9th International Fröhlich’s Symposium

ELECTRODYNAMIC ACTIVITY OF LIVING CELLS
Including Microtubule Coherent Modes and Cancer Cell Physics

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Introductory Remarks

This volume contains papers presented at the International Fröhlich’s Symposium entitled “Electrodynamic Activity of Living Cells” (July 1–3, 2011, Prague, Czech Republic). The Symposium was the 9th meeting devoted to physical processes in living matter organized in Prague since 1987. Hypothesis of oscillation systems in living cells featured by non-linear interaction between elastic and electrical polarization fields, non-linear interactions between the system and the heat bath leading to energy downconversion along the frequency scale, energy condensation in the lowest frequency mode and creation of a coherent state was formulated by H. Fröhlich, founder of the theory of dielectric materials. He assumed that biological activity is based not only on biochemical but also on biophysical mechanisms and that their disturbances form basic links along the cancer transformation pathway. Fröhlich outlined general ideas of non-linear physical processes in biological systems. The downconversion and the elastic–polarization interactions should be connected in a unified theory and its solution based on comprehensive non-linear characteristics.

Biochemical and genetic research of biological systems are highly developed and have disclosed a variety of cellular and subcellular structures, chemical reactions, molecular information transfer, and genetic code sequences— including their pathological development. Nevertheless, the cancer problem is still a big challenge. Warburg’s discovery of suppressed oxidative metabolism in mitochondria in cancer cells suggested the essential role of physical mechanisms (but his discovery has remained without impact on cancer research and on study of physical properties of biological systems for a long time). Mitochondria, the power plants of the cell, have several areas of activity—oxidative energy production is connected with formation of a strong static electric field around them, water ordering, and liberation of non-utilized energy to their surroundings. Mitochondrial function connected with water ordering and excitation of oscillations in microtubules may play a central role in biological activity, in particular in transport, organization, interactions, and information transfer. Mitochondrial dysfunction results in disturbances of the generated electrodynamic field with bad consequences in biological activity and creation of pathological states. A special issue of the biological activity concerns the brain function (consciousness is not yet adequately understood). Experimental investigation using nanotechnology would supply yet unknown data and parameters of physical mechanisms in living systems. Extremely weak biological signals have to be separated from technical noise under conditions of possible non-linear mutual interactions.

Some authors questioned the validity of the Fröhlich hypothesis. Foster and Baish (J. Biol. Phys. 26, 2000, 255) neglected water ordering and concluded that strong damping by water viscosity effects prevents formation of coherent state. Reimers et al. (PNAS 106, 2009, 4219) and McKemmish et al. (Phys. Rev. E 80, 2009, 021912-1) omitted non-linear elastic-electrical polarization interactions and analyzed a linearized model of downconversion with strong damping that cannot represent the Fröhlich system. Fröhlich assumed high quality non-linear system with energy supply. Some methods used for analysis of linear system (for instance method of superposition) are not valid in non-linear systems. For this reason also experimental analysis based on subtraction of the noise from the measured signal spectrum is not a simple question.

There is another special issue concerning the biological activity. Living state and in particular consciousness are very often connected with an idea of non-material and non-measurable entity entering the biological system from outside. There is a splendid harmony and order in nature. Science
should disclose measurable mechanisms of the harmony and order. But the human knowledge about the electrodynamic and electromagnetic fields in biological systems is still at low level.

The Symposium continued in the series of international scientific meetings devoted to physical processes in living cells organized in Prague. The first meeting was entitled “Biophysical Aspects of Cancer” (July 6–9, 1987). At this occasion the anglo-german physicist H. Fröhlich presented a lecture “Coherence in Biology”. The next meeting devoted to the Fröhlich coherent systems, information transfer, and neural activity was in 1993. The role of the Fröhlich coherence in the neural activity was included in the meeting “Biophysical Aspects of Coherence” in 1995 too. The further symposia were entitled “Electromagnetic Fields in Biological Systems” (1998), “Electromagnetic Aspects of Selforganization in Biology” (2000), “Endogenous Physical Fields in Biology” (2002), “Coherence and Electromagnetic Fields in Biological Systems” (2005), and “Biophysical Aspects of Cancer – Electromagnetic Mechanisms” (2008). In 2008 a novel project for research of convergence of physics and oncology was triggered in the USA by the National Cancer Institute and the Institute of Public Health.

This issue contains main part of papers presented at the Symposium. The ideas presented at the Symposium might have impact on future research of physical processes and mechanisms in biological systems. Experimental research may provide a background for understanding of the neglected part of biological activity and reveal the physical mechanisms of the cancer transformation pathway.

The Symposium and this issue were prepared by a scientific team whose members were M. Cifra, D. Havelka, A. Jandová, F. Jelinek, O. Kučera, M. Nedbalová, and F. Šrobár.

Jiří Pokorný
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