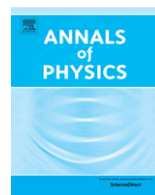




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Einstein-aether theory with a Maxwell field: General formalism

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ABSTRACT

We extend the Einstein-aether theory to include the Maxwell field in a nontrivial manner by taking into account its interaction with the time-like unit vector field characterizing the aether. We also include a generic matter term. We present a model with a Lagrangian that includes cross-terms linear and quadratic in the Maxwell tensor, linear and quadratic in the covariant derivative of the aether velocity four-vector, linear in its second covariant derivative and in the Riemann tensor. We decompose these terms with respect to the irreducible parts of the covariant derivative of the aether velocity, namely, the acceleration four-vector, the shear and vorticity tensors, and the expansion scalar. Furthermore, we discuss the influence of an aether non-uniform motion on the polarization and magnetization of the matter in such an aether environment, as well as on its dielectric and magnetic properties. The total self-consistent system of equations for the electromagnetic and the gravitational fields, and the dynamic equations for the unit vector aether field are obtained. Possible applications of this system are discussed. Based on the principles of effective field theories, we display in an appendix all the terms up to fourth order in derivative operators that can be considered in a Lagrangian that includes the metric, the electromagnetic and the aether fields.

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