Condensed Matter Physics Seminar Series

Angular momentum of electrons and phonons

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Understanding of process such as Einstein-de Haas requires a theory of periodic solids with (I) a well-defined electron angular momentum, (II) a well-defined phonon angular momentum, (III) rotationally invariant Hamiltonian, and (IV) appropriate coupling between electrons and phonons. Presently, it is unclear how to deal with these four requirements in a way that would enable one to compute from first principles the transition rates for the Einstein-de Haas effect in a periodic solid. On the other hand, first-principles electron-phonon calculations for transfer of energy - instead of angular momentum - between electrons and phonons are rather routine these days. In this talk, I will first provide a symmetry-based classification of atomic vibrations with well-defined crystal momentum and phonon angular momentum [1]. In some materials, phonons acquire angular momentum via forces induced by relative displacements of atoms out of their equilibrium positions. For other materials, phonon angular momentum arises from the forces induced by relative velocities of atoms. These effects are dominant terms for all physical properties where ionic motion breaks time-reversal symmetry [2]. In the second part of the talk, I will show that there are algebraically localized eigenstates of electrons in a perfectly periodic solid with a well-defined crystal angular momentum. [3] I will discuss difficulties in generalization of this concept to phonons, as well as how to deal with formulation of ion dynamics in which phonon angular momentum is conserved.

[1] Sinisa Coh, Phys. Rev. B 108, 134307 (2023).
[2] John Bonini, Shang Ren, David Vanderbilt, Massimiliano Stengel, Cyrus E. Dreyer, Sinisa Coh, Phys. Rev. Lett. 130, 086701 (2023).
[3] Kevin Moseni, Sinisa Coh, Phys. Rev. B 109, 174431 (2024).

Sinisa Coh received his Ph.D. in Physics from Rutgers University in 2011. Upon completion of his Ph.D. Sinisa joined the University of California Berkeley and Lawrence Berkeley Lab as a postdoc in physics and materials science. Since 2016 Sinisa has been an Assistant Professor at the University of California, Riverside in Materials Science and Mechanical Engineering. Sinisa's research group in computational materials science at the University of California, Riverside works on nanostructured materials, complex oxides, layered materials, magnetic materials, topological insulators, superconductors, and optical properties of real materials. They design, discover, and characterize functional materials using state-of-the-art computational techniques, symmetry, nearsightedness principles, geometry, and topology.

Friday, November 21st at 10am
4-330 PAB