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Solving the Einstein-Maxwell Equations for the Dispersive Propagation of Light during Mixmaster Kasner Epochs and other Anisotropic Early-Universe Models

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The pre-homogenized very early universe generically experiences Mixmaster-like behavior as it approaches the Big Bang, featuring a sequence of anisotropically expanding Kasner epochs. Beyond drawing general conclusions about the transport of mass-energy in such environments, it would be helpful to obtain as much information as possible about the detailed propagation of energy in rapidly and nonadiabatically expanding metrics for which the geometrical optics approximation substantially breaks down. Here we solve for the propagation of ("test particle") electromagnetic fields through background spacetimes with various sets of Kasner expansion indices. In solving the Einstein-Maxwell equations, we obtain independent fourth-order differential equations for each of the electric and magnetic fields which can be individually solved for the amplitudes and phase velocities of the fields to yield interesting information about how they are parametrically driven by the asymmetrically expanding early universe. Furthermore, we consider other anisotropic (and non-vacuum) models, including metrics related to the Vaidya and Szekeres-Szafron solutions, which include inhomogeneity as well as anisotropy.

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