A New Formulation of Aharonov-Bohm Generalized Electrodynamics

GIOVANNI MODANESE

Free University of Bolzano, Faculty of Science and Technology
Bolzano, Italy

Giovanni.Modanese@unibz.it

Abstract. The extended electrodynamic theory introduced by Aharonov-Bohm in 1963 (after an earlier attempt by Ohmura) and recently developed by Van Vlaenderen and Hively-Giakos, can be re-written and solved in a simple and effective way in the standard covariant 4D formalism. This displays more clearly some of its features. The theory allows a very interesting consistent generalization of the Maxwell equations. In particular, the generalized field equations are compatible with sources (classical, or more likely of quantum nature) for which the continuity/conservation equation $\partial_\mu j^\mu = 0$ is not valid everywhere, or is valid only as an average above a certain scale. And yet, remarkably, in the end the observable $F^{\mu\nu}$ field is still generated by a conserved effective source which we denote as $\left(j^\mu + i^\mu\right)$, being i^μ a suitable non-local function of j^μ. This implies that any microscopic violation of the charge continuity condition is "censored" at the macroscopic level, although it has real consequences, because it generates a non-Maxwellian component of the field. We consider possible applications of this formalism to condensed-matter systems with macroscopic quantum tunneling or Weyl fermions.