Solitary waves induce waveguide that can split light beams

March 15 2012

Researchers have designed the first theoretical model that describes the occurrence of multiple solitary optical waves, referred to as dark photovoltaic spatial solitons. The findings by Yuhong Zhang, a physicist from the Xi'an Institute of Optics and Precision Mechanics of the Chinese Academy of Science, and his colleagues is about to be published in the *European Physical Journal D*. Because the shape of dark solitons remains unaffected by the crystal in which they travel, they induce waveguides, which can be used, for example, to reconfigure optical beams by splitting them.

Dark solitons are generated in so-called photorefractive crystals – crystals that respond to an incoming light beam by decreasing their refractive index as optical intensity increases, causing in the incoming beam to defocus. This effect is called nonlinear self-defocusing. Dark solitons occur when the diffraction of an incoming beam by the notch, located at the crystal's entrance, is compensated by the crystal's self-defocusing effect. As a result, dark solitons can induce waveguides for light beams, allowing them to travel unchanged through photorefractive crystals.

The authors performed the first numerical simulation to model the formation and evolution of one-dimensional multiple dark solitons inside a photorefractive crystal, relying on an approximation technique called the beam propagation method. By expanding the width of the dark notch located at the entrance of the crystal, which, unlike in previous studies, was not given any special function, they showed it was possible to create

multiple dark solitons.

These solitons appeared in either odd or even numbers, depending on the initial beam phase or amplitude. The authors also confirmed previous findings that showed that when multiple solitons are generated, the separation between them becomes smaller. Further, the solitons become progressively wider and less visible, the farther away they are from the main dark notch entry location.

More information: Zhang Y., Lu K., Guo J., Li K., Liu B. (2012), Steady-state multiple dark photovoltaic spatial solitons, *European Physical Journal D* (EPJ D). DOI 10.1140/epjd/e2012-20560-4

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