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Classical electrodynamics for describing optical effects in matter and cold plasmas

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In this talk we use the classical electromagnetism framework to describe the optics of continuous media. We begin revising basic aspects of electromagnetic wave propagation in matter, including constitutive relations, anisotropy and crystal birefringence. In this sense, we introduce the Maxwell-Carroll-Field-Jackiw (MCFJ) electrodynamics, a Lorentz-violating theory in vacuum, which in matter is concerned with relevant material properties, as the Chiral Magnetic Effect (CME) associated with a macroscopic magnetic current, the anomalous Hall effect and the description of systems for detection of cold axions. For a purely timelike background the refractive indices are real, having associated circularly polarized modes that imply birefringence expressed in terms of the rotatory power. One of the interesting properties of the MCFJ model is that the timelike background plays the role of the magnetic conductivity, opening the connection with the CME. In this sense, we show how the electrodynamics formalism can be properly used to examine optical properties of a dielectric medium supporting magnetic current. The same method may be employed to examine the behavior of bi-isotropic and bi-anisotropic matter and chiral cold plasmas.