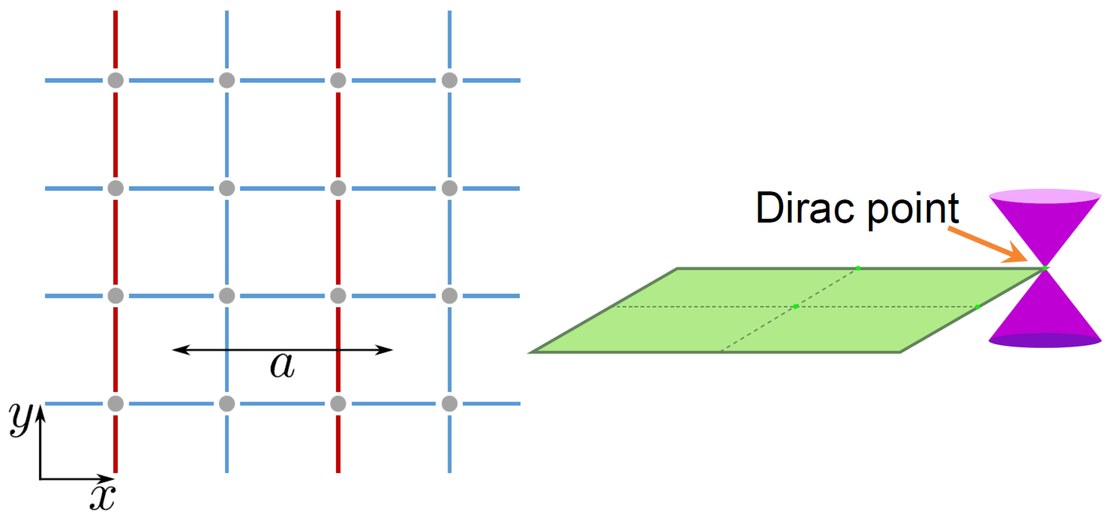
Projectively Enriched Symmetry and Topology in Acoustic Crystals

Haoran Xue[1], Zihao Wang[1], Yue-Xin Huang[2], Zheyu Cheng[1], Letian Yu [1], Y. X. Foo[1], Y. X. Zhao[3], Shengyuan A. Yang[2], Baile Zhang[1]

1. Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore
2. Research Laboratory for Quantum Materials, Singapore University of Technology and Design, Singapore
3. Department of Physics, Nanjing University, China

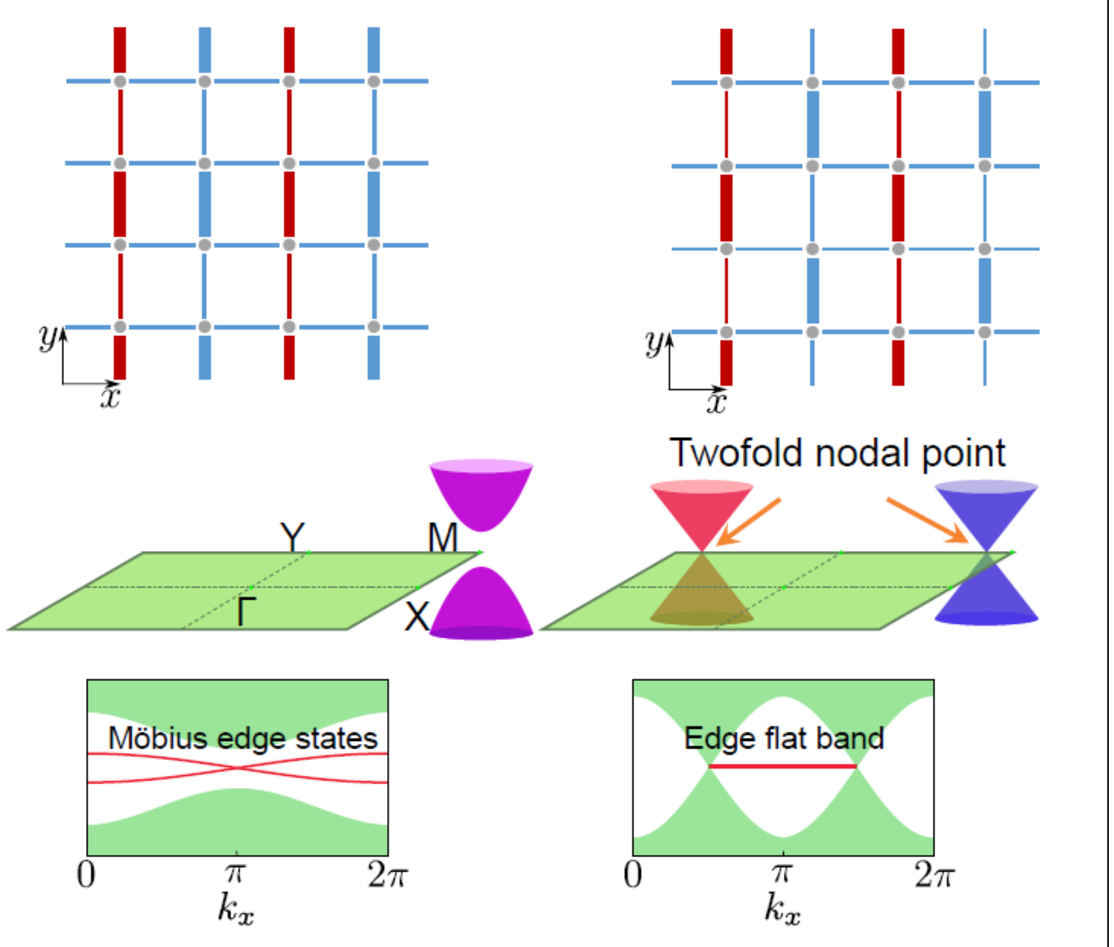
We demonstrate gauge fields can significantly impact the algebra of symmetry operations, which subsequently lead to novel topological phenomena. We demonstrate this idea using an acoustic lattice under a Z_2 gauge field (i.e., with π flux per plaquette), where a Möbius insulator and a Dirac semimetal are discovered.

