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Searching for primordial correlations between the magnetic field and the density perturbation using \mu-distortion

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Damping of non-uniform magnetic field between redshifts of about 10^4 and 10^6 cause the observed CMB to deviate from a perfect blackbody spectrum, producing a so-called μ-distortion. This allows us to search for a correlation $\langle \zeta B^2 \rangle$ between the magnetic field B and the density perturbation ζ by looking for a μT correlation in the CMB, where T is the temperature perturbation. Since the magnetic field perturbations, which produce μ-distortion, will be much smaller scale than the density perturbations, this observable is sensitive to the local limit of $\langle \zeta B^2 \rangle$, naturaly parametrized by b_{NL}, a parameter defined analogously to f_{NL}. We discuss the observability of b_{NL} by CMB experiments. We also discuss post magnetogenesis-era sources of a $\langle \zeta B^2 \rangle$ correlation.

Summary

We find that b_{NL} can be detected by upcoming CMB experiments if the magnetic field strength is at least around 10^{-12} G, with more sensitivity from future experiments. With regard to post-magnetogenesis sources, we explain why there will be no contribution from the evolution of the magnetic field in response to the curvature perturbation (a potential competing effect). Also, we also find a slightly larger signal than a previous result from the evolution of the curvature perturbation in response to the anisotropic stress of the magnetic field.

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