Hot Carrier propagation and detection in monolayer graphene devices

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Understanding the heating, energy flow and relaxation of charge carriers in nanostructures is essential for the management of heat in next generation devices, where the ever decreasing dimensions lead to increasing leakage currents, and Joule dissipation occurs in smaller and smaller volumes. The generated heat, which has to be efficiently driven away from the electronically active region, could also be used for energy harvesting by taking advantage of thermoelectric phenomena.
In this talk, I will discuss our current research on hot-carrier propagation across monolayer graphene. The device consists of a monolayer graphene flake contacted by multiple metal leads. Using two remote leads for electrical heating, a carrier temperature gradient is generated that results in a measurable thermoelectric voltage V_{NL} across the remaining (detector) leads. Due to the nonlocal character of the measurement, V_{NL} is exclusively due to the Seebeck effect. Remarkably, a departure from the ordinary relationship between Joule power P and V_{NL}, $V_{NL} \sim P$, becomes readily apparent at low temperatures, representing a fingerprint of hot-carrier dominated thermoelectricity. By studying V_{NL} as a function of bias, we directly determine the carrier temperature and the characteristic cooling length for hot-carrier propagation, which are key parameters for a variety of new applications that rely on hot-carrier transport.

References

[1] J. F. Sierra, I. Neumann, M. V. Costache, S. O. Valenzuela, Nano Lett. 15 (2015) 4000.