The Power spectrum of Redshifted 21cm Fluctuations in Hierarchical Galaxy Formation Models

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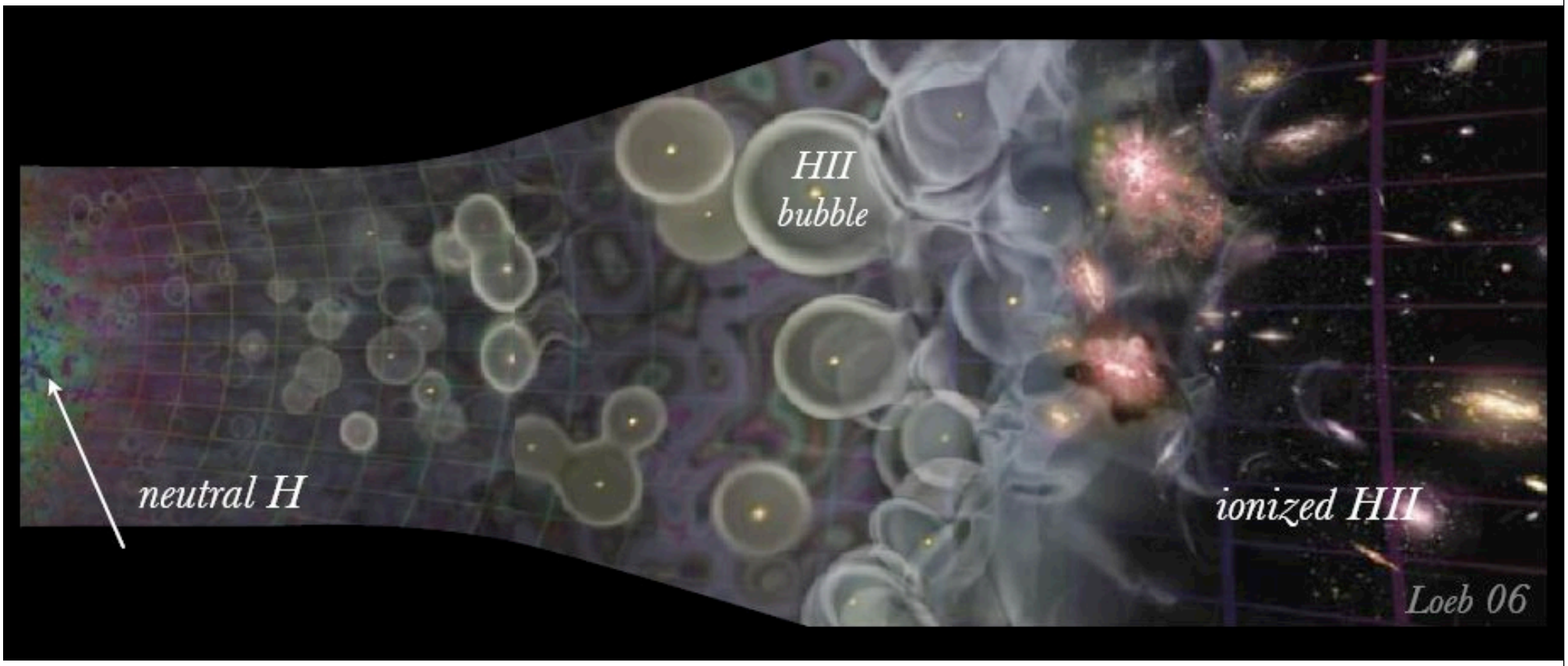
Hello,
My name is Hansik Kim.

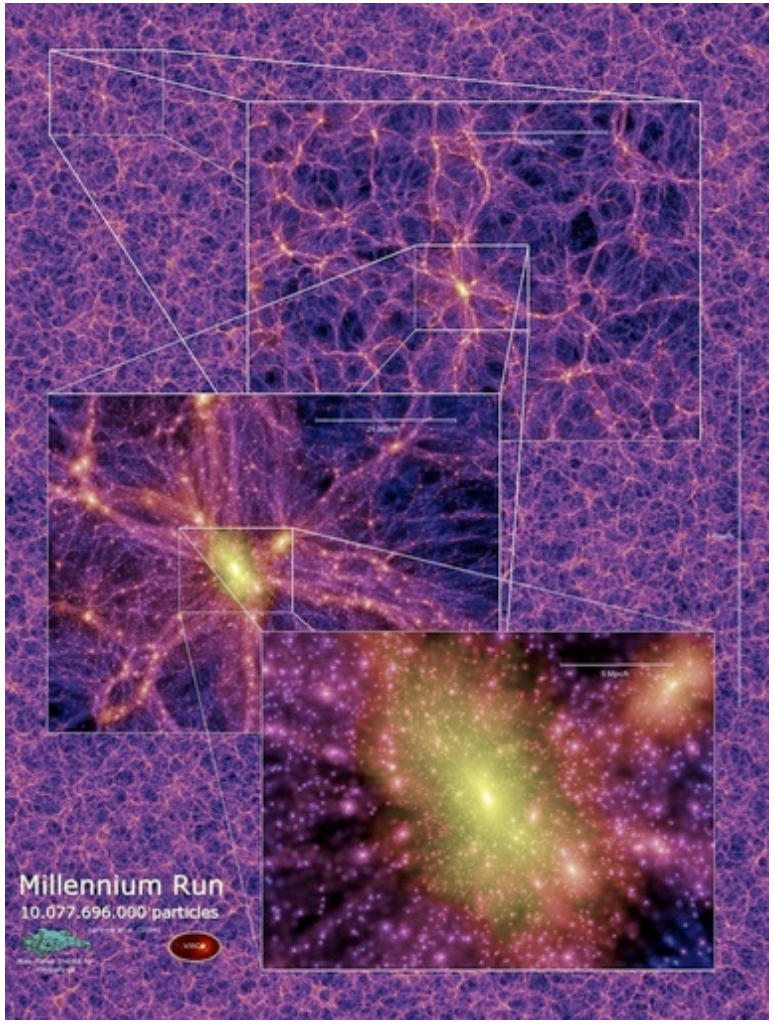
안녕하세요
저는 김한식 입니다.

