Nonlinear topological photonics

Sebabrata Mukherjee, Jonathan Guglielmonand Mikael C. Rechtsman

Department of Physics, The Pennsylvania State University, University Park, PA 16802 USA

Abstract: In 2005, Haldane and Raghu proposed that topological physics is not limited to electrons in solid state materials, but rather can be applied to photons propagating in complex dielectric structures. Since then, a wide range of topological phenomena have been demonstrated in photonics, including chiral edge states, Thouless pumping and Weyl points. However, all of these demonstrations have been in linear, non-interacting systems. Here we describe the observation of topological solitons in three-dimensional laser-written waveguide arrays. The nonlinearity/interactions needed arise from the Kerr effect associated with the ambient glass in which the waveguides are embedded. The solitons, observed in both their bulk and edge manifestations, are fundamentally different in character from other solitons. Furthermore, we show how topological edge states can be used to circumvent a fundamental trade-off in slow-light systems, between bandwidth and slow group velocity, facilitating stronger light-matter coupling. These works open the door to applications of topological protection in nonlinear optics.

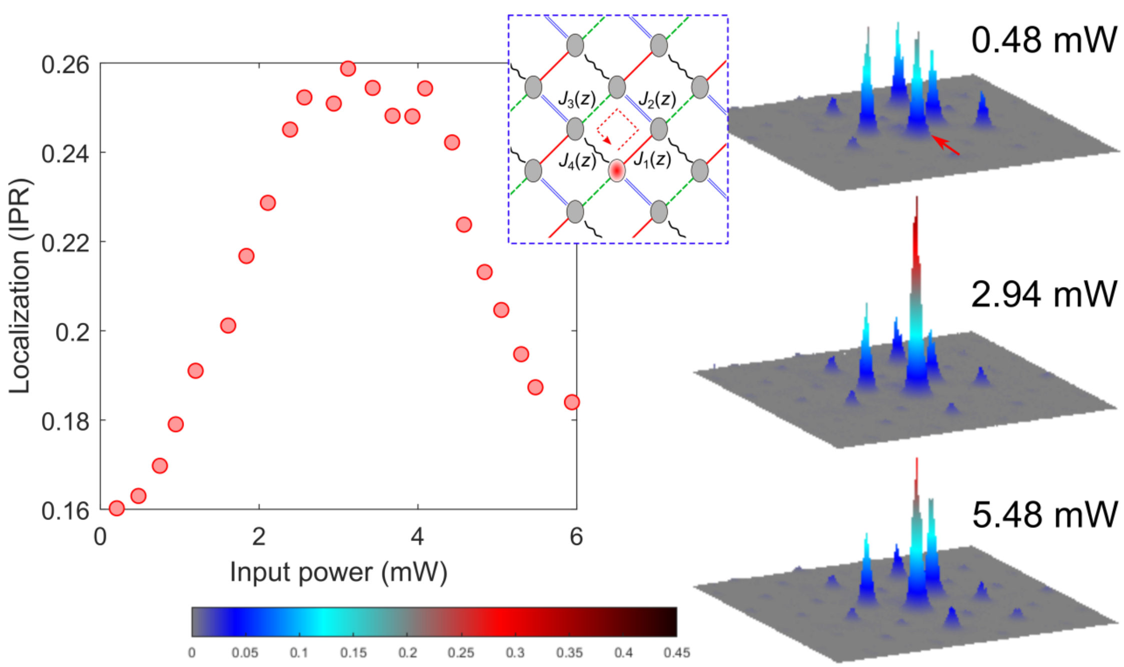

Figure. Degree of localization of a topological soliton as it bifurcates from one band edge and approaches it again on the other side of the Floquet zone. The real-space wavefunction is shown at right, and the inset shows the lattice, an anomalous photonic Floquet topological insulator.