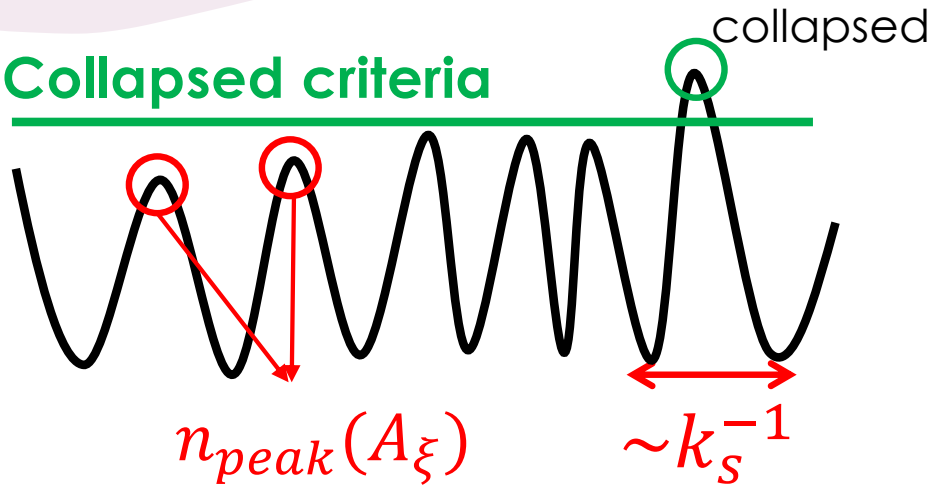
Primordial density contrast

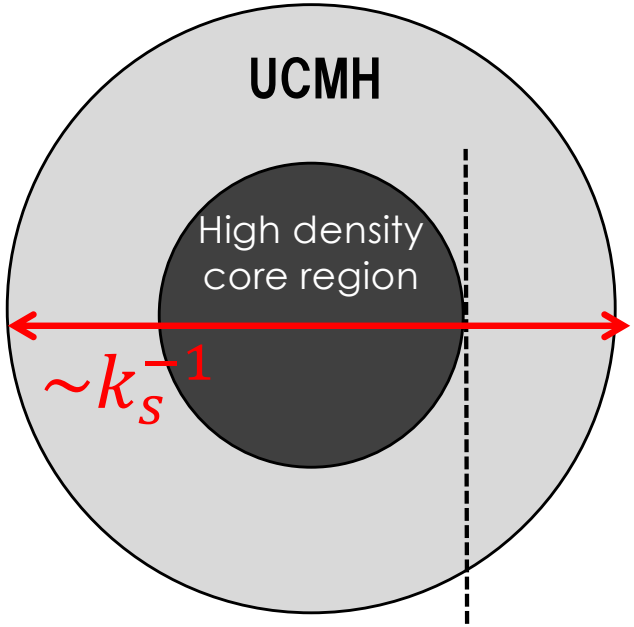
Primordial curvature power spectrum



3.What's Ultracompact Minihalo?

