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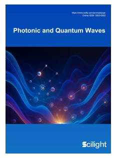

Editorial

Photonic and Quantum Waves

Boris Malomed

Department of Physical Electronics, School of Electric and Computer Engineering, Faculty of Engineering,
Tel Aviv University, Tel Aviv 69978, Israel; malomed@tauex.tau.ac.il
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Wave propagation is the mainstay topic in the broad area of photonics and quantum science. In terms of the wave dynamics, photonic media and quantum matter are naturally classified as linear/nonlinear and conservative/dissipative, as well as one- or multidimensional systems. The phenomenology of the wave generation and transmission includes a great variety of states in these classes of settings. Many wave-propagation patterns discovered in phonics and quantum matter have their counterparts in other fields, such as plasmas, hydrodynamics, magnetism, superconductivity, elasticity, electric networks, etc. The linear propagation typically exhibits expansion of wave beams and packets under the action of the spatial diffraction and/or temporal dispersion, as well as more specific linear dispersive effects, such as spin-orbit coupling. The superposition principle makes it possible to build a variety of nonsteady patterns, including such sophisticated ones as skyrmions, selecting inputs composed as proper combinations of "simple" linear waves. On the contrary, in nonlinear media the interplay of the self-focusing or defocusing with the linear diffraction/dispersion effects selects steady eigenstates, such as bright or dark solitons, vortices, and fronts, as well as complex topologically structured modes in the form of hopfions and skyrmions. A separate but closely related topic is the creation and propagation of excitations in discrete systems (lattices). A profound problem for nonlinear states is their stability, which strongly depends on the form of the nonlinearity (cubic, quadratic, saturable, nonlocal, etc.). In linear and nonlinear media alike, the wave-propagation patterns strongly depend on the spatial dimension, the most fascinating ones being spatiotemporal states in three-dimensional (3D) space. In particular, the stability problem, which may be relatively simple in 1D, is a challenging issue for nonlinear multidimensional states, as the same multidimensional settings typically admit the wave collapse (spontaneous formation of singularities by the evolving wave fields), which tends to destabilize stationary states. For the theoretical analysis of the wave propagation, famous integrable equations, such as the nonlinear Schrödinger (NLS), sine-Gordon, Korteweg-de Vries, and Toda-lattice equations in 1D, and Kadomtsev-Petviashvili equations in 2D, make it possible to produce fundamentally important exact solutions for solitons and other nonlinear modes. Models based on non-integrable equations can be efficiently investigated too, using numerical and approximate analytical methods.

A different research area covers the studies of wave patterns in dissipative nonlinear media. In this case, the balance of the diffraction/dispersive effects with nonlinearity is supplemented with the balance of losses by the intrinsic gain or external pump. As a result, dissipative systems generate, instead of continuous families of self-trapped states, isolated ones, such as stable dissipative solitons, which appear as attractors. Dissipative models, which are often based on complex Ginzburg-Landau and Lugiato-Lefever equations, are highly relevant for studies of diverse types of lasers and plasmonic setups, as well as systems generating frequency combs. Theoretical studies of dissipative models are conducted by means of the combination of systematic numerical simulations and approximate analytical methods. A specific class of models, which are intermediate between conservative and dissipative ones, are those featuring the parity-time (*PT*) symmetry, i.e., systems featuring mutually balanced spatially symmetric distributions of gain and loss elements. Despite their dissipative nature, nonlinear *PT*-symmetric systems are capable to support continuous families of solitons and other modes.

The great progress in theoretical studies of the wave phenomenology is paralleled by impressive achievements in experiments, performed in optics, photonics, and Bose-Einstein condensates (BECs) in ultracold gases. Remarkable experimental results are the creation of diverse species of solitons and related self-trapped modes (such as quantum droplets) in optical fibers and lasers, various types of waveguides, plasmonic systems, and atomic BECs.

The above outline puts optics/photonics and quantum science together due to the great similarity between various phenomena in these areas; in particular, in many cases optical and photonic setups may effectively emulate their counterparts in quantum matter, and vice versa. Moreover, matter waves in cold-atom BECs serve as excellent simulators for many physical phenomena from other fields of physics, such as spin-orbit coupling, ferromagnetism, phase transitions and spontaneous symmetry breaking, formation of black holes, etc.

There is ample space for further development of theoretical and experimental studies in the field of the wave-propagation and pattern-formation phenomenology in photonics and quantum matter. Highly promising directions in the ongoing studies address, in particular, the creation of multidimensional spatial and spatiotemporal states with an intrinsic topological structure (skyrmions, hopfions, spatiotemporal vortices, etc.), interactions of localized states (solitons, quantum droplets, solitary vortices, and others) and the formation of static and moving bound states ("molecules") of such states (binary and multiple bound states, as well as chains and lattices formed by them), photonic and quantum-mechanical settings with an effective fractional diffraction, dispersion, and diffusion, diverse systems including spatial modulation and/or "management" (periodic or nonperiodic modulation of the system along the propagation direction or in time), and others. Actually, the advancement in experimental studies in this area is an especially important direction of the work because, as it often happens, the theoretical results are much more advanced than their experimental counterparts.

The objective of the newly established journal "*Photonic and quantum waves*" is to develop a platform for reporting new achievements produced by theoretical and experimental studies in the research areas outlined above. The submission of original and review articles, both full-length and short ones, is welcome. The articles may address fundamental problems and applications (the range of existing and potentially available applications of the wave phenomenology in optics and photonics is huge; waves in quantum matter may find applications in areas such as quantum computing and data processing, interferometry, metrology, nanotechnology, etc.). Submissions will pass the normal peer-review procedure.

Members of the research communities in the broad areas of optics, photonics, and quantum science, as well as researchers from other areas whose work relates them to the topics outlined above, are wholeheartedly encouraged to submit their new works to this newly established journal.

Conflicts of Interest

Given the role as the Editor-in-Chief of the journal, Boris Malomed had no involvement in the peer review of this paper and had no access to information regarding its peer-review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.