# Reciprocal skin effect and its realization in a topolectrical circuit

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## Motivation

Non-Hermitian Hamiltonians allow for the effective description of open systems, where the energy or particle number are not conserved. Such Hamiltonians may exhibit qualitatively novel phenomena, including:

▷ **exceptional points** - stable defective degeneracy points,

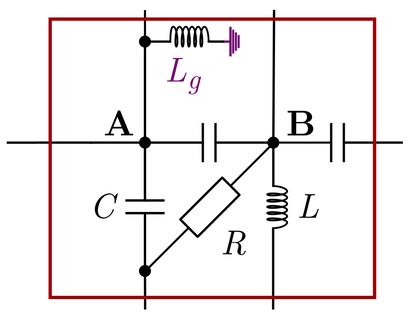
▷ **the skin effect** - an anomalous localization of eigenstates at one boundary if open boundary conditions are imposed,

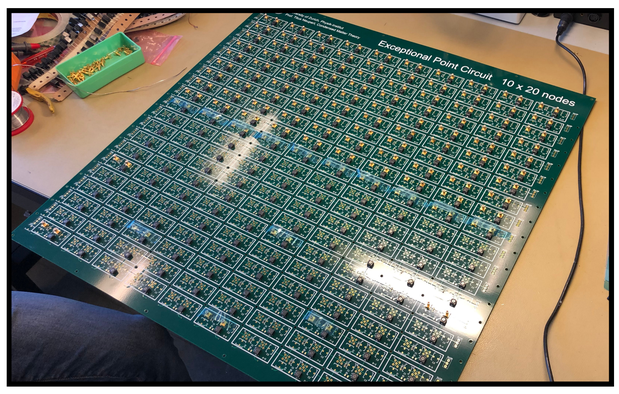
▷ **the breakdown of bulk-boundary correspondence** as the clear difference in the spectral and eigenstate properties depending on the boundary conditions is observed.

These features can be observed in **classical systems** involving gain and loss. In this work, we designed, described and measured the electric circuit whose circuit Laplacian is modeled in analogy to a quantum lattice Hamiltonian.

## Experimental setup

Topolectrical circuit board was assembled using **resistors**, **inductors**, and **capacitors**.