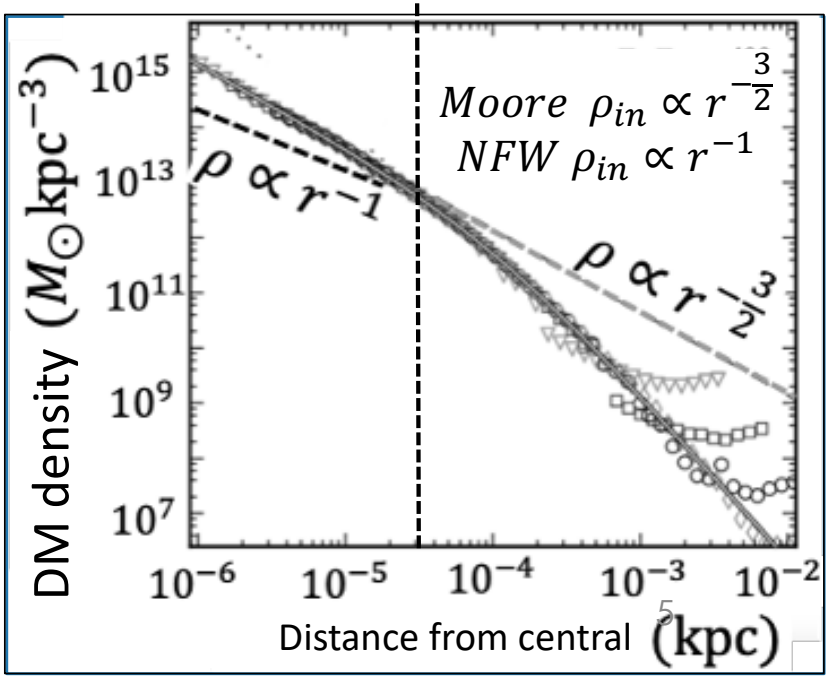
Density perturbation
generated by peak spectrum





Dark matter mass distribution

→Moore or NFW profile (Delos et al.2018)



Core density is very high!! $\rho_c \propto (1+z)^3$

ex) collapse redshift $z_c = 200$

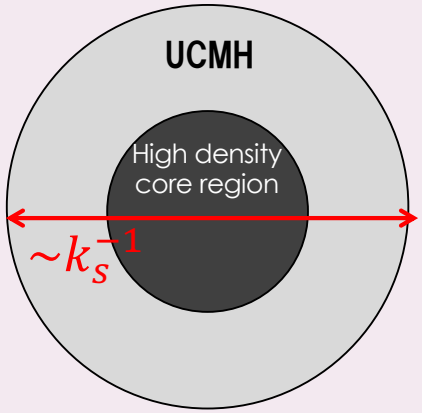
$$\rho_{c,matter} \sim \mathbf{10^7}\rho_m(z=0)$$

1.Introduction

2.Method and Result

3. Summary

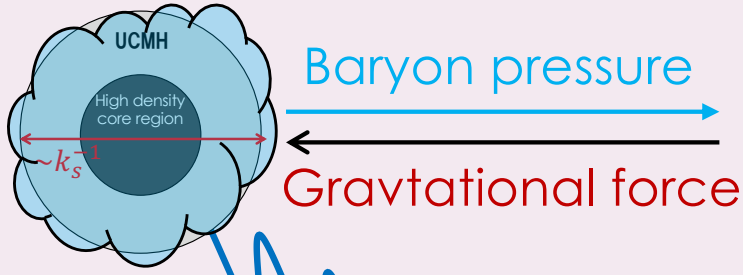
(a) Formation of dark matter structure



Setting the **DM mass profile**

$$\mathrm{M}_{halo} = M_{dm}(k_s)$$

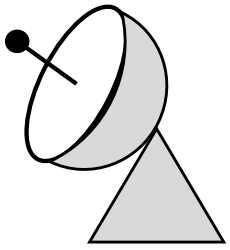
(b) Formation of baryonic structure



Evaluating the **baryon profile**
Using hydrostatic equilibrium
Baryon pressure .vs. Gravitational force

