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# Mobility of discrete solitons in a two-dimensional array with saturable nonlinearity

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In two-dimensional (2D) nonlinear discrete arrays, not much is known about discrete soliton mobility. Essentially, as was described in [1], for cubic nonlinearity only wide discrete solitons are mobile. However these are unstable to a 'quasicollapse' process so that, after moving a few lattice sites, the broad solitons self-focus into narrow localized peaks, which get pinned by the lattice [1].

We study here the issue of mobility of localized modes in 2D nonlinear Schrödinger lattices with saturable nonlinearity [2]. This describes e.g. discrete spatial solitons in a tight-binding approximation of 2D optical waveguide arrays made from photorefractive crystals. We discuss numerically obtained exact stationary solutions and their stability focussing on three different solution families with peaks at one, two, and four neighboring sites, respectively. When varying the power, there is a repeated exchange of stability between these three solutions, with symmetry-broken families of connecting intermediate stationary solutions appearing at the bifurcation points. When the nonlinearity parameter is not too large, we observe good mobility and a well defined Peierls-Nabarro barrier measuring the minimum energy necessary for rendering a stable stationary solution mobile.

We consider the following (general) form of the 2D saturable DNLS equation for an isotropic medium, analogous to the 1D model in [3],

$$i\frac{\partial u_{n,m}}{\partial \xi} + \Delta u_{n,m} - \gamma \frac{u_{n,m}}{(1+|u_{n,m}|^2)} = 0, \tag{1}$$

where $\xi$ is the normalized propagation distance, $u_{n,m}$ describes the electric field amplitude in the $\{n,m\}$ site, and $\Delta$ represents the 2D discrete Laplacian, $\Delta u_{n,m} \equiv u_{n+1,m} + u_{n-1,m} + u_{n,m+1} + u_{n,m-1}$. We use an isotropic approximation which essentially considers the coupling between neighboring sites in the $\hat{n}$ and $\hat{m}$ directions as equal. The parameter $\gamma$ is given by the ratio between the nonlinear parameter and the coupling constant [2, 3].

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