Projective translational symmetries



Without the gauge field, the two primitive translational symmetries satisfying $[L_x, L_y] = 0$. However, under a Z_2 gauge field, the proper translation along *x* is modified to be $\mathbb{L}_x = GL_x$, where G is a gauge transformation. An instant consequence is the modified algebra: $\{\mathbb{L}_x, \mathbb{L}_y\} = 0$. These two projective symmetries, together with *T*, enforce a four-fold nodal point at Brillouin corner.

Phases upon symmetry breaking



Breaking $\mathbb{L}_y$ leads to a Möbius insulator

Breaking both $\mathbb{L}_x$ and $\mathbb{L}_y$ leads to a topological semimetal

Acoustic Möbius insulator

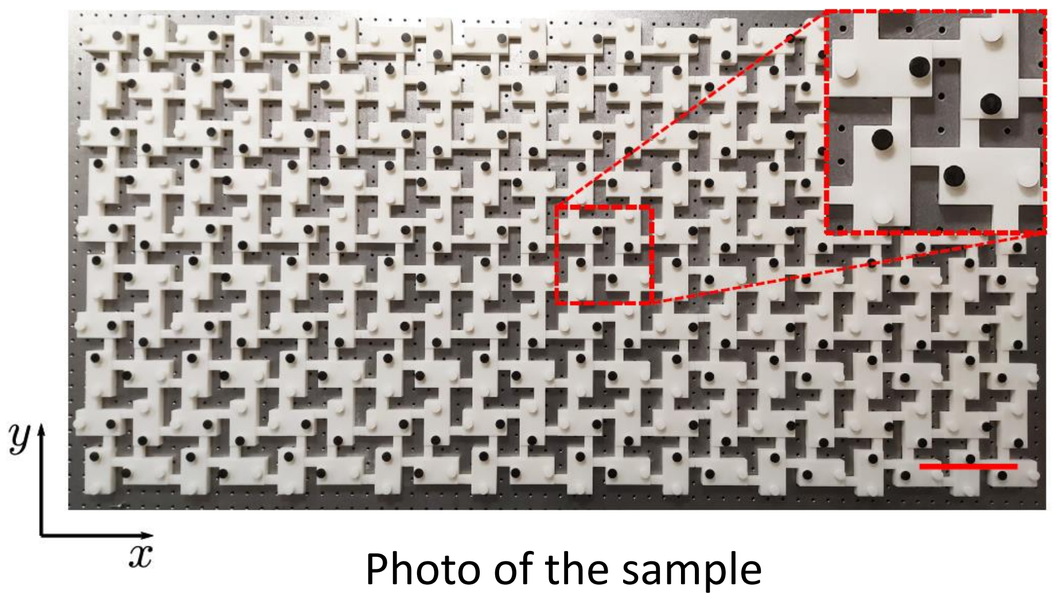
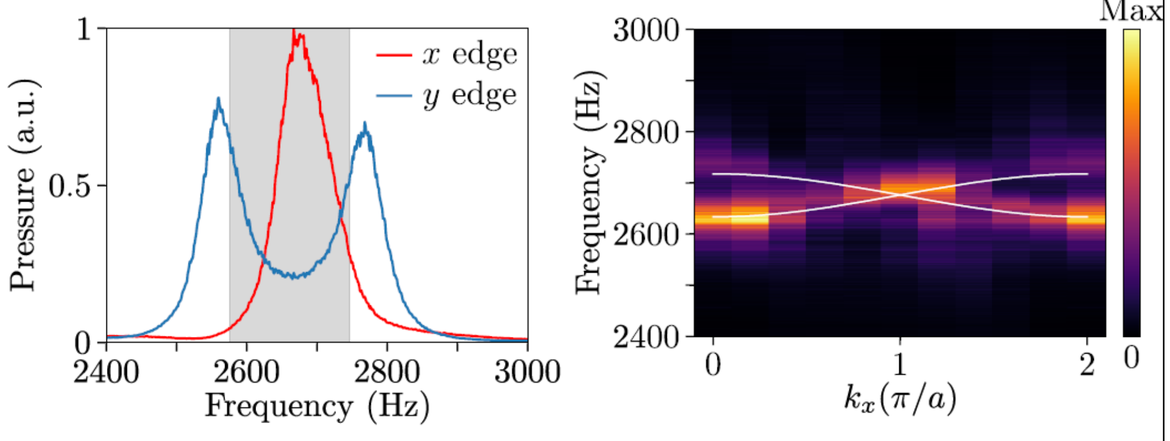
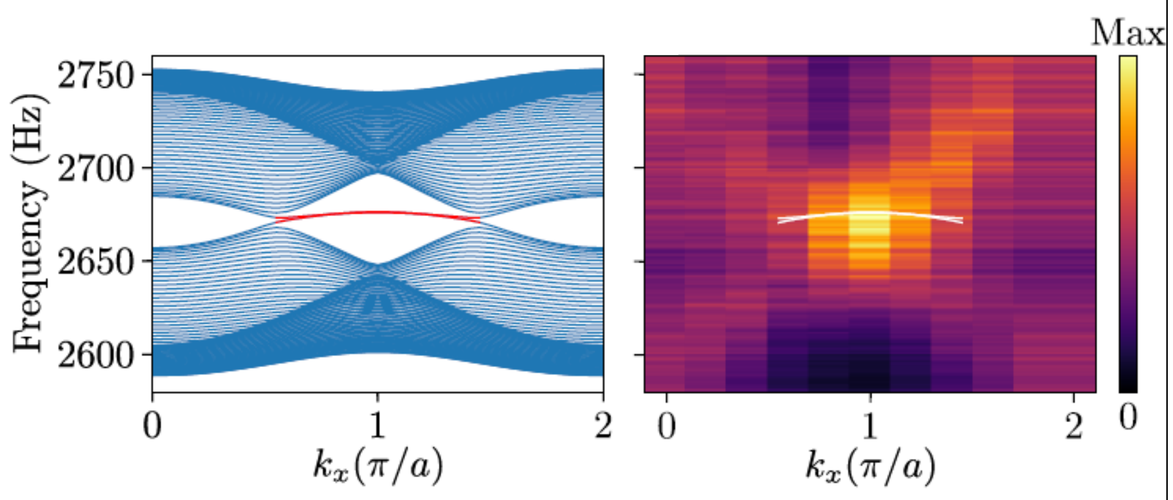


Photo of the sample



Measured edge transmissions Measured edge dispersion

Acoustic topological semimetal



Simulated (left) and measured edge dispersions for the topological semimetal phase. Similar to graphene, there are edge modes connecting the projections of the bulk nodes, as required by the quantized Berry phase of the bulk nodal points.

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