Discrete Switching Waves and Dissipative Solitons in Nano- and Metamaterials

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We describe and compare switching waves, or kinks, and 1D-, 2D-, and 3D-dissipative solitons in such discrete nonlinear nano- and metamaterials as a chain of two- or three-level molecules [1], a chain and lattices of split-ring resonators [2-5] and a chain of spherical nanoparticles [6,7] driven in resonance by external coherent electromagnetic radiation. All these systems are bistable or multistable under certain conditions, and states corresponding to some parts of branches of the systems' response are modulationally unstable. We demonstrate bistability of switching waves when both motionless and moving switching waves exist under the same conditions. Interaction of these waves results in discrete dissipative solitons of different types. There are also motionless and moving waves of switching between homogeneous and spatially modulated states developing due to modulational instability of homogeneous states (Fig. 1). Finally, in driven 3D-lattices of nonlinear split-ring resonators we find different types of topological solitons including knot solitons (Fig. 2).

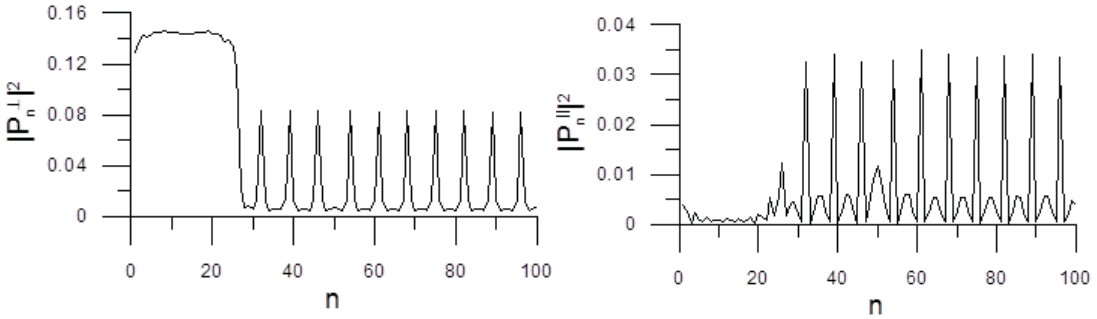

Fig. 1. Discrete vector switching wave between homogeneous (left parts of the figures) and modulationally unstable (right parts) states of for two polarisations (*left* and *right*) representing by response of nanospheres with number *n* in a driven chain.

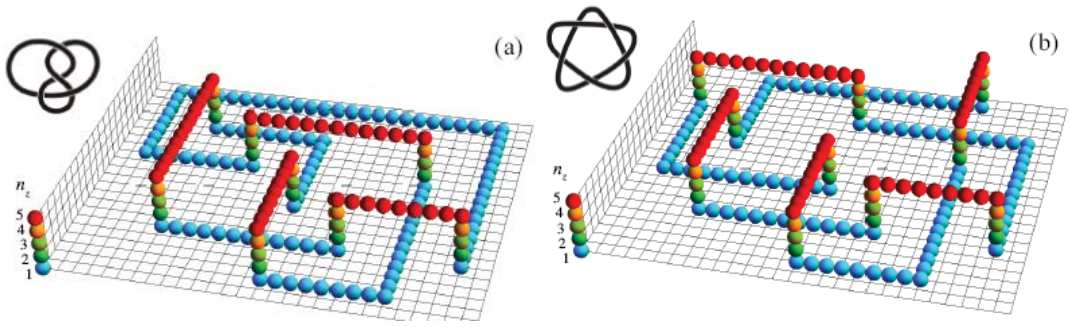

Fig. 2. Discrete knotted solitons with 4 and 5 crossing: (a) figure-eight and (b) cinquefoil knots formed by split-ring resonators excited to the upper branch in a driven lattice.

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