Contribution ID: **5** Type: **Oral**

Canonization-based symmetry breaking in an integrable four-component nonlinear dynamical system on a quasi-one-dimensional lattice with background-controlled intersite coupling

Thursday, 24 September 2026 12:40 (20 minutes)

Eleven years ago we developed the four-component nonlinear integrable dynamical system on a ribbon of two-leg triangular lattice with the common coherent and uncommon background-controlled intersite couplings [1, 2]. The system can be classified as a sort of semi-discrete nonlinear Schrödinger system. It characterized by four basic (independent) fields on zero background and two concomitant (dependent) fields on nonzero background. Due to nonzero background values of concomitant fields the entire Poisson structure of semi-discrete nonlinear system acquires essentially nonstandard form veiling the true physical interpretation of basic fields. Looking for a prospective physical applications of suggested semi-discrete nonlinear integrable system to the modeling of transport phenomena in long macromolecules or other quasi-one-dimensional physical objects, we suggested rather sophisticated multistage transformation to the semi-discrete nonlinear integrable system, characterized by the canonical Poisson structure and physically motivated field functions as well as by the standard canonical Hamiltonian formulation [3, 4, 5, 6]. As a result, we obtained two distinct but physically equivalent realizations of canonized semi-discrete four-component nonlinear integrable system, each one being manifested by a pronounced symmetry breaking between the so-called strong two-component and weak two-component subsystems. The rate of symmetry breaking is governed by the nonnegatively defined background parameter $\mu\nu$, so that for $\mu\nu = 0$ the symmetry between subsystems becomes totally restored. We believe, the value of background parameter $\mu\nu$ could be regulated by external conditions imposed on a lattice. For undercritical values $\mu\nu < 1$ of background parameter $\mu\nu$ each particular canonized system demonstrates bright excitation regime both in strong and weak subsystems, though the density of excitations in strong subsystem prevails over the density of excitations in weak subsystem. For overcritical values $\mu\nu > 1$ of background parameter $\mu\nu$ each particular canonized system demonstrates bright excitation regime in strong subsystem and dark excitation regime in weak subsystem. The crossover between the bright–bright and bright–dark regimes of excitation dynamics established for the case of attractive nonlinearity occurs in the very critical point $\mu\nu = 1$.

References

[1] O.O. Vakhnenko. Integrable nonlinear Schr¨odinger system on a triangular-lattice ribbon, J. Phys. Soc. Japan 84(1), 014003 (12 pages) (2015).
[2] O.O. Vakhnenko. Nonlinear integrable model of Frenkel-like excitations on a ribbon of triangular lattice, J. Math. Phys. 56(3), 033505 (21 pages) (2015).
[3] O.O. Vakhnenko. Symmetry-broken canonizations of the semi-discrete integrable nonlinear Schr¨odinger system with background-controlled intersite coupling, J. Math. Phys. 57(11), 113504 (16 pages) (2016).
[4] O.O. Vakhnenko. Semi-discrete integrable nonlinear Schr¨odinger system with background-controlled inter-site resonant coupling, J. Nonlin. Math. Phys. 24(2), 250–302 (2017).
[5] O.O. Vakhnenko. Distinctive features of the integrable nonlinear Schr¨odinger system on a ribbon of triangular lattice, Ukr. J. Phys. 62(3), 271–282 (2017).
[6] O.O. Vakhnenko, V.O. Vakhnenko, and A.P. Verchenko. Physical insight into the semi-discrete nonlinear integrable systems with the true and false multicomponentness, Chaos Solitons Fractals 200(2), 117043 (24 pages) (2025).

Primary author: Dr OLEKSIY O., Vakhnenko (Bogolyubov Institute for Theoretical Physics)

Presenter: Dr OLEKSIY O., Vakhnenko (Bogolyubov Institute for Theoretical Physics)

Track Classification: MATHEMATICAL PHYSICS