

Elastic bit and Berry phase: Investigating topological phenomena in a classical granular network FREE

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This study investigates the Berry phase, a key concept in classical and quantum physics, and its manifestation in a classical system. We achieve controlled accumulation of the Berry phase by manipulating the elastic bit (a classical analogue to a quantum bit) in an externally driven, homogeneous, spherical, nonlinear granular network. This is achieved through the classical counterpart of quantum coherent superposition of states. The elastic bit's state vectors are navigated on the Bloch sphere using external drivers' amplitude, phase, and frequency, yielding specific Berry phases. These phases distinguish between trivial and nontrivial topologies of the elastic bit, with the zero Berry phase indicating pure states of the linearized granular system and the nontrivial π phase representing equal superposed states. Other superposed states acquire different Berry phases. Crucially, these phases correlate with the structure's eigenmode vibrations: trivial phases align with distinct, in-phase, or out-of-phase eigenmodes, while nontrivial phases correspond to coupled vibrations where energy is shared among granules, alternating between oscillation and rest. Additionally, we explore Berry's phase generalizations for non-cyclic evolutions. This research paves the way for advanced quantum-inspired sensing and computation applications by utilizing and controlling the Berry phase.