Synthetic Gauge Flux, Weyl points and Geometric Phases in Acoustic Systems

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Analogues of quantum Hall effect and quantum spin Hall effect are difficult to realize in acoustic systems because sound waves do not respond to external magnetic fields and do not have an intrinsic spin degree of freedom. By designing acoustic meta-crystals with special interlayer coupling in the z-direction, we show that one can create synthetic staggered flux and hence one-way edge modes in the x-y plane in acoustic meta-crystals which have simple "static" structures with no moving fluid and no dynamic modulation. The acoustic meta-crystals have Weyl points in the three-dimensional band structure and for fixed values of kz, the systems are acoustic analogues of the topological Haldane model. We also constructed a simple phononic crystal with a topological transition point in the acoustic band structure where the band inverts and the Zak phase in the bulk band changes upon a shift in system parameters. As a consequence, the topological characteristics of the band gap changes and interface states form at the boundary separating two phononic crystals. Experiments were performed to measure the Zak phase of the bulk bands of these phononic crystals.