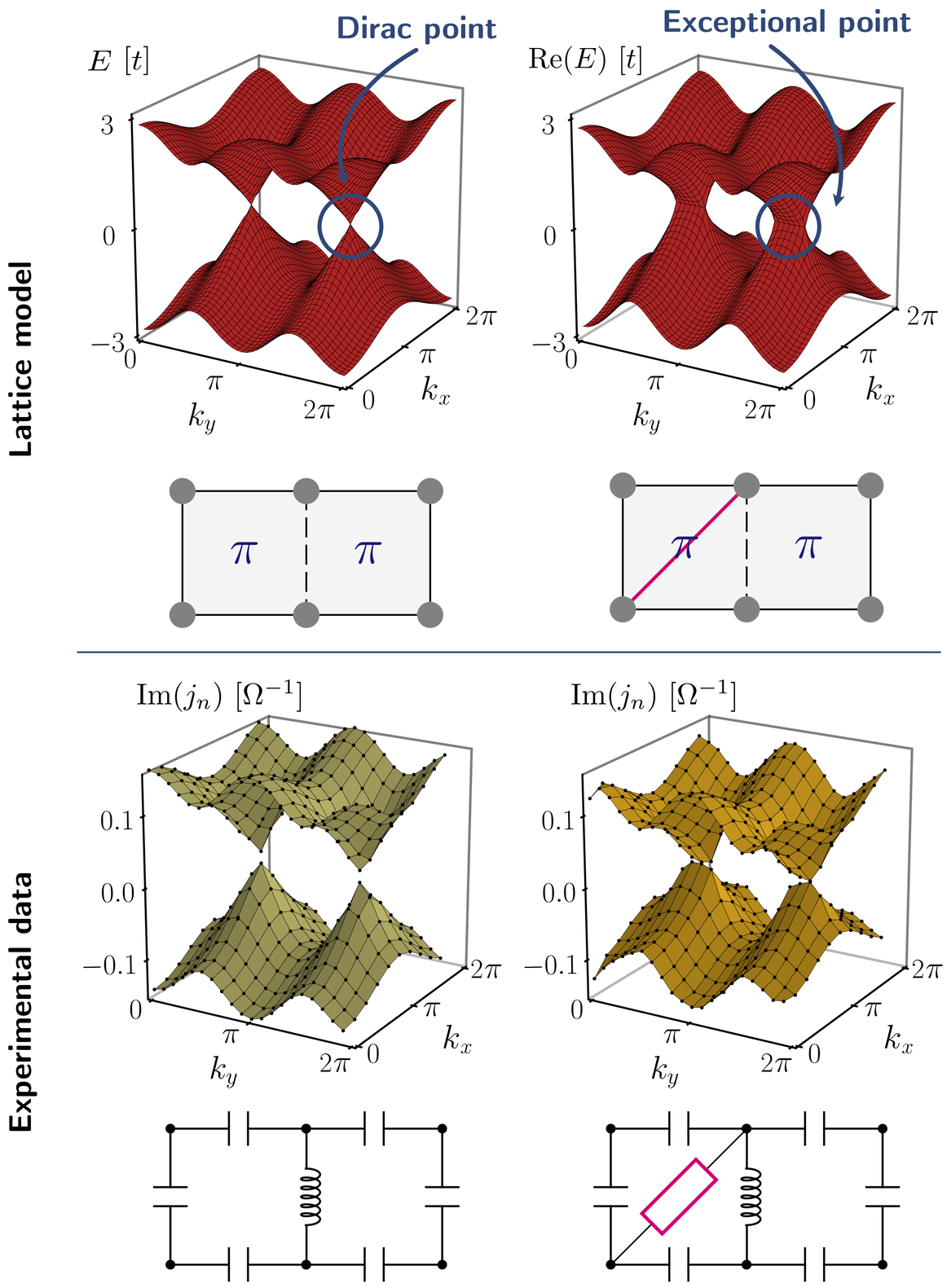




## Non-Hermitian $\pi$-flux model

We are interested in the realization of the $\pi$-flux model with a non-Hermitian diagonal hopping given by the Bloch Hamiltonian

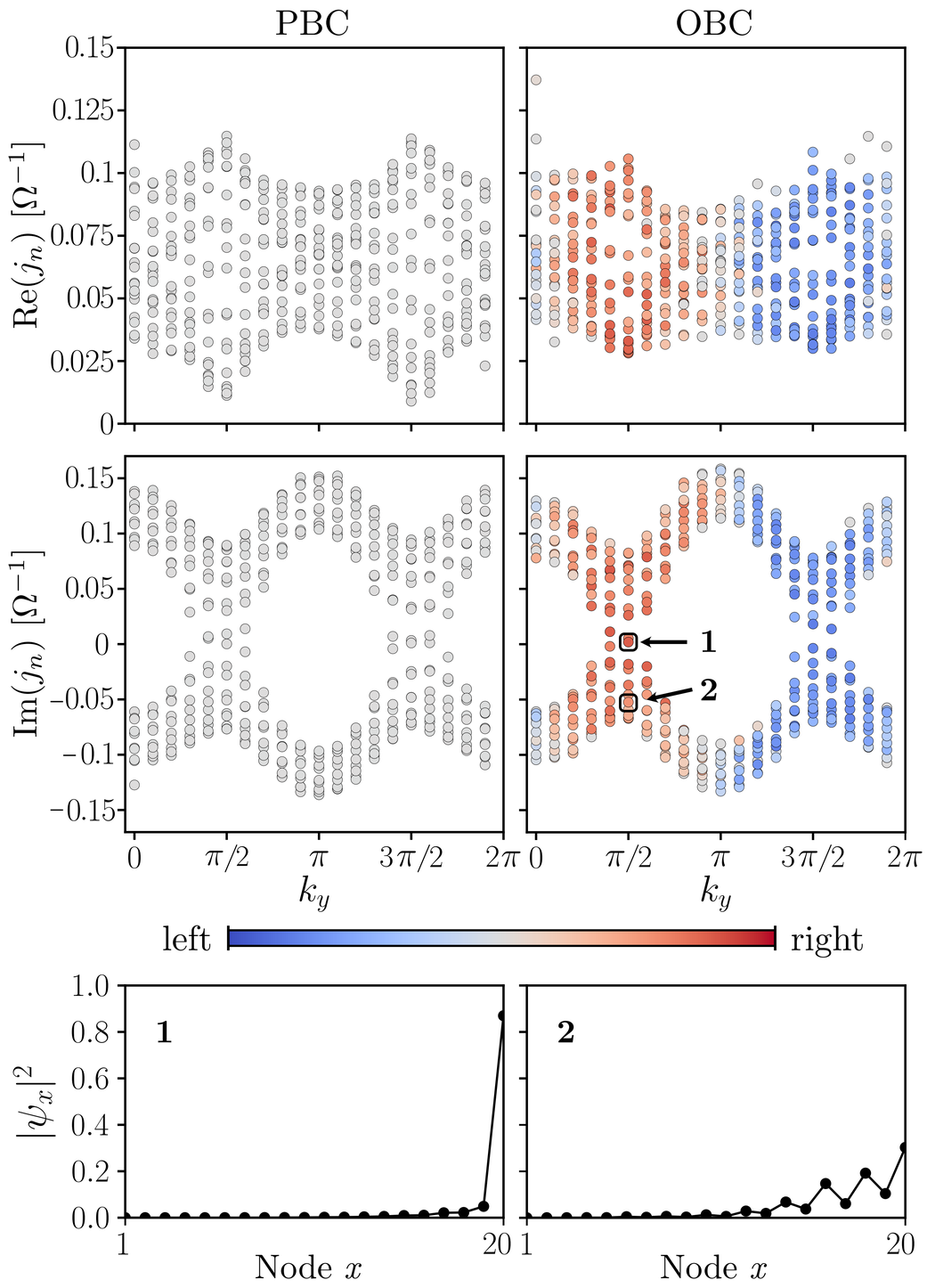
$$H_\pi(k_x, k_y) = t \begin{pmatrix} 2\cos ky & 1 + e^{-ik_x} \\ 1 + e^{ik_x} & -2\cos ky \end{pmatrix} - ir \begin{pmatrix} 0 & e^{ik_y} \\ e^{-ik_y} & 0 \end{pmatrix},$$

