Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3727** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

Symmetry and topology of hyperbolic Haldane models

Tuesday 20 June 2023 10:00 (15 minutes)

One intriguing feature of 2D hyperbolic-lattice models is that their band theories live in hypertoric Brillouin zones. The high-dimensional band structures and the dimensional mismatch between real and momentum spaces present uncharted territory beyond Euclidean topological phases. This work investigates topological phases exhibited by hyperbolic Haldane models, which are generalizations of the graphene Haldane model to various regular hyperbolic lattices. A comprehensive symmetry analysis is performed to constrain the multiple independent first and second Chern numbers arising from the high-dimensional bands. Our extensive analysis of both real- and momentum-space models shows frequent occurrence of topological gaps, most of which characterized by first Chern numbers of 1 and some of 2. Importantly, the numerically computed first Chern numbers respect the predicted symmetry constraints and agree with real-space topological markers, implying a direct connection to observables such as the number of chiral edge modes. With our large repertoire of models, we further demonstrate that the topology of hyperbolic Haldane models is trivialized by strong curvature of the underlying lattices.

Keyword-1

Hyperbolic Lattices

Keyword-2

Topological Phases

Keyword-3

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Session Classification: (DCMMP) T1-7 Quantum Materials Symposium | Symposium sur les matériaux quantiques (DPMCM)

Track Classification: Symposia Day (Tues. June 20) / Journée de symposiums (mardi, le 20 juin): Symposia Day (DCMMP - DPMCM) - Quantum Materials | Matériaux quantiques