# Exciton-polariton X waves

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## Abstract

The study of quantum coherent phenomena of exciton-polaritons (polaritons) in optical microcavities is nowadays a very active area of research. Their nature merges properties of light and matter.

Sending an optical signal without distortion necessitates control over diffraction and dispersion of the traveling pulse. This can be achieved by creation of strongly confined, propagation-invariant localized wave packets (LWP), which behave rather like particles. LWP are crucial for medical and high-tech applications. They allow exciting research in the field of Bose-Einstein condensation (BEC).

3D LWP have been observed in linear acoustic and optical media. They are nonmonochromatic superpositions of nondiffracting Bessel beams with characteristic bi-conical X-shape, thus called X waves. In nonlinear media, the interplay between diffraction, group velocity dispersion (GVD) and nonlinearity leads to formation of spatio-temporal solitons (light bullets). These are bell-shaped wave packets generated in Kerr-like media with anomalous GVD.

Recently, it has been shown that X waves exist also in nonlinear media with normal dispersion. They experience a weaker localization than the bullets and they can exist in the linear limit. High-intensity 3D nonlinear X waves have been demonstrated to form spontaneously from Gaussian laser beams.

Correspondence between time evolution of light in Kerr medium and of an atomic BEC, allows to predict nonlinear matter X waves for an ultra cold Bose gas in an optical lattice. In case of polaritons, LWP have been observed in the form of 1D stable bright cavity solitons.

In our work we show, for the first time, that the lower polaritons (LP) in a microcavity can condensate in a form of 2D nonlinear X LWP. This prediction is based on analogy between description of an atomic BEC and polaritonic superfluid in terms of generic nonlinear Schröodinger equation. Polaritonic X waves form spontaneously from the Gaussian laser beams pumping cavities. Their existence extends to the linear regime.