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Dispersive, superfluid-like shock waves in optics WENJIE WAN, SHU JIA, JASON FLEISCHER, Princeton University — Dispersive shock waves arise from nonlinear wave breaking and mode dispersion, and are a fundamental type of fluid behavior in systems with none or near-zero viscosity, e.g. cold plasmas and superfluids. Here, we exploit the well-known (but underappreciated) relation between superfluids and nonlinear optics to study the photonic equivalent of dispersive, dissipationless shock waves. We experimentally demonstrate fundamental shock waves in one and two dimensions, examine their basic nonlinear properties, and observe collisions between two such shocks. We study spectral energy exchange during interactions, and find that energy and momentum transfer depend on details of the collision region. Results can be explained in terms of a nonlinear Huygens' principle, in which linear superposition of initial waves results in a nonlinear source of new shocks. In higher dimensions, wavefront geometry and expansion directions play a significant role. In addition to providing a versatile platform for new photonic physics, it is anticipated that the results reported here will lead to all-optical modeling of even richer (super)fluid-like phenomena in the near future.

Wenjie Wan
Princeton University

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