HI Intensity Mapping

Jasjeet Singh Bagla

Science with the SKA
IISER Mohali, March 19, 2014

Visibility Correlation

J. Astrophys. Astr. (2001) **22,** 293–307

HI Fluctuations at Large Redshifts: I–Visibility correlation

Somnath Bharadwaj[1] & Shiv K. Sethi[2*]

[1]*Department of Physics and Meteorology & Center for Theoretical Studies, I.I.T. Kharagpur, 721 302, India*
email: somnath@phy.iitkgp.ernet.in
[2]*Raman Research Institute, C. V. Raman Avenue, Sadashivnagar, Bangalore 560 080, India*
email: sethi@rri.res.in

Received 2002 March 15; accepted 2002 May 31

Power Spectrum and Visibility Correlation

$$\langle V_\nu(\mathbf{U}) V^*_{\nu+\Delta\nu}(\mathbf{U})\rangle = \frac{[\bar{I}_\nu \theta_0^2]^2}{2} \int_0^\infty dk_\parallel \frac{P_{\rm HI}(k)}{r_\nu^2 \theta_o^2} \cos(k_\parallel r_\nu^{'} \Delta\nu) \times$$
$$\times \left[1 + \beta \frac{k_\parallel^2}{k^2}\right]^2 \text{ with } k = \sqrt{k_\parallel^2 + (2\pi/r_\nu)^2 U^2}. \qquad (13)$$

Visibility Correlation

- Intensity mapping is a term used to describe detection of HI via the statistical relation between the power spectrum and visibility correlation.
- The main theoretical challange is to estimate the power spectrum of fluctuations in HI.
- Predictions for the post-reionization universe were given in Khandai et al (2010) and Wyithe et al (2010) who used different approaches to arrive at the same result, namely that the bias and non-linear effects boost the small scale power in HI fluctuations by a significant amount.
- All other predictions are based on linear evolution of fluctuations.

P(k) at High Redshifts

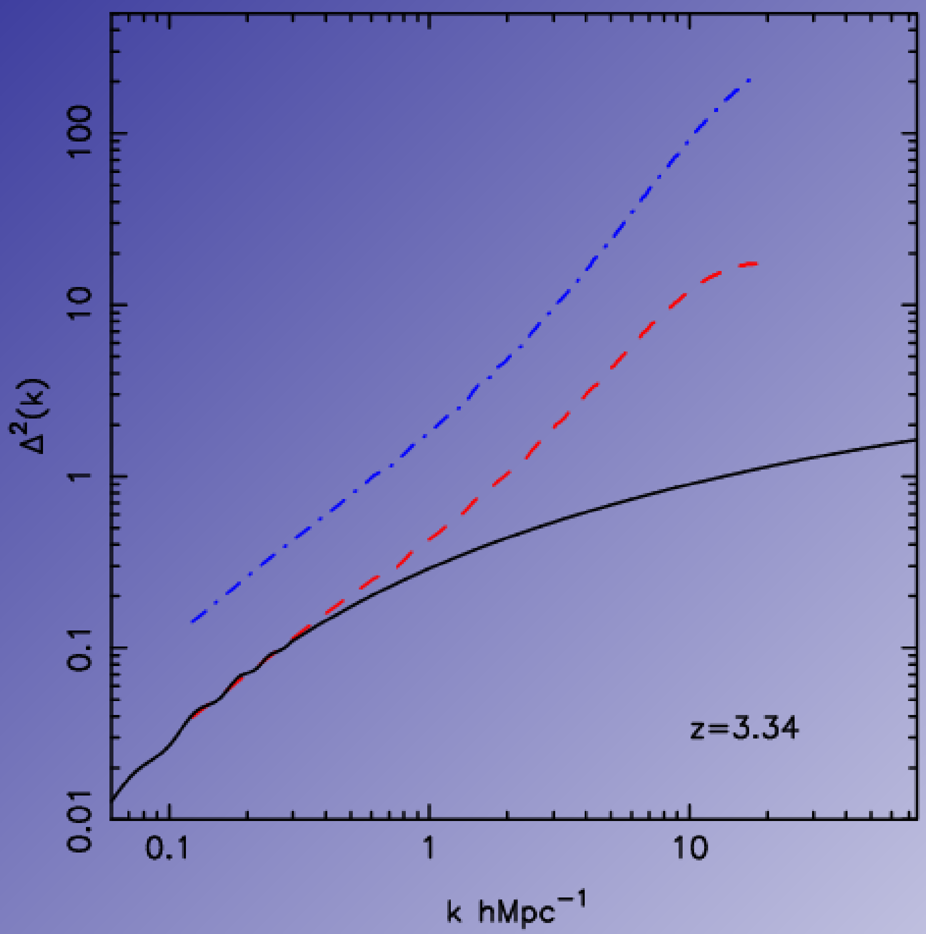
H I as a probe of the large-scale structure in the post-reionization universe

