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Lecture in CSM:

Feedback-Based Mechanical Metamaterials Mimicking Quantum Wave Phenomena

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ABSTRACT

The striking analogy between the electronic band structure of solids and the frequency dispersion of classical systems inspired the idea of mimicking quantum condensed matter wave phenomena on electromagnetic, acoustic, and mechanical platforms. These classical analogues are not merely a way to mimic well-known effects, but also a way to push the study of condensed matter physics to new regimes. The realization is carried out by metamaterials, which are artificially designed structures, usually of periodic nature, composed of subcomponents denoted by unit cells. For mechanical or acoustic systems these components include spring and mass elements, beams, tubes, cavities, etc. Some phenomena, however, when translated into the classical realm, imply inter-cell couplings that are incompatible with Newtonian physics due to being complex-valued, directional, or nonreciprocal. The remedy can then be presented in terms of active metamaterials with an embedded control mechanism, which creates these couplings in a real-time closed loop operation. In this talk we will see classical realization of the quantum Hall effect, black hole Hawking radiation, and non-Hermitian PT-symmetric systems using mechanical and acoustic feedback-based designs.