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Convective thermomagnetic effect in normal and superfluid systems

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It is known that the motion of a medium results in an interaction between the electric and magnetic fields [1]. In particular, the motion of a dielectric in an external magnetic field **H** will lead to its polarization. It is generally assumed that the speed of motion is determined by the mechanical motion of the system. There are, however, situations where this motion is associated with a temperature gradient ∇T.
One of them is related to counterflow thermal conductivity (often referred to as superthermal conductivity) in superfluid systems, due to which even small temperature gradients ($\nabla T \approx 10^{-3} K$) lead to significant fluxes of the superfluid and normal components in the absence of an average mass flux. As shown in [2, 3], in the presence of an external magnetic field, these flows lead to a polarization of the liquid and the appearance of electric fields in the surrounding space, which can be observed by modern experimental methods.
Another situation is the development of thermogravitational convective instability in normal systems, which consists in the mechanical disequilibrium of a hydrodynamic system under the action of a temperature gradient. As a result, in the presence of a magnetic field the system also acquires polarization, which, in turn, can lead to the appearance of an electric field in the surrounding space. The measurement of this field can be used as a basis for creating a sensitive device for determining temperature gradients.

[1] L.D. Landau, E.M. Lifshitz, Electrodynamics of Continuous Media, Butterworth-Heinemann ed., London, 1984.
[2] S. I. Shevchenko and A. M. Konstantinov, JETP Letters, 109, 790 (2019).
[3] S. I. Shevchenko and A. M. Konstantinov, Low Temp. Phys. 46, 48 (2020).

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