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Dissipative solitons of space-time-symmetrized complex Ginzburg-Landau equations: generalized nonlinearity and pulse propagation

POSTER ABSTRACT

Ginzburg-Landau (GL) envelope equations play a fundamental role in nonlinear science, typically modelling the behaviour of a complex order parameter in a system with dispersion, diffraction, amplification and attenuation. The interplay between these effects can lead to the existence of physically distinct families of analytical solitary wave (typically pulses, fronts, sources and sinks). However, it turns out that a linear-gain term tends to destabilize the zero-amplitude state. As a consequence, solitary excitations tend to be rendered unstable against arbitrarily-small background fluctuations.

Here, we consider a two-fold generalization of the classic GL model. Firstly, a homogeneous dual power-law response is proposed for the system nonlinearity. Secondly, the slowly-varying envelope approximation (which underpins essentially all analyses to date) is relaxed so that the governing equation is fully-second-order in both space and time. Analyses are rooted in relativistic and pseudo-relativistic covariance, and these characteristics are manifest in the corresponding exact analytical solitary solutions. Moreover, the velocity combination law is directly analogous to the more familiar Lorentz rule from Einstein's relativistic kinematics. The symmetrized GL solitons reduce to their conventional counterparts asymptotically, and in a manner reminiscent of the way Newtonian mechanics emerges from special relativity. We also consider the implications for wave stability.