Course syllabus: Exceptional Non-Hermitian Topology by Flore K. Kunst

Lecture 1: Hermitian topological phases of matter (2 hour lecture + 1 hour exercises)

Brief summary of gapped and gapless Hermitian non-interacting topological phases:

- gapped topological phases: integer quantum Hall effect (IQHE), Chern insulators (IQHE without a magnetic field)
- gapless topological phases: Dirac theory, Weyl semimetals

Example: one-dimensional SSH chain:

- symmetries
- topological phases
- topological invariant
- bulk-boundary correspondence

Exercise session: computing the band spectrum of the SSH chain with periodic and open boundary conditions, compute the topological invariant, …

Lecture 2: Introduction into non-Hermitian physics (2 hour lecture + 1 hour exercises)

Introduction into non-Hermiticity:

- Classical systems
- Quantum systems

Example: one-dimensional Hatano-Nelson model:

- complex-energy spectrum
- winding number
- non-Hermitian skin effect

Start with two-dimensional Weyl semimetal and add non-Hermitian terms:

- gapped phase
- exceptional rings
- exceptional points

Point gaps and line gaps

Exercise session: symmetry-protected phases including parity-time (PT) symmetry

Lecture 3: Non-Hermitian topological band theory (2 hour lecture + 1 hour exercises)

Exceptional nodal phases

Symmetries

Exercise session: symmetry-protected phases including parity-time (PT) symmetry

Lecture 4: Non-Hermitian SSH chains (2 hour lecture + 1 hour exercises)

Example 1: one-dimensional non-Hermitian SSH chain with PT symmetry:

- complex-energy spectrum
- exceptional point
- presence and absence of end states

Example 2: one-dimensional non-Hermitian anisotropic SSH chain:

- complex energy spectrum with periodic and open boundary conditions
- topological invariants
- end states
- non-Hermitian skin effect

Discuss the breakdown of the bulk-boundary correspondence

Exercise session: compute the band spectrum for the anisotropic SSH chain with periodic and open boundary conditions, compute the topological invariant, study the skin effect

Lecture 5: Two types of bulk-boundary correspondences (2 hour lecture + 1 hour exercises)

Discuss the two main methods for redefining the conventional bulk-boundary correspondence:

- non-Bloch bulk-boundary correspondence
- biorthogonal bulk-boundary correspondence

Truly non-Hermitian bulk-boundary correspondence: Spectral winding and the non-Hermitian skin effect