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Nonlinear mechanism of magnetic field impact on charge transport in macromolecules

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Charge transport accompanies redox processes in respiration, and involves electron transport chain in Krebs cycle. Some stages of this transport occur in polypeptide macromolecules which support the formation of bound nonlinear electron states in the form of solitons formed due to relatively strong electron-lattice interaction in hydrogen-bonded polypeptide chains [1]. As an external magnetic field can affect the dynamics of solitons, we study the influence of an external time oscillating magnetic field on the dynamics of solitons. It is shown that the soliton properties depend on the amplitude and the frequency of the magnetic field, as well as on the orientation of the magnetic field with respect to the molecular chain axis. It is shown that in a perpendicular magnetic field the soliton dynamics is a superposition of the free electron plane wave in the plane perpendicular to the molecular chain, and of the soliton propagation along the chain. The latter is described by the modified Nonlinear Schrödinger equation with an extra term depending on the magnetic field. This equation is solved using nonlinear perturbation theory [2,3]. It is shown that the soliton velocity and phase are oscillating in time at the main frequency of the external field frequency, as well as at its higher harmonic multiple.

Such complex effects of external time-depending magnetic fields on the dynamics of solitons in polypeptides affects the charge transport in the redox processes of biological systems and could explain the physical mechanism of the therapeutic effects of oscillating magnetic fields.

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Primary authors: Prof. BRIZHIK, Larissa (Boglyubov Institute for Theoretical Physics); Prof. PIETTE, B.M.A.G. (Department of Mathematical Sciences, University of Durham)

Presenter: Prof. BRIZHIK, Larissa (Boglyubov Institute for Theoretical Physics)