Evolution of Hydrogen in the Universe

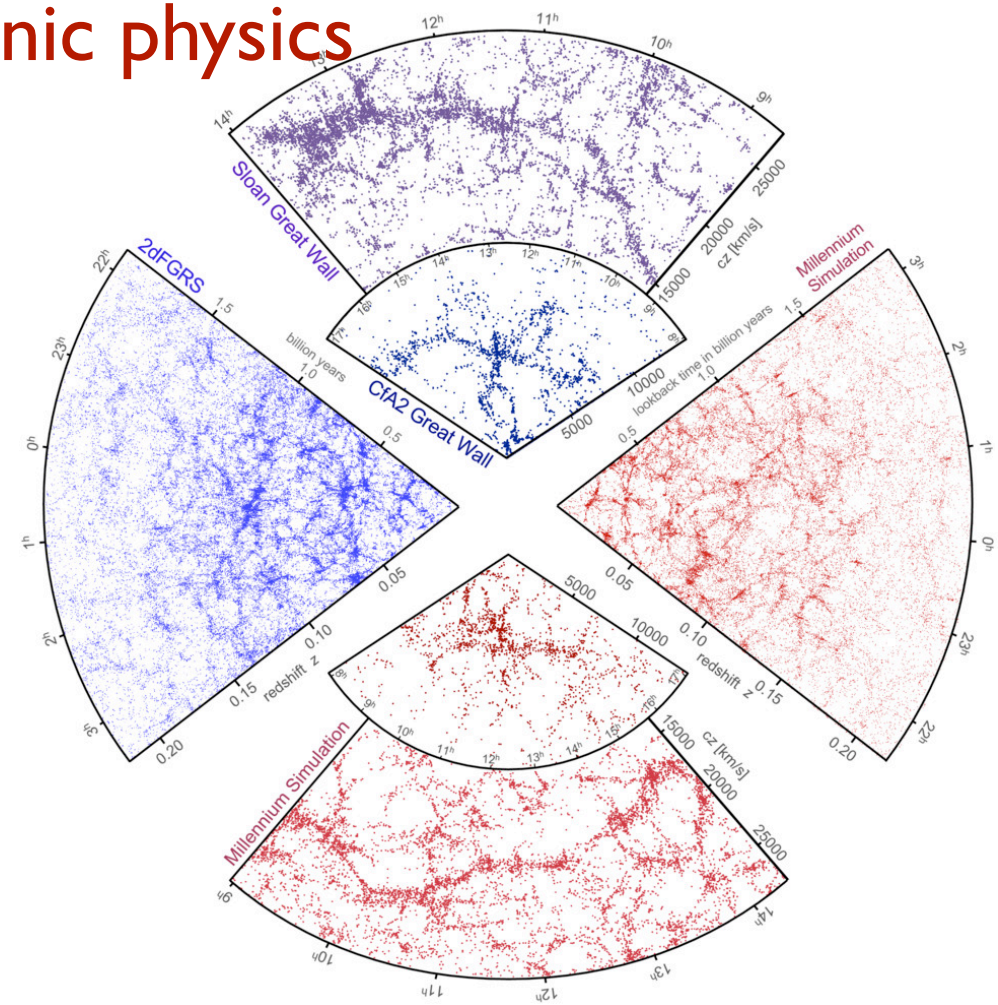


Building Universe!!

Gravity



Baryonic physics



What I would like to say....

- **Semi-Analytic galaxy formation model.**
- **.....**
- **Attempt to predict the 21cm power spectrum at EoR.**
- **.....**

  - Parameterisation unavoidable in galaxy formation models
  - Range of scales involved – several orders of magnitude
  - Uncertainty about the key physics

How to make Kimchi

Chinese Cabbage
Radish
Spring Onion
Green Onion
Sugar
Sea salt
Red Pepper Powder
Salted Shrimp
Anchovy Sauce
Minced Garlic
Crushed Ginger

1. 배추 절이기 및 헹구기

- 배추 밑둥에 칼집을 넣어 반으로 가른다.
- 분량의 물에 소금양의 반을 풀어 녹인 뒤 배추를 적셔 배춧잎 사이사이에 소금물이 고루 배도록 한다.
- 배추 줄기 부분은 나머지 소금으로 켜켜이 뿌려 큰 통에 속이 위로 오도록 담는다
- 남은 소금물을 붓고 한 4시간 정도 지난 후 뒤집어서 4시간 가량 절인다.
- 다 절여진 배추는 흐르는 물에 세번 정도 헹군다
- 헹궈 낸 배추는 채반에 엎어서 물기를 빼 준다

2. 다시마 물과 찹쌀풀 준비하기

- 찬물에 다시마를 넣어 끓이기 시작한다
- 팔팔 끓어 오르면 불을 끄고 20분 정도 두었다가 다시마를 건져내고 차게 식힌다
- 분량의 찹쌀가루와 물을 갠 다음 잘 저어가며 풀을 쒀 차게 식힌다

3. 양념 소 준비하기

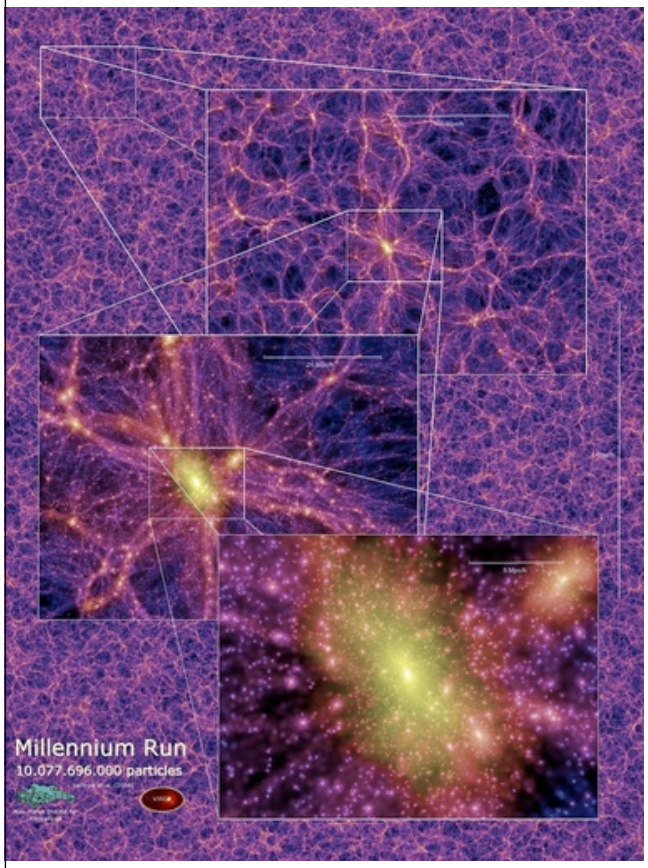
- 무는 2mm굵기로 채 썬다
- 깨끗이 씻은 부추와 쪽파, 미나리는 각각 4cm길이로 썬다
- 생새우는 옅은 소금물에 씻어 건져 물기를 뺀 다음 믹서에 간다