$$\rho_{gas}(k_s), T_{gas}(k_s)$$

(c)Neutral hydrogen 21-cm line

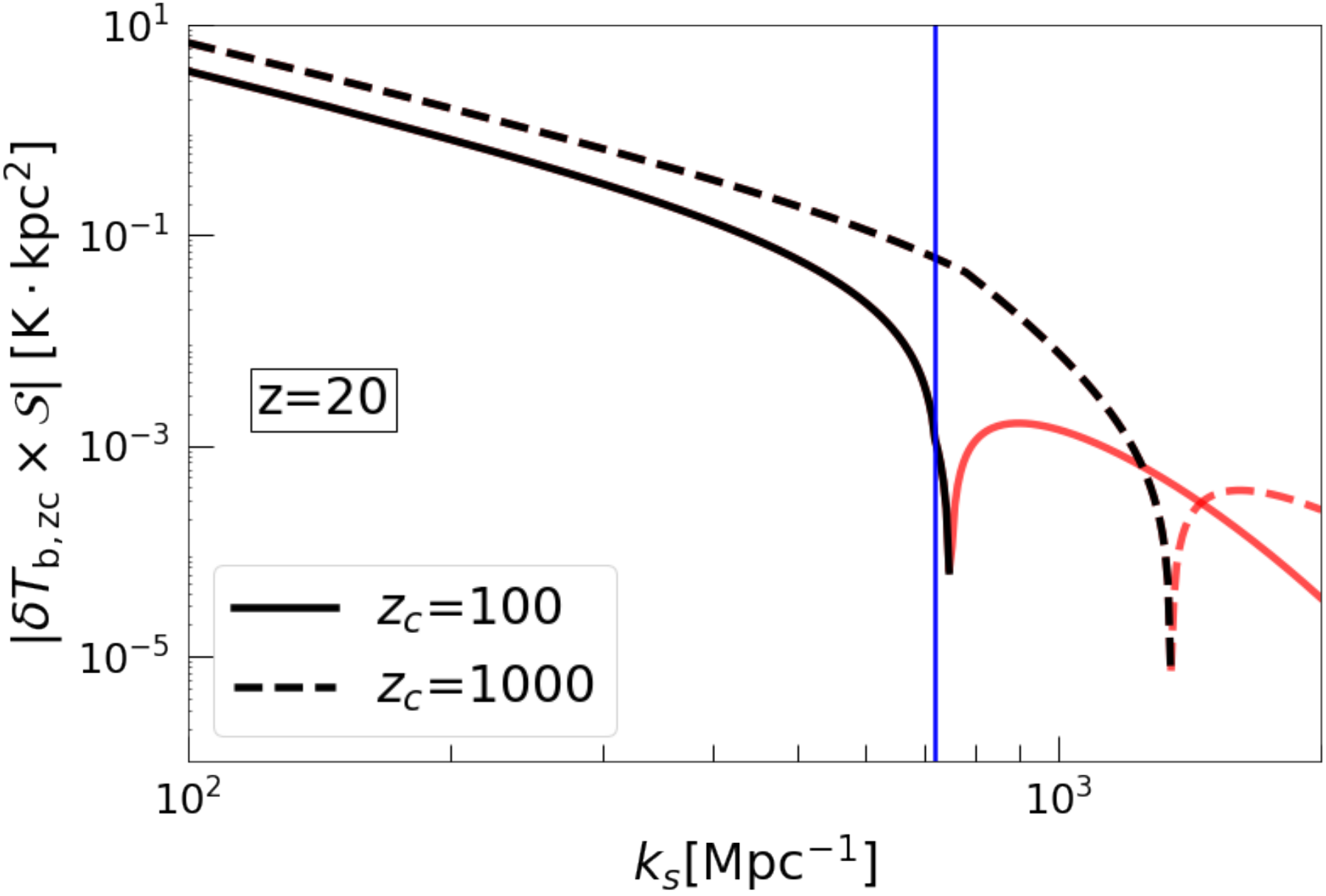


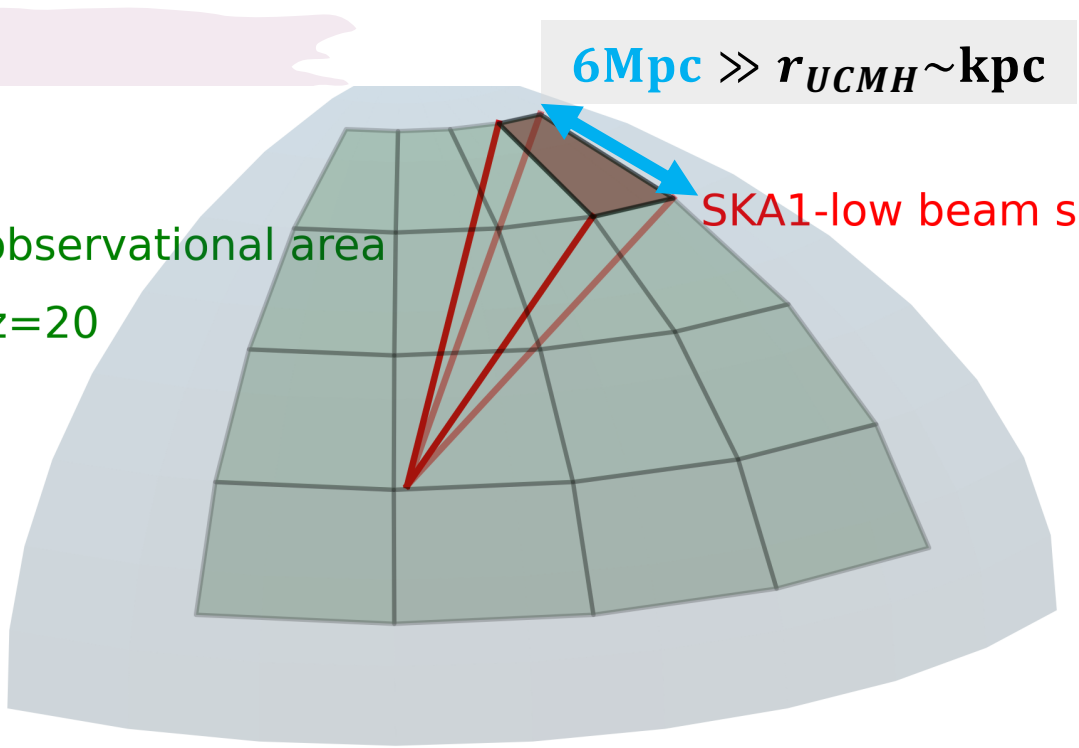
Calculating the individual UCMH 21-cm signal

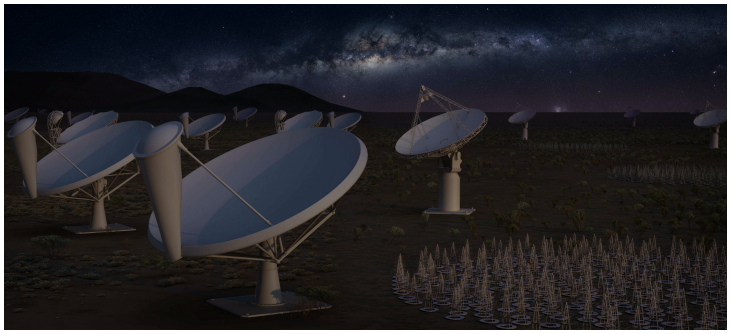
$$\delta T_b(k_s)$$

SKA1(Future)

Result (individual UCMH signal)







SKA observation image (SKA home page)

