



Weekly Seminar

Chiral phonons in 2D systems

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Time: 4:00pm, December 30, 2015 (Wednesday)

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Venue: Room w563, Physics building, Peking University

地点: 北京大学物理楼, 西563会议室

Abstract

Recently, a remarkable phenomenon of the phonon Hall effect was observed in a paramagnetic insulator, which is indeed a surprise since phonons as neutral quasiparticles cannot directly couple to magnetic field via Lorentz force. The following theoretical studies showed that through Raman spin-phonon interaction the magnetic field can have an effective force to distort phonon transport, and thus drive a circulating heat. Inspired by the phonon Hall effect, very recently we found chiral phonons in systems that break time reversal or spatial inversion symmetries.

In magnetic systems, where time reversal symmetry is broken, phonons generally carry a nonzero angular momentum. At zero temperature, a phonon has a zero-point angular momentum in addition to a zero-point energy. With increasing temperature, the total phonon angular momentum diminishes and approaches zero in the classical limit. The nonzero phonon angular momentum can have a significant impact on the Einstein–de Haas effect.

In non-magnetic crystals with inversion symmetry breaking, we find chiral phonons with valley contrasting circular polarization. At valley centers, there is a three-fold rotational symmetry endowing phonons with a quantized pseudo angular momentum, which includes spin and orbital parts. The chiral valley phonons are verified and the selection rules are predicted in monolayer Molybdenum disulfide. Due to valley contrasting phonon Berry curvature, a valley phonon Hall effect can also be observed.

[1] L. Zhang, J. Ren, J.-S. Wang, and B. Li, Phys. Rev. Lett. **105**, 225901 (2010).

[2] L. Zhang and Q. Niu, Phys. Rev. Lett. **112**, 085503 (2014).

[3] L. Zhang and Q. Niu, Phys. Rev. Lett. **115**, 115502 (2015)

About the speaker

He was born in 1977 in Taixing, Jiangsu, China. He got Ph.D degree in Physics in National University of Singapore in Jan 2012. Before Jul 2015, he worked as postdoctoral research fellow in National University of Singapore and University of Texas at Austin, USA. He now is Jiangsu Specially-Appointed Professor in Nanjing Normal University. His research field is quantum thermal transport and related research in energy science; the main topics include theory on phonon angular momentum and its application, phonon and magnon Hall effect, interfacial thermal transport and thermal rectification. He has published more than 20 papers on Phys.Rev. Lett., Phys. Rev. B, Appl. Phys. Lett., etc. He will be the Chair of Phonons 2018, a well-known international conference on phonons since 1975.