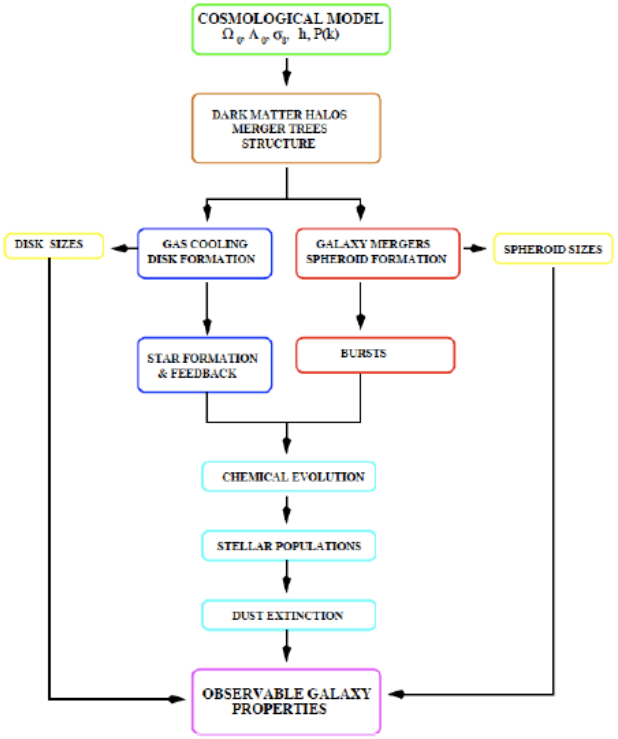
4. 양념소 만들기와 소 넣기

- 먼저 무채에 고춧가루를 넣고 버무려 고춧가루물이 배도록 한다
- 다싯물을 조금 넣어 촉촉하게 고춧가루물이 우러나도록 한다
- 다진 새우젓을 양념 재료에 넣고 1시간 가량 불려 준다
- 멸치액젓과 생새우 나머지 소 재료들을 섞어 버무린다
- 배춧잎 사이사이에 넣은 후 겉잎으로 전체를 돌려 싸고 단면이 위로오도록 차곡차곡 담은 뒤 우거지를 덮어 준다

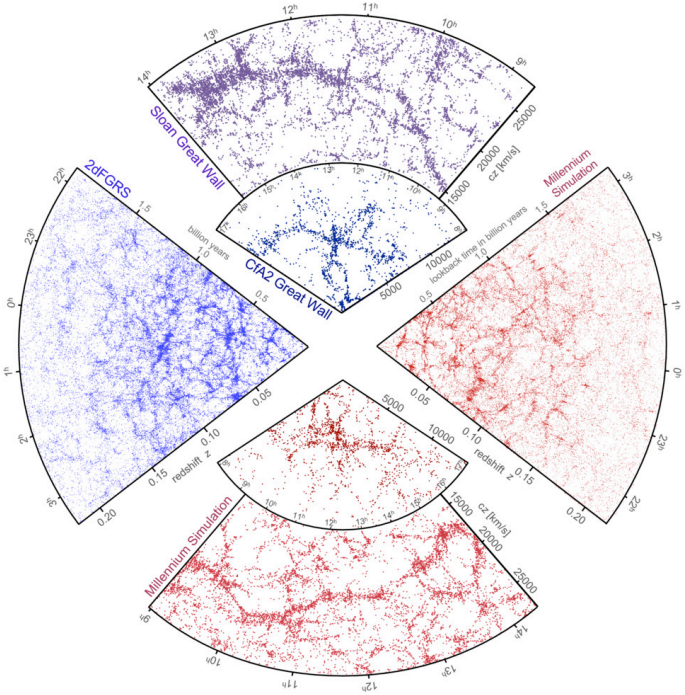
치펠이식 체험단 빌대식 "김치 클래스" 에서.... 이하연 선생님 제공

Graphic Designed by blog.naver.com/tangkwon

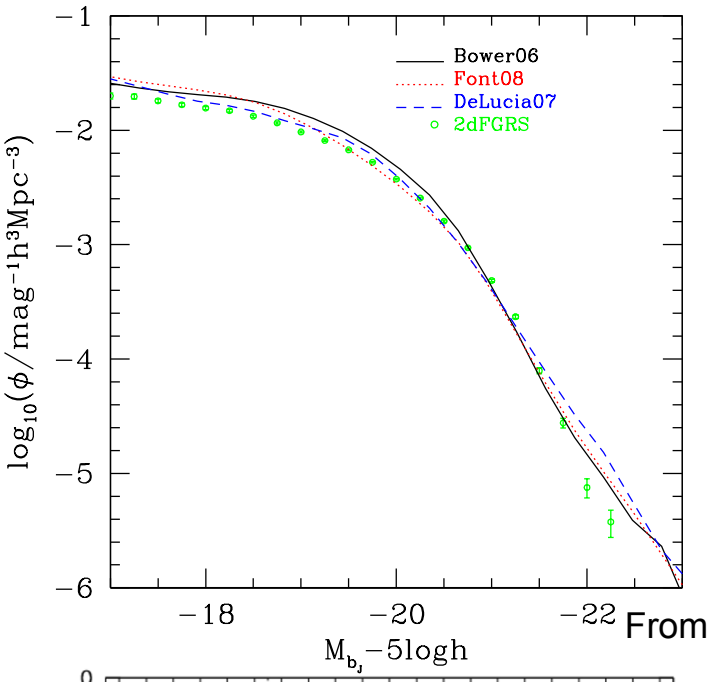


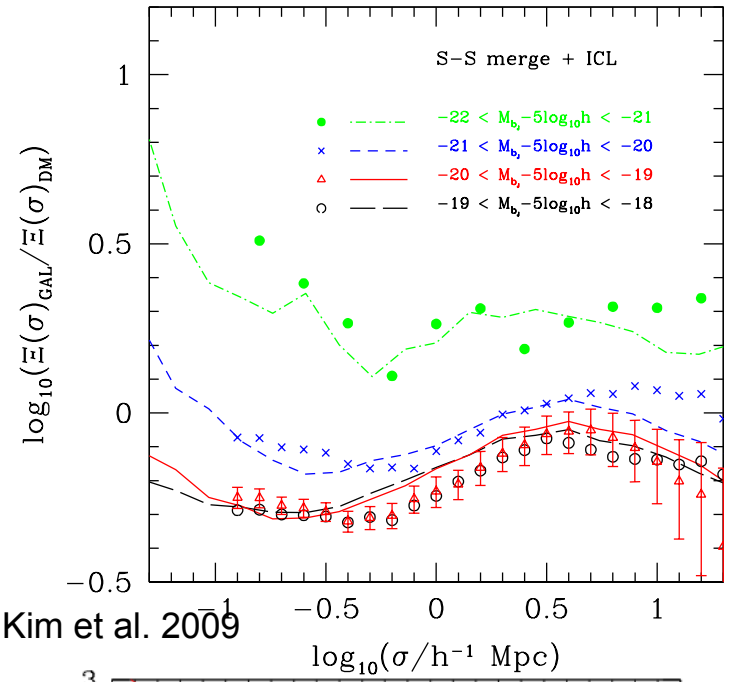


- **Rapid exploration of the parameter space of galaxy formation physics.**
- **Large, statically useful samples.**
- **Wide range of properties, multi-wavebands.**

