IDENTIFYING TOPOLOGY DIRECTLY FROM MAXWELL'S EQUATIONS: BAND STRUCTURES AND BLOCH EIGENSTATES NOT REQUIRED

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Recently, the study of topological structures in photonics has generated significant excitement, due to these systems' ability to realize robust, non-reciprocal chiral edge states and cavity-like confined states that may have applications in both linear and non-linear devices. However, traditional band theoretic approaches can present some challenges for identifying the topology of photonic crystals and metasurfaces due to both fundamental and numerical difficulties. In this talk, I will develop a mathematical framework for determining a photonic structure's topology directly from its real-space description (i.e., Maxwell's equations), without the need to calculate its band structure or Bloch eigenstates. Instead, this framework is based on the photonic system's spectral localizer, which yields a set of local invariants, protected by local gaps, for every symmetry class [1]. Using this framework, I will show that non-trivial topology, and associated boundary-localized resonances, can appear in photonic crystals that lack complete band gaps [2]. Finally, I will show how to develop local invariants for topology stemming from a system's crystalline symmetries, which allows for the prediction of spatially-localized topological states without the construction of Wannier centers or the calculation symmetry indicator invariants [3].

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References:

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