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Prospects for Weak Lensing surveys with next-generation arrays

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Recently, R. Cen (2006) has suggested that small protogalactic halos at high redshift ($z \simeq 20-25$) could be surrounded by extended ($r \approx 1h^{-1}$Mpc) gaseous halos, which could be marginally detected by LOFAR. However, more recent work on the mass function at high z shows that these estimates could be too optimistic. Moreover, the variance over the sky of this signal could be very large, thus undermining the practical usage of these halos for the determination of cosmological parameters using weak lensing.

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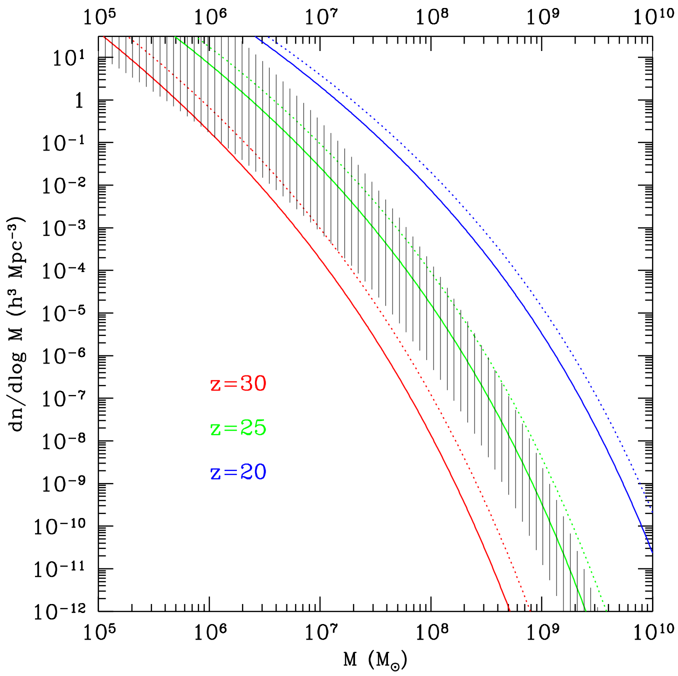

Figure 1: Figure 1: Number density of dark matter halos at different redshifts. *Continuous* lines are for the best-fit (variable power spectral index n_{eff} of Reed et al. (2006),[7], while *dotted* lines are Sheth-Tormen mass functions used by Zhang et al. [12]. The shaded region shows the $\pm 1\sigma$ bounds allowed by large scale modulation of the density threshold for gravitational collapse, calculated only for $z = 25$ [2].

1. Introduction

One of the most interesting and speculative targets for radio surveys with next generation instruments like LOFAR [8] are protogalaxies at high redshifts (z > 15), i.e. before the epoch of primary reionization. We do not have yet any observational evidence for these ancestors of the present-day luminous content of our Universe, but recently few theoretical studies have attempted to predict the aspect of these objects at different wavelengths ([5, 2, 3, 9]). In particular, Cen [4] has recently suggested that scattered Ly-alpha radiation around collapsing protogalactic halos in the mass range $10^{5.5} - 10^7 h^{-1} \mathrm{M}_\odot$ (h being the Hubble constant in units of 100 km $\cdot$ sec$^{-1} \cdot$ Mpc^{-1}) could be detected in the frequency range of LOFAR, and could even make these objects useful as background galaxies in weak lensing studies at radio frequencies [12]. However, we will demonstrate that our current knowledge of galaxy formation in the *Concordance* cosmological model is not yet sufficient to enable one to reliably estimate the number density of these objects and their detectability.
Hereafter we will assume a 3-years WMAP cosmology (Spergel et al. 2006 [11]), with $\Omega_m = 0.24, \Omega_\Lambda = 0.76, \sigma_8 = 0.74, n = 0.951$.

2. Halos at high redshift

Estimates of the number density of 21cm halos which could be used for weak lensing are very uncertain. Cen et al. base their estimates only on the mass function, which is defined as an ensemble

average over the whole Universe. Very recently, Reed et al. [7] have shown that the Sheth-Tormen mass function [10] overestimates the number density of halos, particularly at redshifts larger than 10. For the cosmological model adopted here, the difference between the more accurate mass function of Reed et al. and the ST mass function adopted by Cen et al. in their calculations is larger than 50% at $z > 25$, for $10^{5.5} \leq M \leq 10^7 M_\odot$, as can be seen in Figure 1. Moreover, Barkana & Loeb (2004, [2]) have also shown that a small fluctuation in the background density can greatly affect the threshold density for collapse, thus producing large scale fluctuations in the number density of protogalactic halos. The uncertainty is shown as a shaded region in Fig. 1.
It is then clear that, ultimately, both these effects can affect the reliability of the weak lensing signal detected in these surveys. The presence of a large variance, in particular, could seriously affect the usefulness of these background galaxies in weak lensing surveys for the determination of cosmological parameters.
In addition to these fundamental uncertainties, other physical effects can and do affect the existence of extended gaseous halos at high redshift. We are currently investigating tidal fields from large scale structure, which could strip and limit gaseous halos, and ram-pressure stripping due to peculiar motions w.r.t. the intergalactic medium. Although the magnitude of peculiar motions is small, the high average density of the intergalactic medium (which scales as $(1+z)^3$) can result in gas stripping from the outer regions, thus limiting the actual extent of these extended gaseous halos.

Acknowledgments

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