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Magnetohydrodynamics and Plasma Cosmology

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Abstract We study the linear magnetohydrodynamic (MHD) equations, both in the Newtonian and the general-relativistic limit, as regards a viscous magnetized fluid of finite conductivity and discuss instability criteria. In addition, we explore the excitation of cosmological perturbations in anisotropic spacetimes, in the presence of an ambient magnetic field. Acoustic, electromagnetic (e/m) and fast-magnetosonic modes, propagating normal to the magnetic field, can be excited, resulting in several implications of cosmological significance.

1 Introduction

Although Plasma Physics and Cosmology are two well-established fields of Theoretical Physics, the formulation of magnetohydrodynamics in curved spacetime is a relatively new development [1]. In particular, in spite the fact that MHD processes in flat spacetime gained much attention [2], only recently we were able to discuss exact spherically symmetric MHD solutions within the context of General Relativity (GR) [3], something that gave rise to efforts of exploring MHD processes in the vicinity of central engines [4–6]. On the other hand, magnetic fields are known to have a widespread presence in our Universe, being a common property of the intergalactic medium in galaxy clusters [7], while, reports on Faraday rotation imply magnetic fields of significant strength at high redshifts [8, 9]. These results lead the scientists to go even further and to look for gravitational instabilities in magnetized cosmological spacetimes, either in the Newtonian [10] or the GR limit [11–16].

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