Majid Amooshahi, J Phys Chem Biophys 2018, Volume 8
DOI: 10.4172/2161-0398-C2-031

4th International Conference on Physics

September 17-18, 2018 | Berlin, Germany

Canonical relativistic quantization of electromagnetic field in the presence of an anisotropic conductor magneto-dielectric medium

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A canonical relativistic quantization of electromagnetic field is introduced in the presence of an anisotropic conductor magneto-dielectric medium. The medium is modeled by a continuum collection of the vector fields and a continuum collection of the antisymmetric tensor fields of the second rank in Minkowski space-time. The collection of vector fields describes the conductivity property of the medium and the collection of antisymmetric tensor fields describes the polarization and the magnetization properties of the medium. The conservation law of the total electric charges, induced in the anisotropic conductor magneto-dielectric medium, is deduced using the antisymmetry conditions imposed on the coupling tensors that couple the electromagnetic field to the medium. Two relativistic covariant constitutive relations for the anisotropic conductor magneto-dielectric medium are obtained. One of the constitutive relations relates the free electric current density four-vector, induced in the medium, to the strength tensor of the electromagnetic field. Another constitutive relation relates the antisymmetric electric -magnetic polarization tensor field of the medium to the strength tensor of the electromagnetic field. It is shown that for a homogeneous anisotropic medium the susceptibility tensor of the medium satisfies the Kramers-Kronig relations. Also it is shown that for a homogeneous anisotropic medium the real and imaginary parts of the conductivity tensor of the medium in frequency domain, are related to each other by the Kramers-Kronig relations and a relation other than the Kramers-Kronig relations. The electromagnetic field together with the anisotropic conductor magneto-dielectric medium are quantized in a canonical relativistic standard way in the Gupta-Bleuler framework.

Biography

Majid Amooshahi is faculty member of physics department in university of Isfahan, Isfahan, Iran.

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