SKA1-low cannot resolve individual UCMH

Beamsize is 1000 times larger than UCMHsize

We observe
UCMH number fluctuation

① Calculate the mean 21-cm signal from UCMH $\overline{\delta T_b}(A_\xi)$

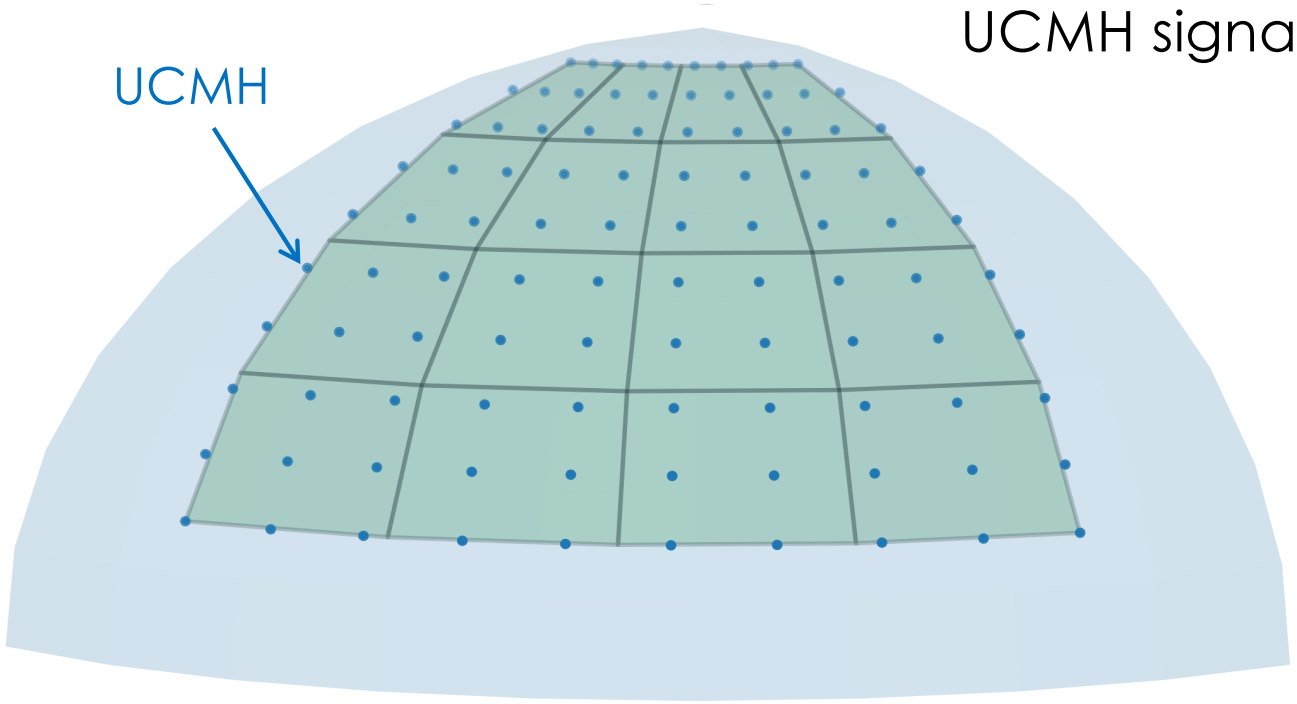
②UCMH number traces the dark matter fluctuation $\delta_{N,UCMH} = b\delta_{DM}$

21-cm fluctuation in observational region per **pixel**

$$\langle \delta T_b^2 \rangle_{UCMH}^{\frac{1}{2}}(A_\xi) = \langle N\delta_{N,UCMH} \mathrm{T_{b,one}} \rangle = b\langle \delta_{DM}^2 \rangle^{\frac{1}{2}} \overline{\delta T_b}$$

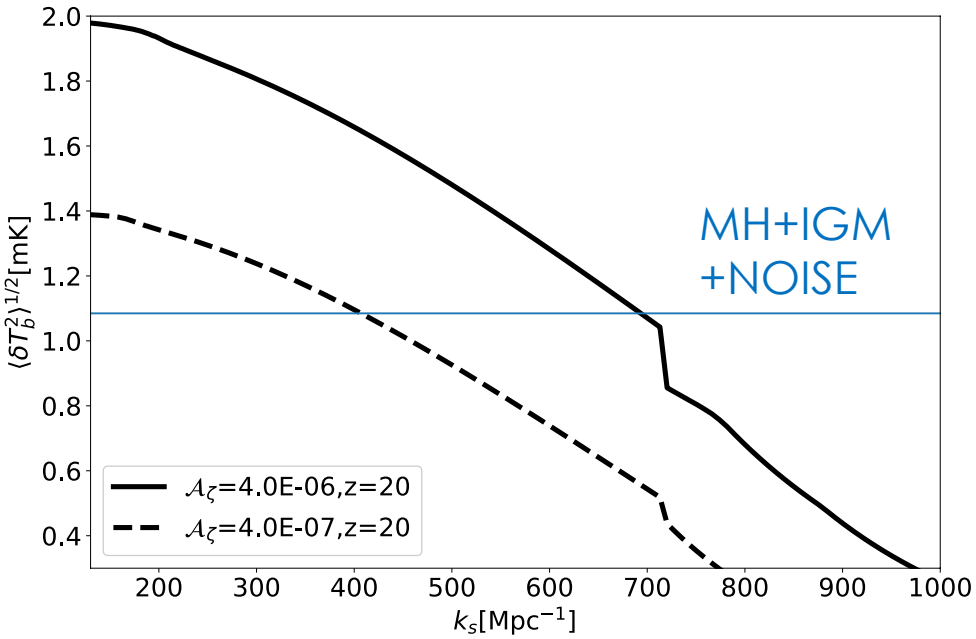
③$\langle \delta \mathrm{T_b^2} \rangle_{\mathrm{UCMH}}(A_\xi) \geq \langle \delta \mathrm{T_b^2} \rangle_{IGM+MH+NOISE}$

