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Minicourse announcement

Topology in Quantum Matter: From Fundamentals to Frontiers

SRB
DIASPORA
Visits of Diaspora Scientists

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1. Foundations: Berry phase & Chern number

- Bloch bands and Bloch bundle
- Berry connection, curvature, and Zak phase
- Chern number/TKNN invariant. Hall conductivity.
- Bulk-boundary correspondence.
- Minimal models: Su-Schrieffer-Heeger, Bernevig-Hughes-Zhang, Haldane

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2. Time-Reversal Topological Insulators & Superconductors. Tenfold way.

- Altland-Zirnbauer symmetry classes (TRS, PHS, chiral)
- Fu-Kane parity criterion and Pfaffian formulation
- 3D topological insulators.. 3D TI surface Dirac cone
- Kitaev chain and Majorana bound states

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3. Crystalline Topology & Higher-Order Phases

- Symmetry indicators and topological quantum chemistry.
- Wannier obstruction and symmetry-protected topology.
- Mirror/rotation/inversion invariants.
- Higher-order TIs: hinge/corner states; fragile topology.

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4. Quantum Geometry & Responses

- Quantum geometric tensor: Berry curvature + Fubini-Study metric
- Modern theory of polarization and orbital magnetization
- Anomalous Hall effect. Berry-curvature dipole and nonlinear Hall conductivity.
- Superfluid weight and geometric contributions
- Flat/near-flat Chern bands; moiré miniband geometry (overview)

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5. Non-Hermitian Topology: NH Dirac fermions, Interactions, and flat bands.

- Biorthogonal formalism. NH Bloch bands.
- NH Dirac fermions.
- Interaction effects.
- Exceptional flat bands