Dynamics of Quantum Nonlinear Scattering in Terms of Stationary States

A Brattley[1,2], K Gabriel[3], J McCarty[3], and K K Das[3,4]

[1]*Department of Physics, Yale University, New Haven CT, USA*
[2]*Department of Physics, Massachusetts Institute of Technology, Boston MA, USA*
[3]*Physical Sciences, Kutztown University of Pennsylvania, Kutztown PA, USA*
[4]*Physics and Astronomy, SUNY Stony Brook, Stony Brook NY, USA*
Contact Email: allison.brattley@yale.edu

We provide a comprehensive study of stationary states in a coherent medium with a quadratic nonlinearity in the presence of step, barrier or well potentials in one dimension. The description is in terms of the nonlinear Schrödinger equation and hence applicable to a variety of systems, including interacting ultracold atoms in the mean field regime and light propagation in optical fibers. We show that the full landscape of solutions can be described by a single expression involving Jacobi elliptic function with the inclusion of a complex-valued phase shift. All relevant boundary conditions can be intuitively visualized as intersections of phase space curves. We present a method for utilizing the stationary solutions to describe nonlinear scattering by a barrier potential, that can capture scattering of single wave packets as well interference effects of two counter-propagating wave packets.