Normal and anomalous diffusion of two-dimensional solitons

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The dissipative solitons that appear in nonlinear optics can suffer explosions: after remaining localized for a certain period of time without major profile changes, they can grow and become broader for a short time, returning to the original spatial profile afterwards, and repeating the cycle intermittently [1, 2, 3].

We consider the dynamics of dissipative solitons in two spatial dimensions, inspired by a model of mode-locked lasers based in the complex Ginzburg-Landau equation.

We found that there are two regimes for the spatial motion of the soliton: in the "normal" regime the soliton explodes asymmetrically most of the time; and in the "subdiffusive" regime the soliton experiences long sequences of symmetric explosions before exploding asymmetrically. We analyzed the soliton's trajectories in both regimes using the tools of anomalous diffusion [4]. For the normal regime we found statistics similar to Brownian motion. For the subdiffusive regime we observed large trajectory-to-trajectory variations and weak ergodicity breaking that can be explained using a simple continuous-time random walk model [5].

In this presentation we analyze the distributions of generalized diffusivities [6] for the trajectories, and the distributions of relative angles [7], that explain the transition between the regimes and the "destructive" effect of additive noise.

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