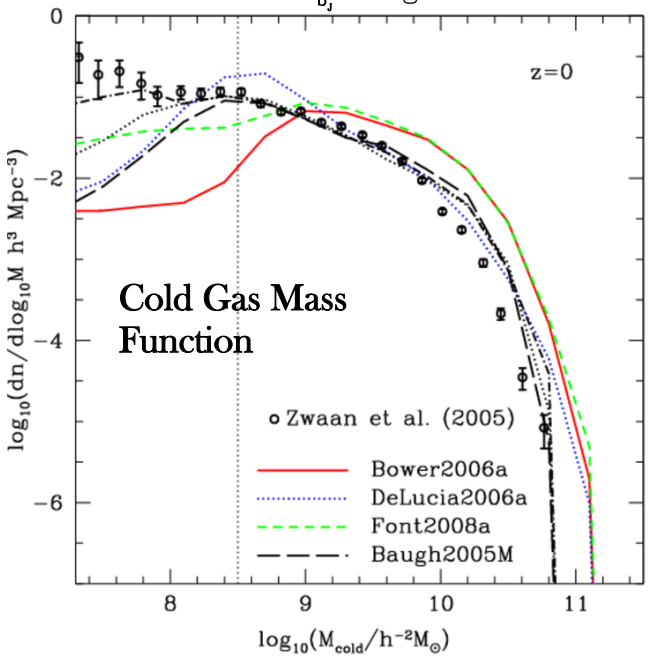


Examples

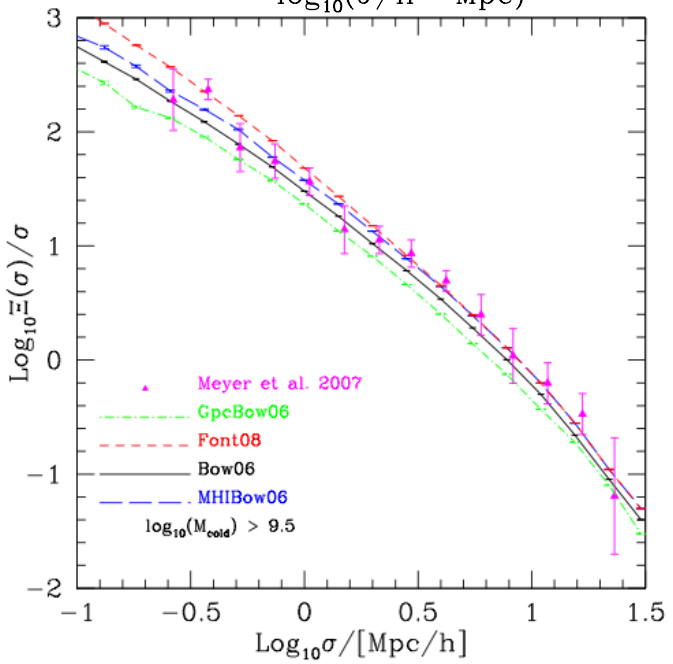




From Kim et al. 2009



From Power, Baugh & Lacey 2010



From Kim et al. 2011

Feedback processes

- SNe feedback is effective in low mass galaxies and modelled in GALFORM as

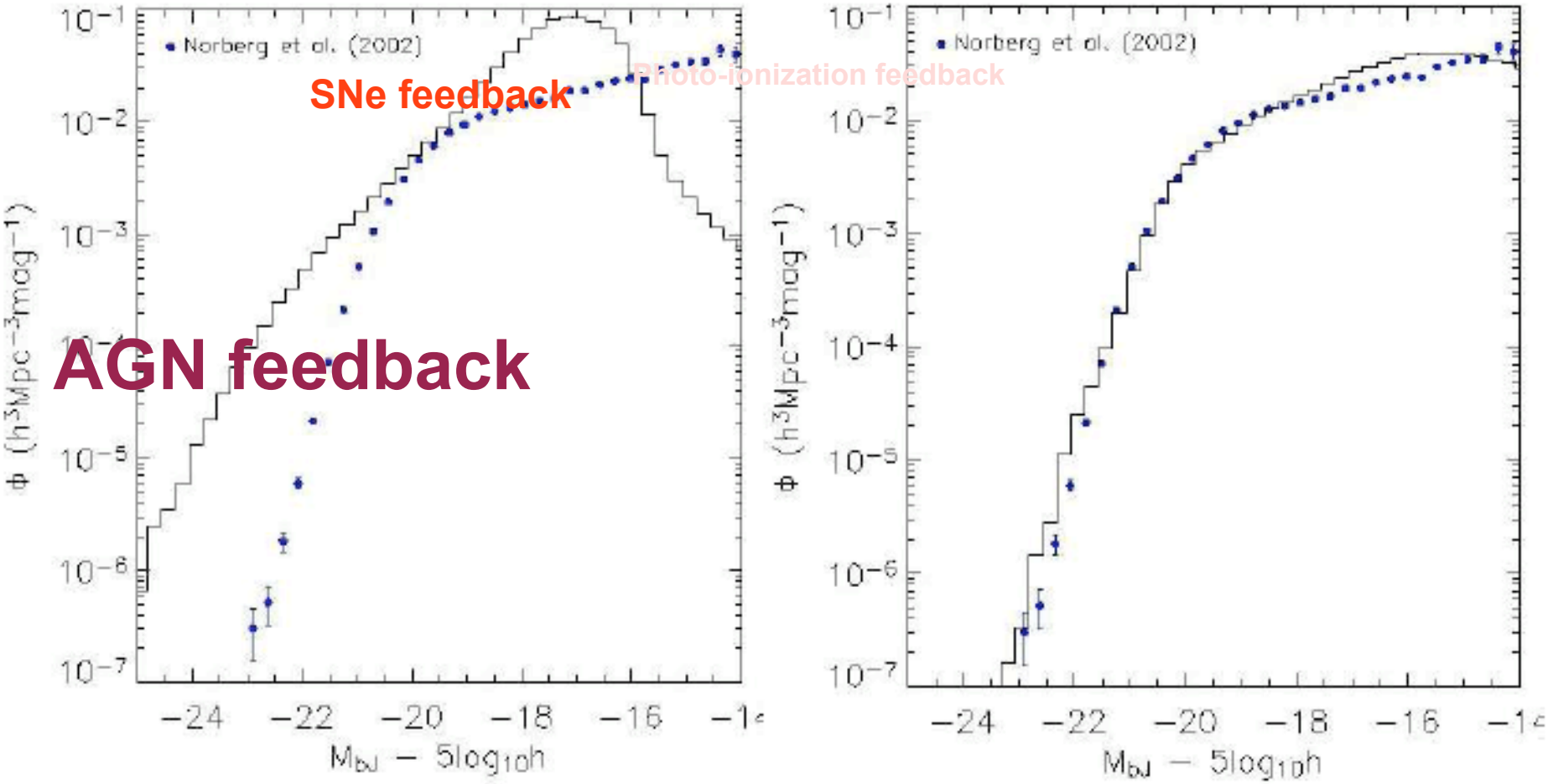
$$\dot{M}_{eject} = \beta\psi, \quad (1)$$

