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ARNOLD SOMMERFELD
CENTER FOR THEORETICAL PHYSICS



Arnold Sommerfeld Lecture Series

Professor Andrei Bernevig

Princeton University, USA

Public Lecture:

In Integers We Trust: The Periodic Table of Materials From Mendeleev to Topology

Materials science has always balanced on the twin pillars of observation and abstraction—from the alchemists' crude recipes to today's AI-driven materials design. In this talk, we begin by revisiting the pre-quantum era, when early chemists grappled with the nature of elements and compounds, and examine how Mendeleev's periodic table first imposed order on the chemical world. We then show that what underpins this table is the surprising power of integers and discrete mathematics—why you can't "slip in" between whole numbers—and trace how that insight underlies quantum mechanics, blurring the boundary between chemistry and physics.

Building on these foundations, we survey modern families of functional materials—superconductors, antiferromagnets, charge-density waves, high-temperature superconductors, and semiconductors—and ask what makes them uniquely useful, from microchips to maglev trains. Just as Mendeleev used patterns to predict new elements, we discuss the quantum strategies for classifying the much larger set of materials, formed by these elements, today—introducing topology and topological invariants, showing how band-structure integers classify phases of matter. We highlight online databases that catalog these discoveries. Finally, we look ahead to how machine learning and artificial intelligence, guided by our new periodic table of materials, are revolutionizing the search for novel compounds, ushering in a new era of predictive materials discovery.

Tuesday, May 6, 2025, 17:15 h, Room B 052, Theresienstr. 39, LMU

Prof. D. Efetov

Prof. U. Schollwöck