SEMINAR ANNOUNCEMENT

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UPC campus nord, B4-212 (aula seminari)

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“Nonlinear dissipative photonics with spin-orbit coupling”

Nonlinear dissipative optics in 2D settings has been a subject of studies for a long time [1]. Currently, a great deal of interest is drawn to 2D patterns in polariton condensates [2]. An important effect in binary polariton condensates, including TE- and TM-polarized photon fields, is spin-orbit coupling (SOC). The present talk aims to summarize recent results predicting robust localized vortex modes (quasi-solitons) supported by the interplay of gain, loss, nonlinearity, and SOC. Dissipative SOC-driven solitons were first obtained in the 2D model including saturable gain \((g > 0)\), loss \((a > 0)\) and SOC constant \(\beta\) [3]

\[
i\partial_t \psi_\pm = \left(-\nabla^2 + i\alpha\right) \psi_\pm + \beta \left(\partial_x \mp i \partial_y\right)^2 \psi_\pm, f = -1 + \frac{g}{1 + \varepsilon \left(|\psi_+|^2 + |\psi_-|^2\right)} - \frac{a}{1 + \left(|\psi_+|^2 + |\psi_-|^2\right)}.
\]

SOC couples terms with vorticity difference \(\Delta S = 2\) between components \(\psi_\pm\). As a result, the model generates two species of stable 2D solitons: vortex-antivortex (VAV) pairs and semi-vortices, the latter ones being a bound state of a zero-vorticity soliton in one component and vortex in the other, as shown in the figure, which displays amplitude and phase patterns in each component:

Further, in a physically relevant setting localization can be provided not by self-trapping but by an external trapping potential \(\sim r^2\) [4]:

\[
i\partial_t \psi_\pm = \left[-(1-i\eta)\nabla^2 + \left(|\psi_+|^2 + \alpha |\psi_-|^2\right) + i\left(\varepsilon - \sigma |\psi_-|^2\right) + r^2\right] \psi_\pm + \beta \left(\partial_x \mp i \partial_y\right)^2 \psi_\pm.
\]

This model generates stable VAVs and mixed modes (MMs) states, which combine terms with vorticities 0 and \(\pm 2\) in both components. In nonlinear optical settings per se, SOC can be realized in a dual-core planar waveguide with \(PT\) symmetry, represented by the balanced linear gain and loss in the two cores. Stable soliton families of the MM type have been found in this setting [5].