where ψ is the instantaneous star formation rate, and β is the efficiency of the feedback process defined by

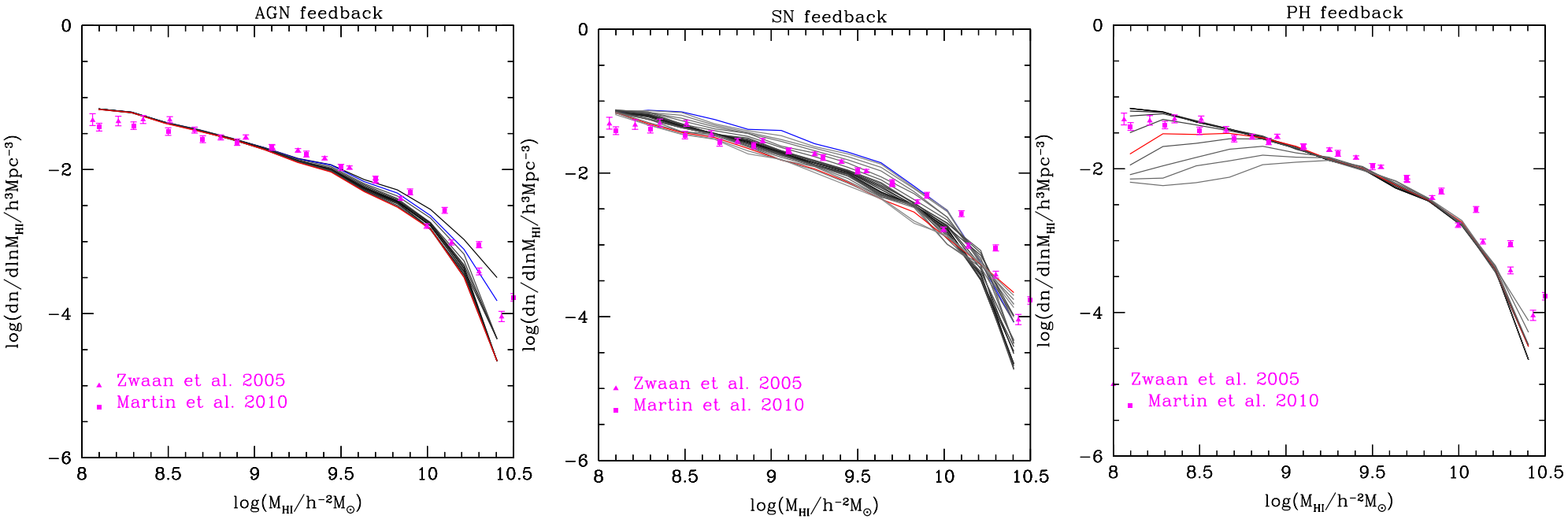
$$\beta = (V_{disk}/V_{hot})^{-\alpha_{hot}}, \quad (2)$$

- Vhot=485km/s and ahot=3.2
- AGN feedback in massive haloes(but small effect at EoR).
- Photo-ionization feedback(but the Millennium simulation is not enough halo mass resolution to see)

Roles of feedbacks at local Universe



Luminosity function



Kim et al. in pre

HI mass function

Let’s move to EoR using GALFORM

Redshifted 21cm power spectrum at EoR from model

GALFORM using N-body merger trees based on the Millennium simulation.

$$N_{\gamma,\mathrm{cell}} = N_{\mathrm{photon}}(\mathrm{IMF}, Z) f_{\mathrm{esc}} \frac{M_{\star,\mathrm{cell}}}{m_{\mathrm{p}}}, \quad (4)$$

escape fraction

$$Q_{\mathrm{cell}} = \left[\frac{N_{\gamma,\mathrm{cell}}}{(1+F_{\mathrm{c}}) N_{\mathrm{HI,cell}}} \right], \quad (5)$$

