An operator-based approach to classifying topology in open and nonlinear systems

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In this talk, I will provide an overview of some of the outstanding problems in the classification of topological materials in physical systems, and I will discuss how many of these problems can be addressed through the spectral localizer framework. For example, the chiral edge states that are guaranteed in systems with non-trivial Chern numbers hold great promise in photonic devices, where they can act as isolators or circulators in communications technologies. However, such photonic systems rarely conform to the idealized paradigm of a topological insulator adjacent to a trivial insulator. Instead, photonic systems usually abut air on at least one surface, into which the photons can radiate. Thus, many photonic systems instead resemble a topological insulator next to a “photonic metal,” i.e., a material that lacks a spectral gap for photons. As part of this talk, I will discuss how to classify such gapless heterostructures using the local markers in the spectral localizer framework, in both toy models as well as realistic systems described by differential operators. A second field of current interest in the photonic community is classifying the topology of non-linear systems, such as those described by a Gross–Pitaevskii equation. I will first illustrate how a localized state in such a system can exhibit atypical behavior, which has been experimentally observed. Then, I will demonstrate how the spectral localizer framework enables these input localized states to be topologically classified. Finally, I will also show how the spectral localizer framework can be directly applied to 2D electron gasses in semiconductor heterostructures, possibly patterned with antidot potentials.

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References

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