



Department of Materials Science
& Engineering
College of Design and Engineering

Department Seminar

Dear Colleagues & Students,
You are cordially invited to a special seminar on

Date: 19 Aug 2026, Wednesday

Time: 11am - 12pm

Venue: E7-03-09 - Seminar Room 4, 15 Kent Ridge Cres, Singapore 119276([Map](#))

Function Follows Form:

When Shape Dictates Functionality Of Quantum Materials



By Dr. Philip J.W. Moll

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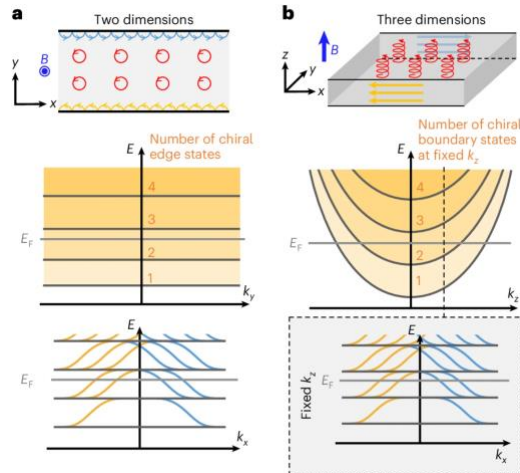
Hosted by Assistant Professor Ahmet Avsar

Abstract:

Symmetry is a core guiding theme in condensed matter research, informing the search for novel materials with unusual response functions. It enforces certain response functions to vanish if they are incompatible with the symmetry of the crystal lattice. For example, centro-symmetry and electronic directionality, such as diode-like behavior, is fundamentally incompatible. While this is rigorously true for bulk response functions, mesoscopic shapes may change the effective symmetry group of the problem, and unlock functionality forbidden by symmetry in the bulk. With recent advances in 3D mesoscopic control of single crystal structures via focused ion beam machining, shape control emerges as a powerful design principle towards electronic functionality in quantum materials.

A few recent examples of novel electronic behavior demonstrate this principle. In the Kagome superconductor CsV_3Sb_5 , mesoscopic confinement within the Kagome planes uncovers chiral transport[1] associated with a thus-far enigmatic coherent many-body state[2]. Further in Bi [3], strongly quantizing magnetic fields push electric transport currents to the surface – replacing completely the electronic symmetry of its hexagonal unit cell by the designed shape. Shape control uncovers a 3D version of the quantum Hall effect, in which geometric edge currents encircle the device in the quantum limit. In the iron-based superconductor FeSe [4], an inversion symmetric material, strong superconducting diode effects can be designed, tuned and even

inverted by shape control over the formation of nematic domains on the mesoscale. These cases serve as an example for the emergent paradigm of 3D shape control over electronically active quantum materials.



[1] C. Guo et al., Nature 611, 461–466 (2022) [2] C. Guo et al., Nature 647, 68–73 (2025) [3] J. Seo et al., Nat. Phys. 22, 232 (2026); [4] R.D.H. Hinlopen et al., arXiv:2604.26631

Biography:

Philip Moll is a director at the Max-Planck Institute for the Structure and Dynamics of Solids in Hamburg, Germany. His “microstructured quantum matter” department investigates electronic transport on mesoscopically shaped 3D crystals of quantum materials.

Philip obtained his PhD in 2012 at ETH Zurich in the group of Bertram Batlogg, working on iron-based superconductors in high magnetic fields. He joined UC Berkeley to work with James Analytis on topological systems. In 2015, he was awarded an independent Max-Planck research group at the MPI for Chemical Physics of Solids. Working with Andy Mackenzie and Claudia Felser, he focused on mesoscopic phenomena in ultra-clean layered metals and electron hydrodynamics. Moving to EPFL in 2018 as a tenure-track assistant professor, he established a group in the materials science department working towards shape/size control of topological systems before moving to Hamburg in 2022.

He was awarded the ETH Metal, the ABB award and the Swiss Microscopy Society award for his work in Switzerland. In 2018 he won the Nicholas Kurti Science prize, the APS fellowship in 2025 and was awarded multiple prestigious junior grants, such as two ERC projects and a Swiss National Science Foundation Professorship.

Looking forward to seeing all of you!

