Electrical and Electronics Department

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Noise-induced creation and annihilation of dissipative solitons (DS) in a passively mode-locked laser[1] TESFAY TEAMIR[2], PARVIZ ELAHI, GHAITH MAKEY, ILDAY FATIH , Bilkent Univ — Passive mode-locking, resulting in self-organized formation of femtoseconds-long laser pulses, constitutes a far-from-equilibrium steady state. Mode-locking is not only important for laser technology, but also of fundamental interest for broad class of systems. Despite numerous studies on their nonlinear dynamics, there is little understanding of the transitions that intrinsic noise can induce. We show that transitions between single-DS and multi-DS states can be triggered. Near critical points, DS states are observed to repeatedly exchange energy among themselves, form DS clusters with varying or vibrating temporal separation, often followed by random transformations among different states. This critical behavior appears to be caused by soliton-soliton or soliton-generated dispersive wave interactions. Irrespective of the specifics of the state, the measured noise level of the laser starts at a moderate value, is then reduced, as the DS's energy is increased. Further increases in power (nonlinearity) drives it towards a noisy critical state, where creation or annihilation of pulses occurs just before a new steady state is formed. These noise-induced transitions between steady states can shed light on the thermodynamics of far-from-equilibrium systems.

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