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Theory of the effective Seebeck coefficient for photoexcited graphene

Thermoelectric phenomena in photoexcited graphene have been the topic of several theoretical and experimental studies because of their potential usefulness in optoelectronic applications [1,2]. However, available theoretical descriptions of the thermoelectric effect in terms of the Seebeck coefficient do not take into account the role of the photoexcited electron density. In this work, [3] we adopt the concept of effective Seebeck coefficient [4] and extend it to the case of a photoexcited two-dimensional (2D) electron gas. We calculate the effective Seebeck coefficient for photoexcited graphene, we compare it to the commonly used "phenomenological" Seebeck coefficient, and we show how it depends on the photoexcited electron density and temperature. Our results are necessary inputs for any quantitative microscopic theory of thermoelectric effects in graphene and related 2D materials.

References

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[2] K.-J. Tielrooij et al., Nat. Nanotech. 10, 437 (2015).
[3] A. Tomadin and M. Polini, Phys. Rev. B 104, 125443 (2021).
[4] G.D. Mahan, J. Appl. Phys. 87, 7326 (2000).

Figures

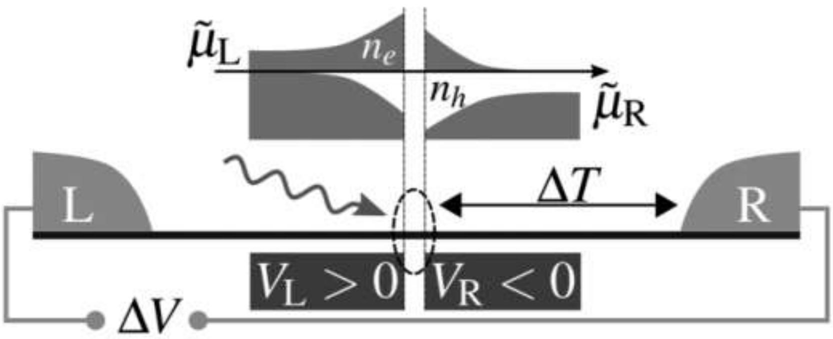

Figure 1: Radiation impinging onto a p-n junction (dashed oval) in graphene (thick line) induced by a split-gate (dark rectangles) with opposite potentials $V_{L,R}$. The electron (n_e, gray) and hole (n_h, white) densities in space are shown above graphene. The electrochemical potential ($\tilde{\mu}_{L,R}$) is well-defined away from the junction only, preventing the application of the standard expression for the thermoelectric current (I=$RS\Delta T$) between the contacts and the junction. The voltage ΔV is measured between the contacts L, R (light gray).