J. S. Bagla,[1★] Nishikanta Khandai[1,2★] and Kanan K. Datta[1,3,4★]

[1] *Harish-Chandra Research Institute, Chhatnag Road, Jhunsi, Allahabad 211019, India*
[2] *Department of Physics, Carnegie Mellon University, Pittsburgh, PA 15213, USA*
[3] *Department of Physics and Meteorology & Centre for Theoretical Studies, IIT, Kharagpur 721302, India*
[4] *The Oskar Klein Centre for Cosmoparticle Physics, Department of Astronomy, Stockholm University, Albanova, SE-10691 Stockholm, Sweden*

Accepted 2010 April 24. Received 2010 April 19; in original form 2009 September 5

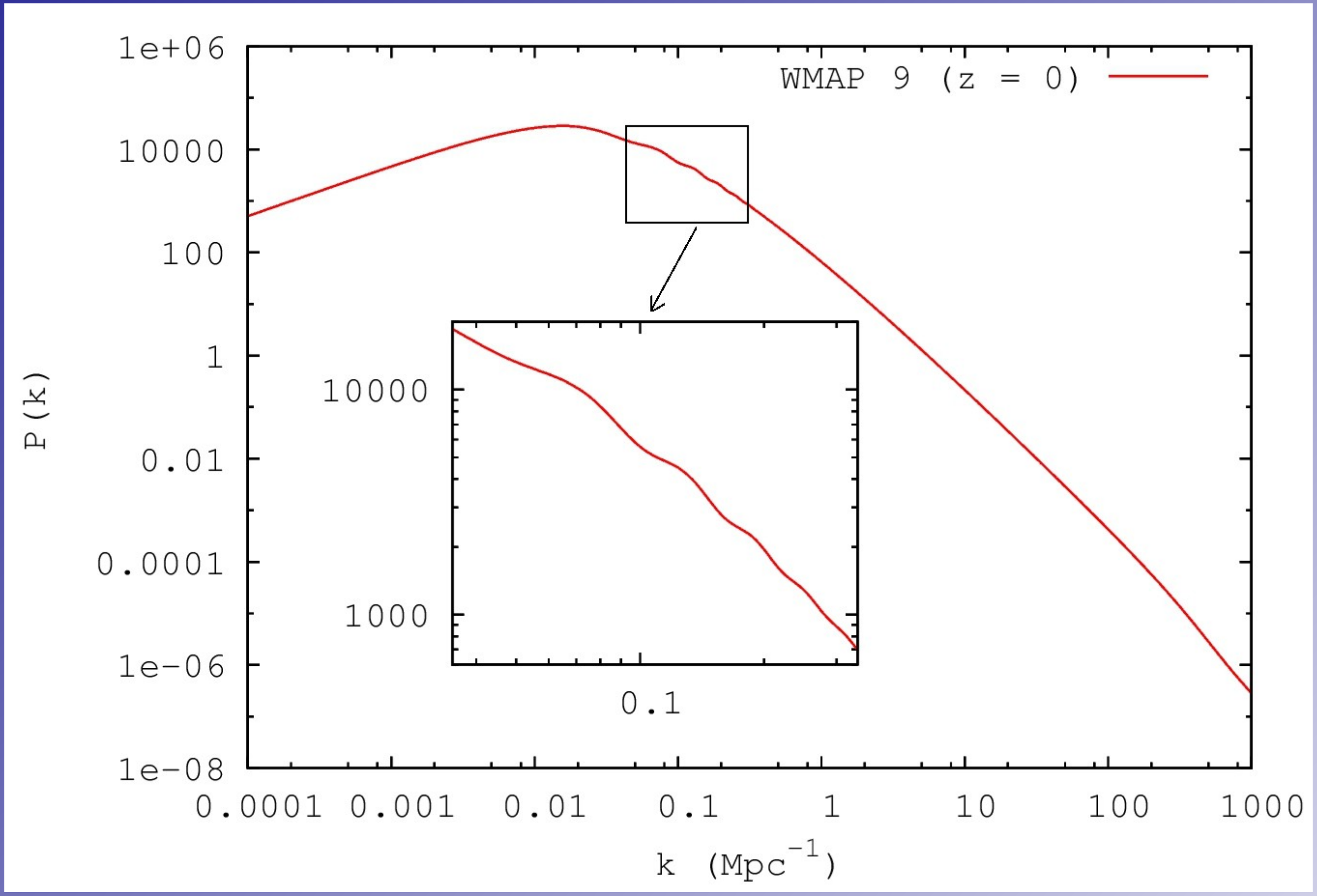
P(k) at High Redshifts



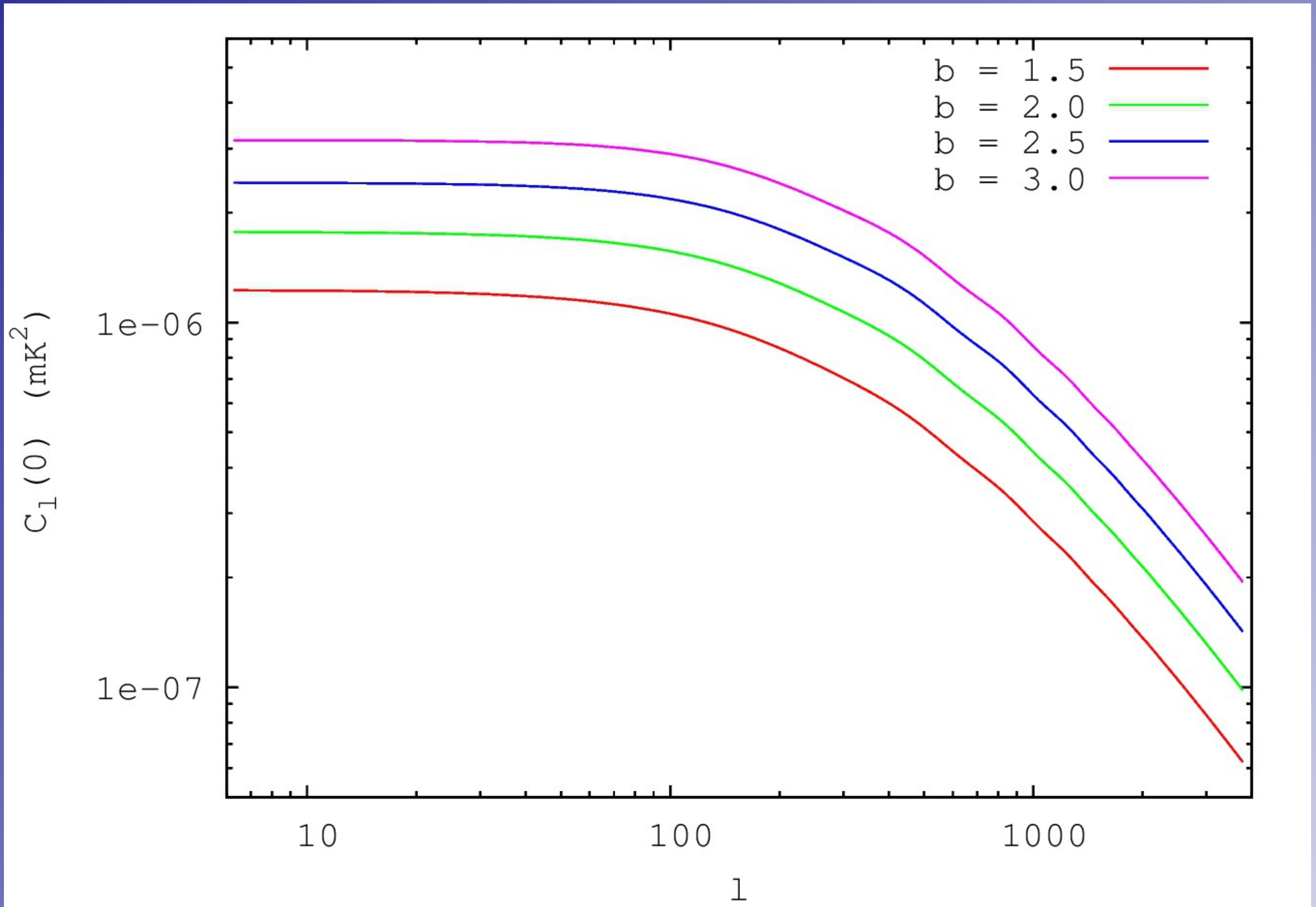
Implications of High Bias

- Detection of rare objects may be as efficient an option.
- However, quantitative understanding and cosmological parameters can only be recovered from the visibility correlation.
- One needs to explore implications of non-linearity and high bias.

