



Probing primordial magnetic fields using cosmological weak lensing shear and Ly α effective opacity

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Abstract. In this article we present our results of upper bounds on primordial magnetic fields coming from two cosmological observables, the cosmological weak lensing shear and the Ly α effective opacity.

Keywords : Cosmology: – primordial magnetic fields – cosmological weak lensing shear – Ly α clouds

1. Introduction

From previous studies it is known that the presence of primordial magnetic fields during prerecombination era could generate additional matter perturbations (over and above inflationary matter perturbations) in the universe. In the matter power spectrum this can contribute appreciably as an additional power at smaller scales ($k \sim 1 - 10 h \text{ Mpc}^{-1}$; for magnetic field strength B_0 of the order of nG; for details see Gopal & Sethi (2003); Pandey & Sethi (2012, 2013) and the references therein; Figure 1a).

Primordial magnetic fields are assumed to be tangled magnetic fields with a power law energy power spectrum: $P_B(k) = P_{B0}(k) k^{n_B}$ on large scales, $k > k_D$, where k_D is a cut-off wave number set by the Alfvén wave damping scale.

In the recent past, cosmological weak lensing and the study of Ly α clouds in the redshift range $2 < z < 5$ have emerged as reliable methods to precisely determine the matter power spectrum on scales below $10 h^{-1} \text{ Mpc}$. In particular, these methods can estimate the matter power spectrum at small scales which are not directly accessible to other methods e.g. galaxy surveys. Since these are the scales which are highly affected by the existence of primordial magnetic fields, a careful analysis of these cosmological observables can actually probe the existence of these magnetic fields.

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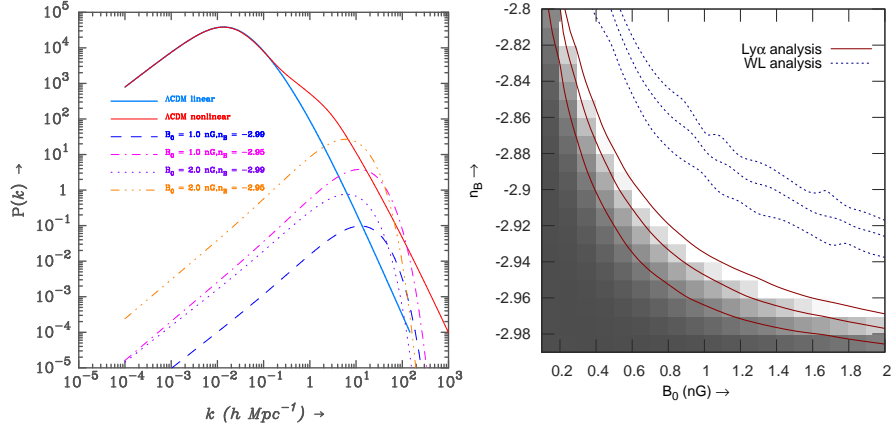


Figure 1. The plot on the left side (1a) shows the matter power spectrum for various cases. For magnetic cases there is a cut-off at magnetic Jeans scale due to magnetic pressure. The plot on the right side (1b) shows the constraints on magnetic field parameters B_0 and n_B coming from our weak lensing shear and $\text{Ly}\alpha$ effective opacity analysis, the lines are 1, 3 and 5 σ contours over B_0 and n_B plane.

2. The work and the results

In this work we simulated the observables, [1] cosmological weak lensing (2-point) shear correlation functions (ξ_E, ξ_B) and [2] $\text{Ly}\alpha$ effective opacity (for details see Pandey & Sethi (2012, 2013)). We also did χ^2 analysis of our simulated values for the observables with the observed values for those taken from Fu et al. (2008) and Faucher-Giguère et al. (2008). From our χ^2 analysis we get one of the best upper bounds on primordial magnetic field strength ($B_0 < 0.6$ nG for $n_B = -2.9$ with 5σ ; see Fig 1b) known till date for nearly scale invariant models of primordial magnetic fields, i.e. $n_B \simeq -3$ (see Pandey & Sethi (2012, 2013) and references therein).

References

- Faucher-Giguère C.-A., Prochaska J. X., Lidz A., Hernquist L., Zaldarriaga M., 2008, ApJ, 681, 831
 Fu L., et al., 2008, A&A, 479, 9
 Gopal R., Sethi S. K., 2003, JApA, 24, 51
 Pandey K. L., Sethi S. K., 2012, ApJ, 748, 27
 Pandey K. L., Sethi S. K., 2013, ApJ, 762, 15