Spiral Diffraction and Solitons in Envelope Dynamics of Topological Insulators

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Abstract

The envelope dynamics for interior waves of topological insulators are studied where broken time symmetry leads to gaps opening in the spectrum at dirac points. In both honeycomb and lieb lattice structures, carrier waves near the broken dirac points exhibit spiral diffraction patterns that are uncommon for dispersive wave systems. These spiral diffraction patterns are related to complex solutions of the Klein-Gordon equation and this connection is used to derive asymptotic approximation for the long time behavior. In the nonlinear regime, families of soliton solutions are found for the nonlinear Dirac equation with a diagonalized nonlinearity. These families have a bright-dark structure and undergo collapse as they approach one of the band edges.