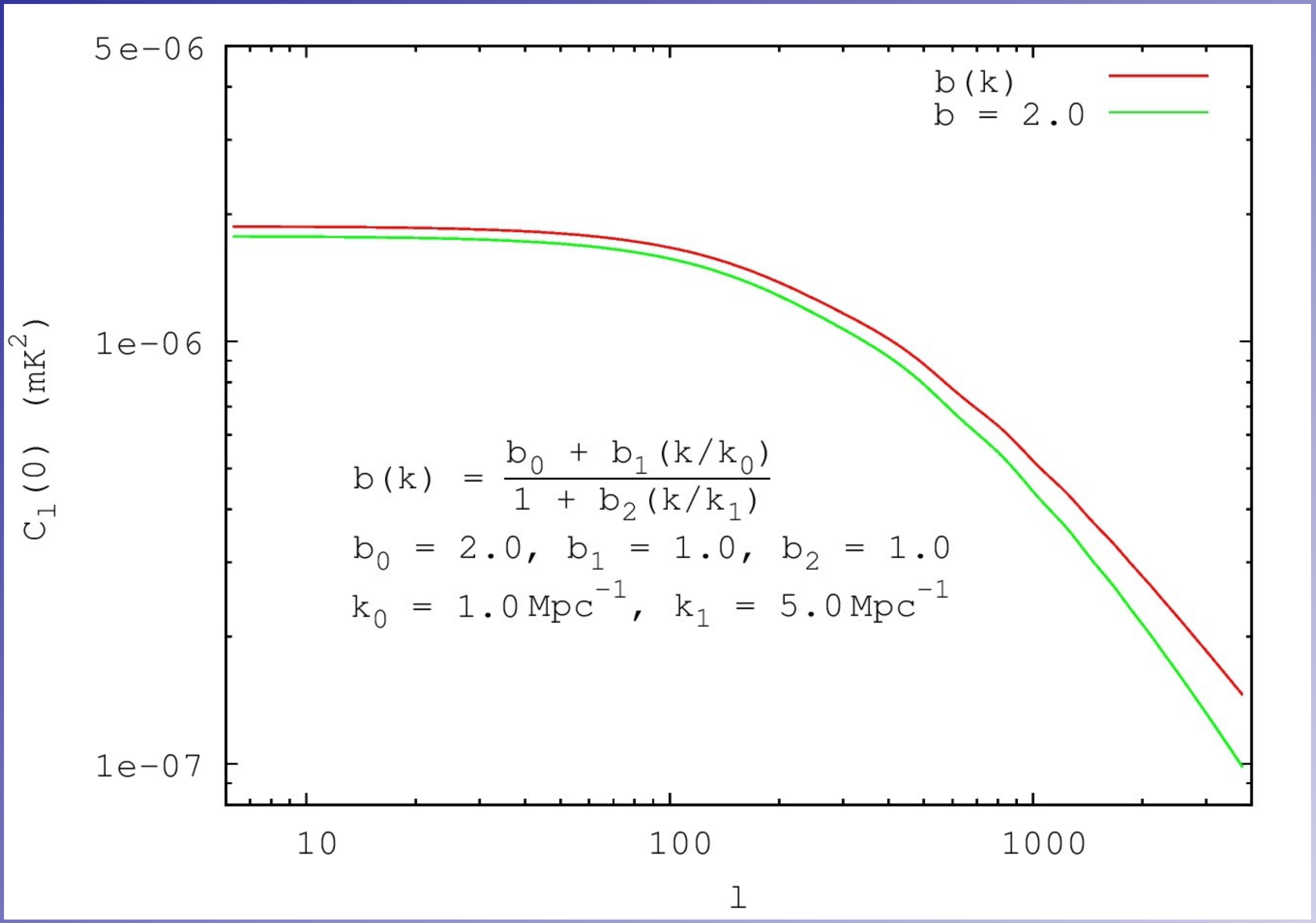
Linear Power Spectrum



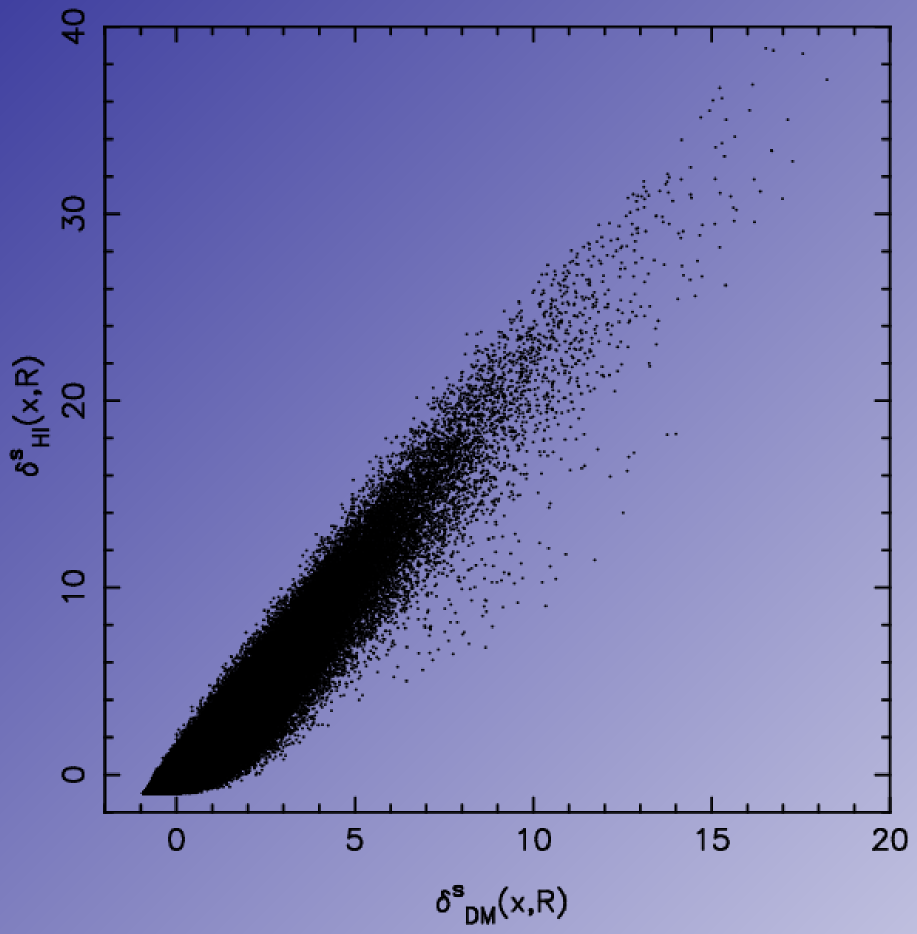
Constant Bias



Scale Dependent Bias



Adding Realism



HI Intensity and SKA Precursors

- Modelling signal is not very difficult.
- Foregrounds pose a serious challange.
- A thorough understanding of instruments is also essential.
- (Added later): Upgraded ORT is the best instrument for detection of HI at z ~ 3 till SKA mid comes online.