HII region finding

mean number of recombinations per hydrogen atom

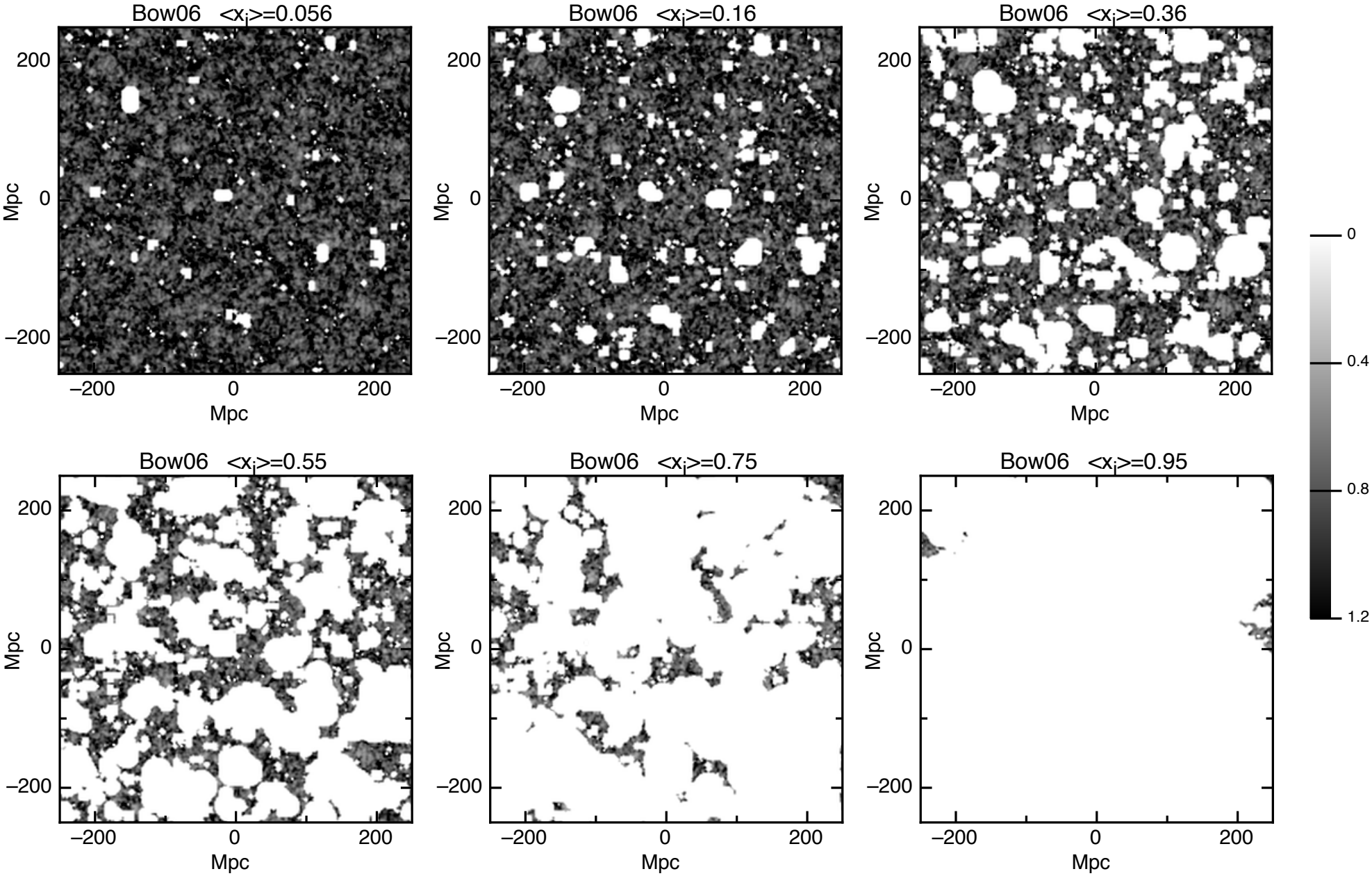
$$N_{\mathrm{HI,cell}} = n_{\mathrm{HI}} (\delta_{\mathrm{DM,cell}} + 1) V_{\mathrm{cell}}, \quad (6)$$

$$\Delta T = 23.8 \left(\frac{1+z}{10} \right)^{\frac{1}{2}} [1-Q] (1+\delta_{\mathrm{DM,cell}}) \ \mathrm{mK}. \quad (7)$$

