Discrete nonlinear Schrödinger equation dynamics in complex networks

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We investigate dynamical aspects of the discrete nonlinear Schrödinger equation (DNLS) in finite lattices. We start from a periodic chain with nearest neighbor interactions and form a small world network by inserting randomly links connecting distant pairs of sites across the lattice. We use a localized initial condition and focus on the time averaged probability of occupation of the initial site as a function of the degree of complexity of the lattice and nonlinearity. For defocusing nonlinearity we find that selftrapping occurs at increasingly larger values of the nonlinearity parameter as the lattice connectivity increases while close to the fully coupled network localization becomes more preferred. For nonlinearity values above a certain threshold we find localization when the number of long distant bonds is small followed by delocalization and enhanced transport at intermediate bond numbers while close to the fully connected limit localization reappears. We present exact time dependent solutions for the fully coupled lattice with arbitrary numbers of sites.