Electric Response Induced by Third Sound in Superfluid Helium

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It is predicted that oscillations of temperature during propagation of third sound in unsaturated superfluid films cause appearance of an alternating electric field in the surrounding space. As the potential difference is proportional to the temperature gradient a non-stationary thermoelectric effect must take place that is impossible in normal systems [1].

The possibility of appearance of thermally activated vortices in the film was taken into account. It is shown that even in a neighborhood of the superfluid transition the effect of the thermally excited vortices is weak and it leads only to renormalization of third sound speed [2].

The magnitude of the observable electric field depends significantly on the substrate type, the method of its coating and the temperature region. For the low-temperature region ($T \ll 1\mathrm{K}$), the electric field produced by the film is inversely proportional to the cube of the equilibrium film thickness. For the high-temperature region ($T \sim 1\mathrm{K}$), the generated electric field is independent of the film thickness.

It is shown that the differential thermal electromotive force (the ratio of electric potential amplitude to the film temperature amplitude) can exceed such one in metals and reach 10^{-4} V/K.

[1] S. I. Shevchenko and A. M. Konstantinov, J. Low Temp. Phys. **1**94, 1 (2019).
[2] S. I. Shevchenko, A. M. Konstantinov, Pis'ma Zh. Eksp. Teor. Fiz. **104**, 518 (2016).