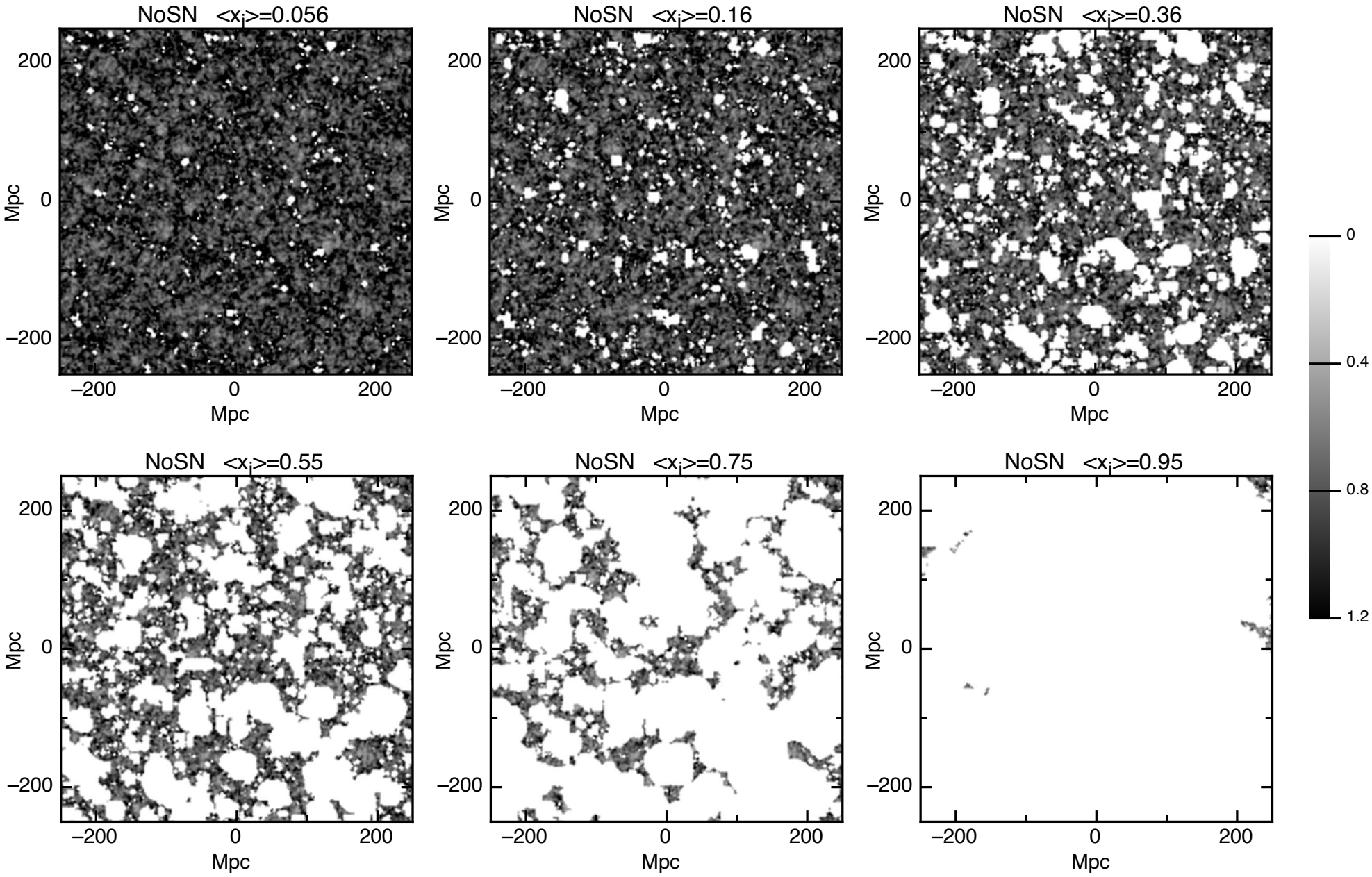
21cm PS

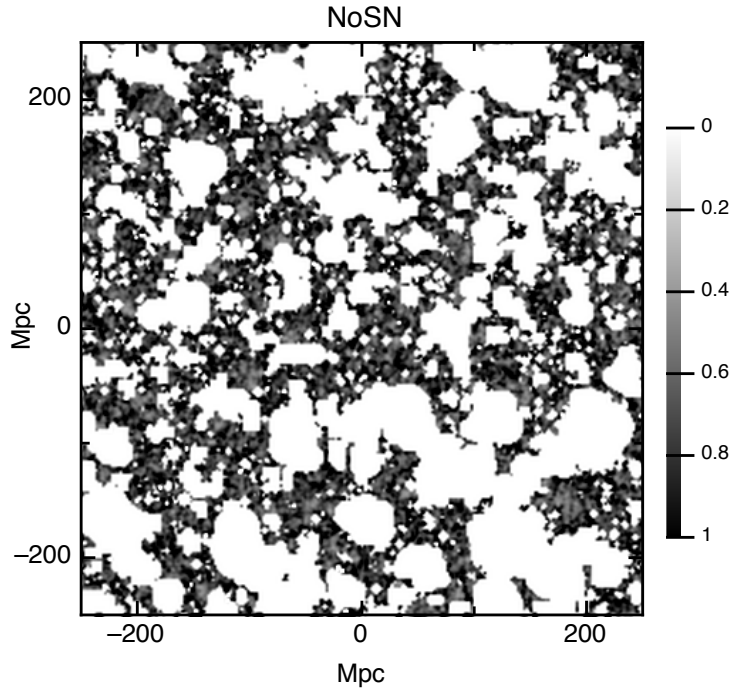
$$\Delta^2(k) = k^3/(2\pi^2) P_{21}(k) \quad (8)$$

