Abstract

It is known that linearization of the Einstein equations for a nearly-flat spacetime metric (weak gravitational field) leads to a set of equations that resembles Maxwell's formalism.

From an experimental point of view, it has been shown that generalized electric-type fields can be induced in (super)conductors by the presence of the Earth's weak gravitational field. These observations led to the formal introduction of a fundamental, modified electric-type field, characterized by an electrical component and a gravitational one, determining detectable corrections to the free fall of charged particles.

The above remarkable experimental results can be now combined to the theoretical weak-field gravity formulation, leading to a more general definition of new generalized electromagnetic fields. The latter feature a component defined in terms of the weak gravitational perturbations, and satisfy a specific set of equations that can be put in a form closely analogous to Maxwell's equations. This symmetry is then exploited to analyze a gravity/superconductivity interplay, the new generalized fields being involved in quantum effects originating from the interaction with the weak gravitational background (in analogy to what happens for gravity-induced electric fields in superconductors).

In particular, the emerging formal symmetry between the Maxwell and weak gravity equations allows to use the Ginzburg–Landau model for the description of the physics, resulting in a mean-field theory for the system's thermodynamics, including the effects of thermal fluctuations. We then analyse how the local gravitational field could couple to the superfluid condensate in the superconductor, making use of the time-dependent Ginzburg–Landau equations in the regime of fluctuations. Special symmetries of the system of differential equations will be also used to obtain analytic solutions, explicitly describing the effects of the proposed interplay.