UCMH signal is detectable



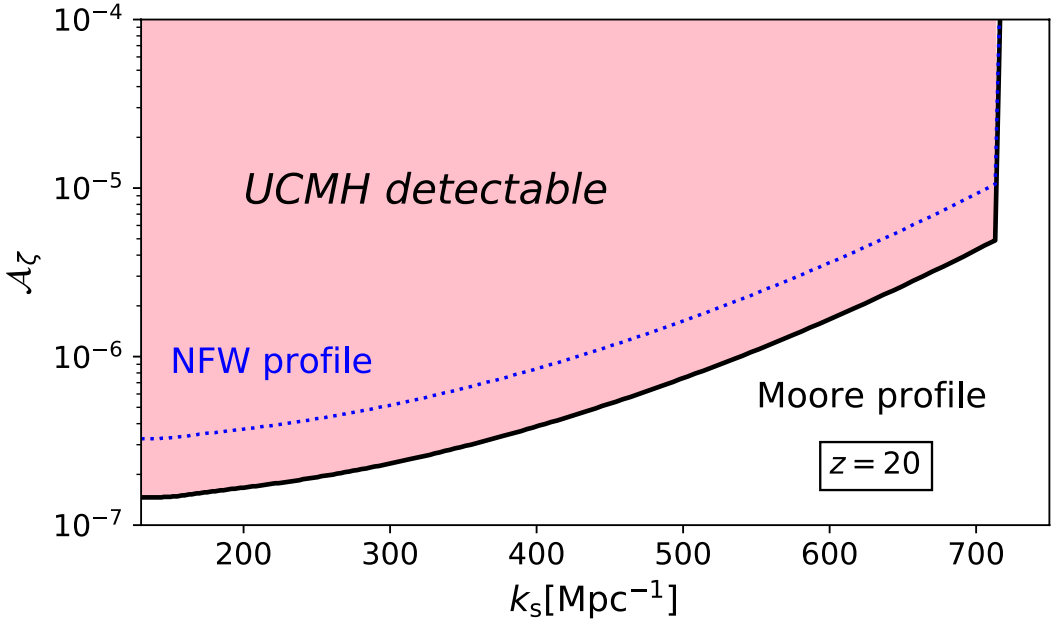
UCMH fluctuation signal

$$\langle \delta T_b^2 \rangle^{\frac{1}{2}}_{UCMH}(A_\xi) = b\langle \delta_{DM}^2 \rangle^{\frac{1}{2}} \overline{\delta T_b}$$



UCMH detectability

$$\langle \delta \mathrm{T_b^2} \rangle_{\mathrm{UCMH}}(A_\xi) \geq \langle \delta \mathrm{T_b^2} \rangle_{IGM+MH+NOISE}$$



3. Summary

We calculate the 21-cm fluctuation signal from UCMHs.

We discuss the potential on SKA1-low, to provide the constraint on the primordial curvature power spectrum from UCMHs.