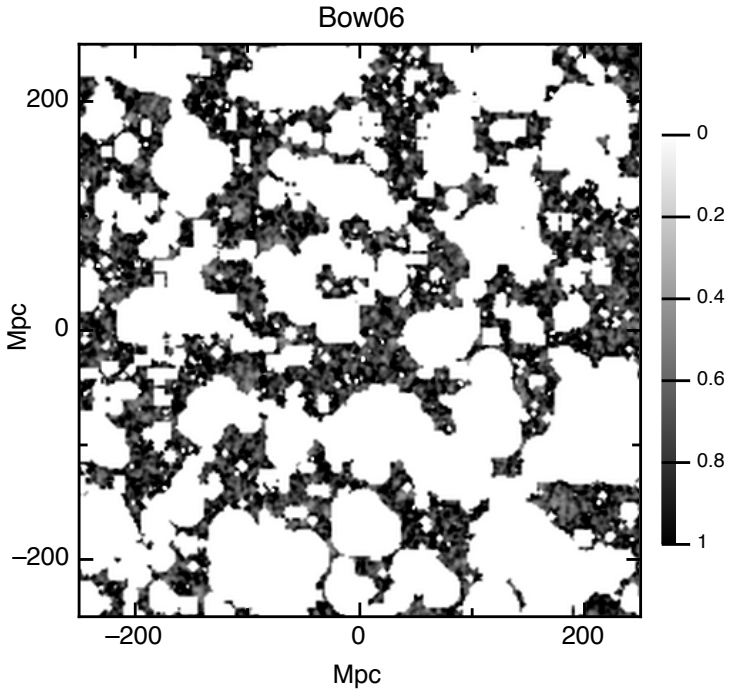
21cm intensity maps

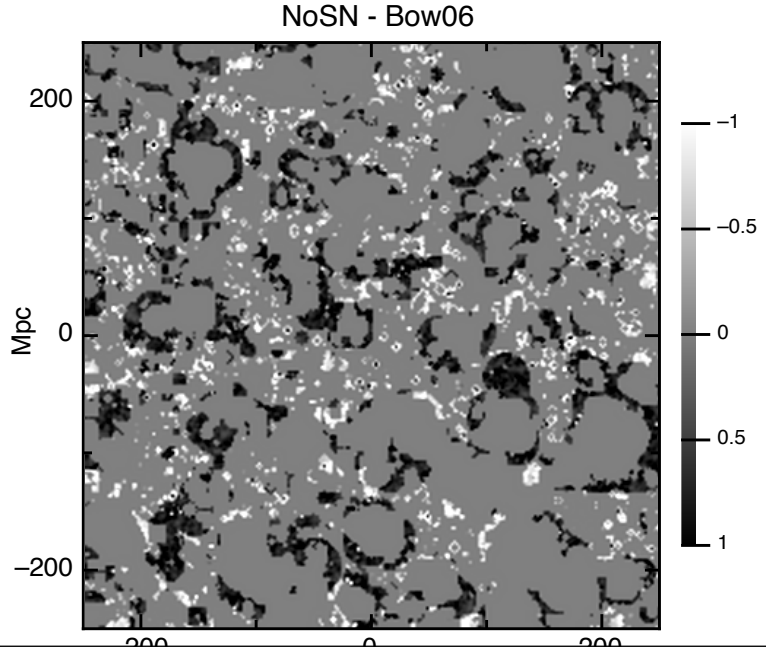


21cm intensity maps





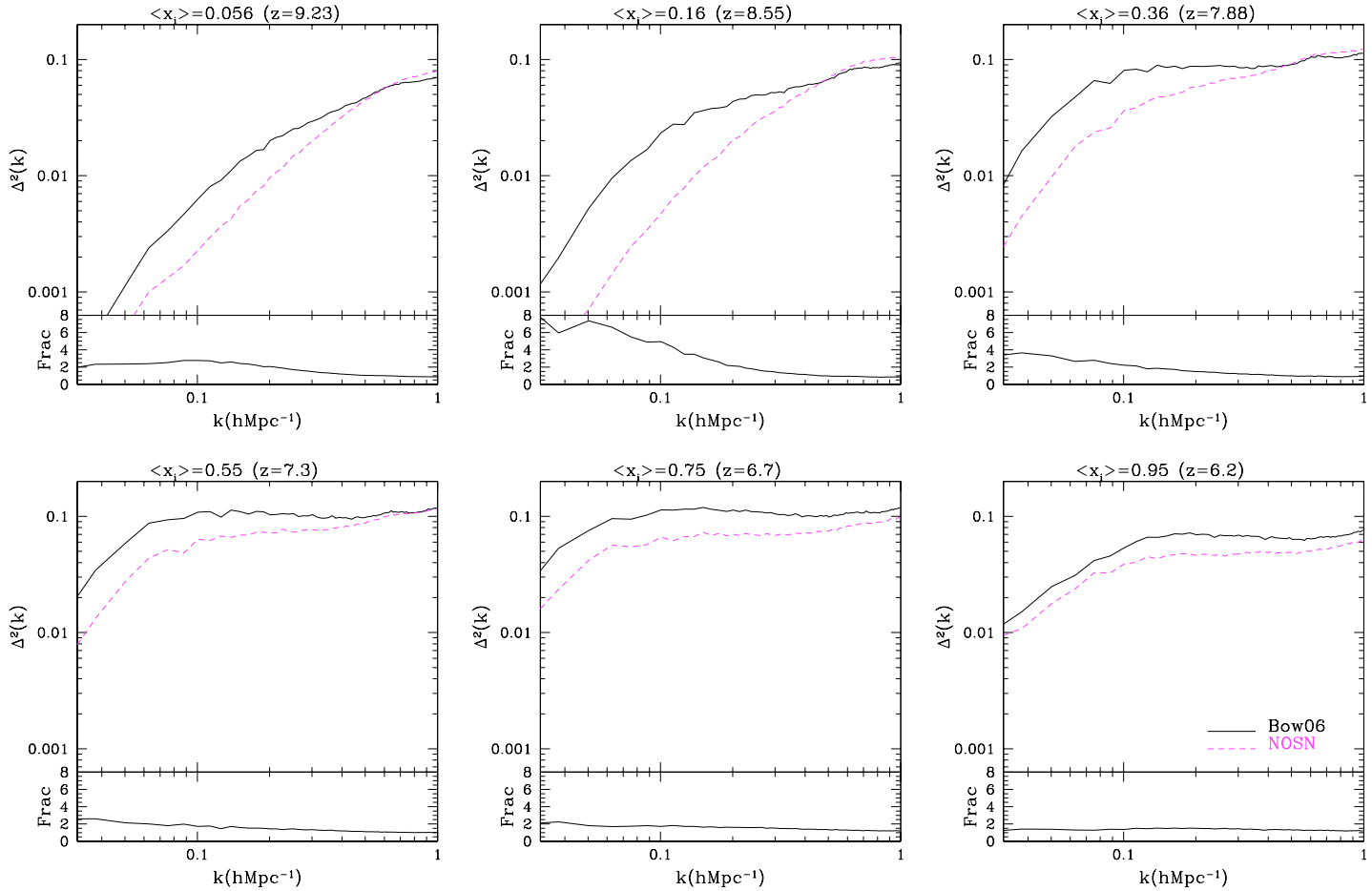




NoSN-Bow06

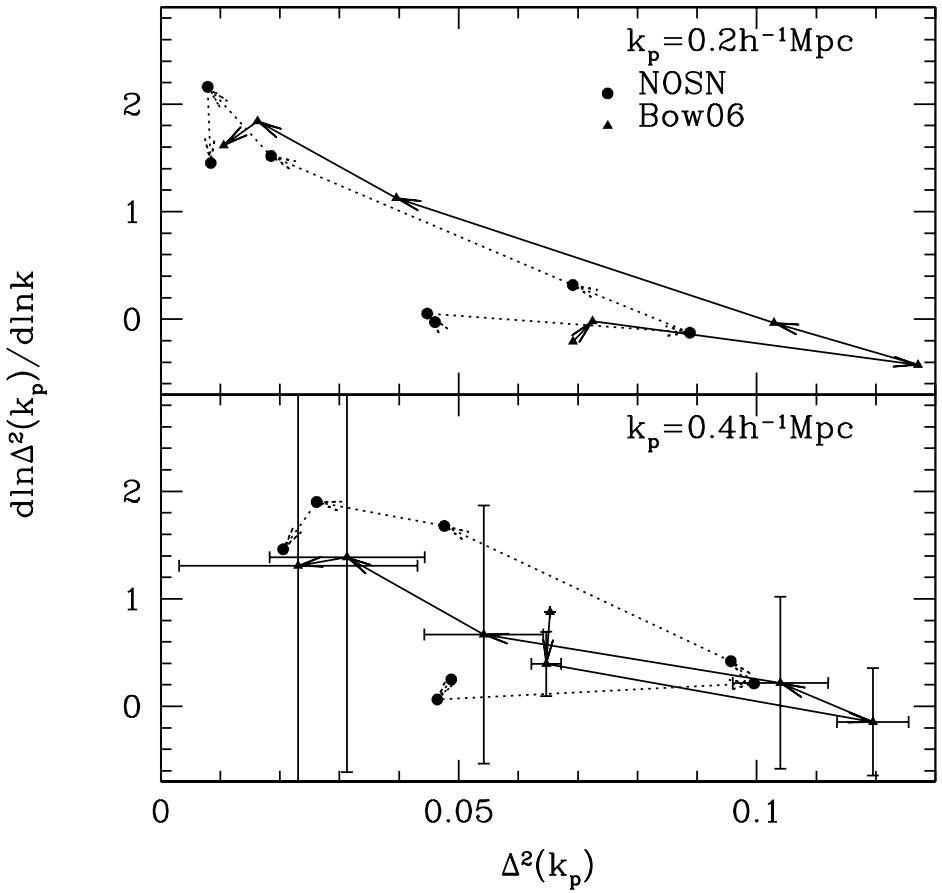
$\langle x_i \rangle \sim 0.55$

Predictions of 21 cm power spectrum at EoR



The SNe feedback impacts on the 21cm PS at EoR not only amplitude but also slope

Prediction for upcoming observation.



The predicted estimation from MWA with 1000hrs integration time and 6MHz of bandpass.

What I've done, am doing & will do....

- Taste and style of Kimchi depend on the choice of recipes.
- Semi-Analytic model (with good recipe) is one of the useful tools to understand the Universe.
- Attempt to use the Semi-analytic modelling to see the EoR.
- We could see the SNe feedback effect imprinted on the 21cm power spectrum at EoR.
- Self consistent photo-ionization feedback modelling on the semi-analytic model.
- Using higher resolution simulation merger trees to understand the photo-ionization feedback.
- Impact of the self consistent photo-ionization feedback modelling at local Universe.

Thank you.

감사합니다.