which is **reciprocal**: $H(k_x, k_y) = H^{\mathrm{T}}(-k_x, -k_y)$.



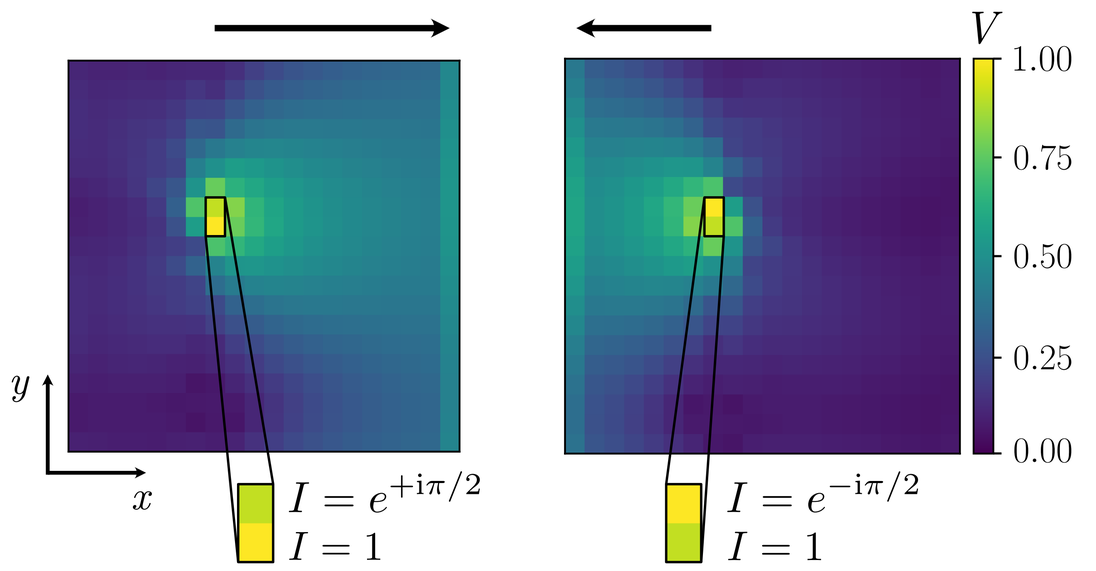

## Reciprocal skin effect in 2D systems

**All** OBC and PBC eigenstates of the circuit Laplacian differ non-perturbatively.




## Reciprocal skin effect as a polarization detector

A voltage will build up on the **left** or **right** edge of the system, depending on the propagation direction and polarization of incident electromagnetic waves.




More details in arXiv:1908.02759 [cond-mat].

https://www.physik.uzh.ch/en/groups/neupert.html