



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

MATHEMATICS COLLOQUIUM

Topological insulators and robust edge transport

By

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Abstract

Surprising asymmetric transport phenomena along interfaces separating insulating bulks have been observed in many areas of applied sciences, e.g., electronics, photonics, and geophysics. Such transport, displaying strong robustness to perturbations as an obstruction to Anderson localization, affords a topological origin: systems in the same topological class display similar robust, quantized, interface transport.

This talk considers systems modeled by elliptic partial differential operators on the Euclidean plane. We introduce a simple topological classification by means of confining domain walls, which provides an explicit computation of a topological invariant, technically the index of a Fredholm operator. We next define a physical observable that allows us to quantify the asymmetry of the edge transport. The evaluation of such an observable is challenging in practice. We present a bulk-edge correspondence, a pillar of topological phases of matter in the physics literature, stating that the interface current observable is in fact equal to the aforementioned simple topological invariant. The theoretical findings are illustrated with examples ranging from electronics applications to geophysical fluid flows.

Bio:

Guillaume Bal is a Professor of Applied Mathematics at the University of Chicago and the current director of its Committee of Computational and Applied Mathematics. He received a PhD in Mathematics at the University of Paris 6 in 1997 and has held postdoctoral and faculty positions at Stanford University, Columbia University, and The University of Chicago. His research interests primarily revolve around the interplay between the constitutive coefficients and the solutions of partial differential equations. This finds applications in the theory of inverse problems, in particular inverse kinetic problems and the class of high-resolution high-contrast hybrid imaging modalities, in the derivation of mesoscopic models such as kinetic and diffusive equations in the analysis of wave propagation in highly heterogeneous media, and more recently in the role of non-trivial topologies to explain unusual phenomena such as transport that is robust to perturbations and a quantized obstruction to Anderson localization.

Date : 14 November 2025 (Friday)

Time : 3:00p.m.-4:00p.m.

Venue : Lecture Theatre F (near Lift 25/26)

All are Welcome!