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Theoretical and Experimental Analysis of the Mechanisms of the Interaction of Terahertz Radiation with Neurons

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Abstract – The aim of the work is to study the mechanisms of THz radiation influence on membranes and neural signaling pathways, which alters intermolecular interactions, including the permeability of cell membranes.

Keywords – THz radiation, neurons, membrane permeability

I. INTRODUCTION

At present, there is evidence pointing to the interaction of terahertz (THz) radiation with biological objects of different levels of organization, from simple molecules, such as water [1], to complex biopolymers, such as sugars, proteins, DNA [2], respectively, to cells, tissues [3], and the body as a whole [4]. The analysis of the mechanism of the primary physical action of THz radiation on biological objects is confronted with the problems of explaining its transmission to membrane structures, signaling pathways and the genetic apparatus of the cell [5]. Currently, these problems are not fully resolved. The project aims to study the mechanisms of influence of THz radiation on the membrane and signal structures of nerve cells, which changes the intermolecular interactions, including the permeability of cell membranes. Transmembrane delivery of pharmacological or other means to cells in neuro-induced pathological conditions is one of the most important tasks of finding new ways to correct these conditions. In this regard, the search and development of effective and safe methods and technologies that make it possible to facilitate the delivery of such agents through membrane structures that are both sufficiently efficient, able to localize the delivery zone and sufficiently safe for the organism remain relevant. Therefore, the development of methods for influencing the reversible permeability of the membranes of nerve cells seems quite promising.

II. RESULTS

The project will carry out a comprehensive experimental assessment of the possibility of a controlled

change in the permeability of membranes using non-ionizing electromagnetic radiation in the terahertz frequency range. A method will be developed for diagnosing changes in cell membrane permeability under the action of THz radiation using THz-TDS [6]. A theoretical-experimental analysis of the mechanisms of the action of electromagnetic radiation in this range on biological systems will be carried out [7]. An experimental selection of the most effective frequencies, energies and other parameters and modes of exposure will be conducted. The safety of such effects will be investigated and the necessary conditions and characteristics of the radiation will be identified. All this will allow, on the one hand, to identify and clarify known mechanisms for the formation of transmembrane pores, and, on the other hand, to develop new physical tools for efficient cell transfection, targeted delivery of drugs and other (especially hydrophobic) biologically active compounds; which, in turn, will improve the efficiency of targeted correction of a wide range of pathologies. This project will greatly improve the knowledge of the interaction of THz waves with cells and the surrounding medium and the influence of the intracellular protein composition of cells. Also the permeabilization of neurons or other targeted cells under chemical agent will be studied.

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