Valley caloritronics by graphene nanoribbons

Xiaobin Chen, Lei Zhang, and Hong Guo

Department of Physics, Center for the Physics of Materials, McGill University,
3600 University Street, Montreal, Quebec H3A 2T8, Canada
xbchen@physics.mcgill.ca

Abstract

We propose and theoretically investigate a new idea of *valley caloritronics,* where quantum transport of the *valley* degrees of freedom is thermally induced. Valley caloritronics addresses questions such as thermal generation of valley polarized current and more importantly, pure valley current without an accompanying charge current. After establishing a general physical picture, we show that heat-induced pure valley current can be generated by virtue of wedge-shaped graphene nanoribbons in a two-probe device setup. We discover that the quantum transport properties of valley degrees of freedom can be very different when driven by a voltage bias or by a temperature bias. A very surprising result is that an alternating valley current can be *thermally* generated via gate control: namely the heat-induced valley current changes its flow direction in some quasi-periodic manner versus the value of a gate voltage at a fixed polarity. Our results indicate a vast potential for developing valley caloritronic devices.

References

[1] L. Zhang, K. Gong, J. Chen, L. Liu, Y. Zhu, D. Xiao, and H. Guo, Phys. Rev. B, **90** (2014) 195428.

[2] A. Rycerz, J. Tworzyd lo, and C. Beenakker, Nat. Phys. **3** (2007) 172.

Figures