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ALFVEN MODES DRIVEN NONLINEARLY BY METRIC PERTURBATIONS IN ANISOTROPIC MAGNETIZED COSMOLOGIES

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We consider anisotropic magnetized cosmologies filled with conductive plasma fluid and study the implications of metric perturbations that propagate parallel to the ambient magnetic field. It is known that in the first-order (linear) approximation with respect to the amplitude of the perturbations no electric field and density perturbations arise. However when we consider the nonlinear coupling of the metric perturbations with their temporal derivatives, certain classes of solutions can induce steeply increasing in time, electric field perturbations. This is verified both numerically and analytically. The source of these perturbations can be either high-frequency quantum vacuum fluctuations, driven by the cosmological pump field, in the early stages of the evolution of the Universe, or astrophysical processes, or a nonlinear isotropization process, of an initially anisotropic cosmological space–time.

Keywords: Cosmology; astrophysical plasma.

1. Introduction

Magnetic fields are known to have a widespread presence in our Universe, being a common property of the intergalactic medium in galaxy clusters,[1] while, reports on Faraday rotation imply significant magnetic fields in condensations at high redshifts.[2] Studies of large-scale magnetic fields and their potential implications for the formation and the evolution of the observed structures, have been the subject of continuous investigation (see e.g. Refs. 3–12 for a representative though incomplete list). Magnetic fields observed in galaxies and galaxy clusters are in energy equipartition with the gas and the cosmic rays.[13] The origin of these fields, whether of astrophysical or cosmological origin, remains an unresolved issue.