PHYSICS
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Ferroelastic modulation and the Bloch formalism

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120 Engineering (Hammond Auditorium)

Abstract

My talk will focus on the subject of symmetry, which with its underlying basis of order and periodicity governs much of the rules of solid-state physics. Innate to the symmetry of crystalline material is translational periodicity that naturally emerges as an Abelian symmetry group to describe the Bravais lattice, and which led to Bloch's theorem. Translational symmetry has also played a key role in the reduction of space groups where it is used to induce the representations of the space group, a procedure that has greatly simplified the determination of electronic structure. A consequence of this procedure is that the Bloch state solutions have crystal momentum as a constant of motion. As such, these solutions are limited to non-spiral solutions for non-magnetic material.

I will discuss a study of an ordering induced structural phase transition that results in a lowering of symmetry, followed by an artificial reordering process

driven to restore symmetry. The resulting structures that are described by a tensor periodic potential exhibit unusual electronic and optical properties. The theory for their conduction band energy states can be developed by a procedure that deviates from the usual Bloch formalism: Bloch's theorem, Brillouin zones, Bragg scattering, energy gaps, and of course non-spiraling eigenstates. It appears that in the case of tensor modulated structures, the reduction of space groups depends on the translation symmetry that is "appropriate" for inducing this. This represents a departure from our classical notions of symmetry in a crystalline lattice. The existence of spiral states for electrons and photons in these OSLs is peculiar and is associated with a change from Riemann to Finsler geometry. The propagating, localized, partially localized and spiral states observed for these tensor modulated structures indicate their possible use for novel applications related to electronics and photonics and especially optical energy storage.