

Allgemeines Physikalisches Kolloquium

Donnerstag, 06.05.2021 um 16 Uhr c.t.
Online-Kolloquium

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Emergence and dynamics of spatio-temporal localized structures in passively mode-locked lasers

Nonlinear optical cavities are test benches of pattern formation. In these strongly dissipative systems, self-organization occurs as the result of the interplay between the nonlinearity mediated either by gain, absorption or nonlinear refractive index of the material and the dispersive effects of the cavity. We will review our recent theoretical and experimental results regarding the emergence and the dynamics of temporal and spatio-temporal localized structures in the output of semiconductor mode-locked lasers. We will disclose new instabilities that occur in vertical external-cavity surface-emitting lasers that stem from the influence of third order dispersion. The latter induces the appearance of asymmetrical pulse satellites that destabilize the mode-locking regime, which leads to complex excitable dynamics and pulse explosions. Our work is set within the framework of time delayed dynamical systems. The latter materialize in situations where distant, point-wise, nonlinear nodes exchange information that propagates at a finite speed, which is a particularly suitable approach for the modeling of an optical pulse bouncing between the various elements composing a laser cavity. However, time delayed systems are usually considered devoid of the essential dispersive effects for pattern formation. We will show how dispersion may appear naturally in singular delayed equations, and make the link via a normal form description with the physical properties of Gires-Tournois interferometers.