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Stabilizing role of the dissipation effects in the dynamics of electrosolitons in magnetic field

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Analytical [1] and numerical [2] study of the magnetic field impact on the dynamics of electrosolitons, i.e., charged Davydovs solitons, in one-dimensional systems has shown that in the presence of the field soliton velocity and acceleration attains oscillations with the frequency determined by the field. It has been shown that the impact of a magnetic field within both approaches depends not only on the field strength, but also on the parameter values of the system which define such properties of polarons like their energy, amplitude, width of localization. Because of the non-zero acceleration soliton velocity gradually increases with time and at large times soliton starts to radiate linear sound and electromagnetic waves due to which soliton loses its energy and becomes less stable.
Nevertheless, in real situations there are always present dissipative effects. Molecular chains interact with the surrounding, electron itself interacts not only with the acoustical phonons, but with other vibrational modes, etc., so that the energy dissipation has to be taken into account. It is shown that it can be done by adding an additional term into the corresponding equations of motion. In the continuum model soliton dynamics in the magnetic field is governed by the Modified Cubic Nonlinear Schoedinger Equation with two extra terms determined by the presence of the magnetic field and energy dissipation. Both extra terms are small. The equation is solved using the nonlinear perturbation method. It is shown that with increasing soliton velocity due to magnetic field energy dissipation increases and as a result, soliton acceleration decreases and its dynamics is stabilized.
The obtained results demonstrate that soliton dynamics remains stable even in relatively strong magnetic fields. Therefore, solitons can provide effective long-range electron transport in biological systems and novel low-dimensional functional materials used in modern nano- and biotechnologies.

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[1] L. Brizhik. Chaos, Sol. Fractals 187 (2024) 115459 https://doi.org/10.1016/j.chaos.2024.115459.
[2] L. Brizhik B.M.G. Piette, Chaos, Sol. Fractals 208 (2026) 118339 https://doi.org/10.1016/j.chaos.2026.118339

Primary author: BRIZHIK, Larissa (Boglyubov Institute fr Theoretical Physics)

Presenter: BRIZHIK, Larissa (Boglyubov Institute fr Theoretical Physics)

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