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ICPYS-LTP 2018

IX International Conference for Professionals and Young Scientists

LOW TEMPERATURE PHYSICS

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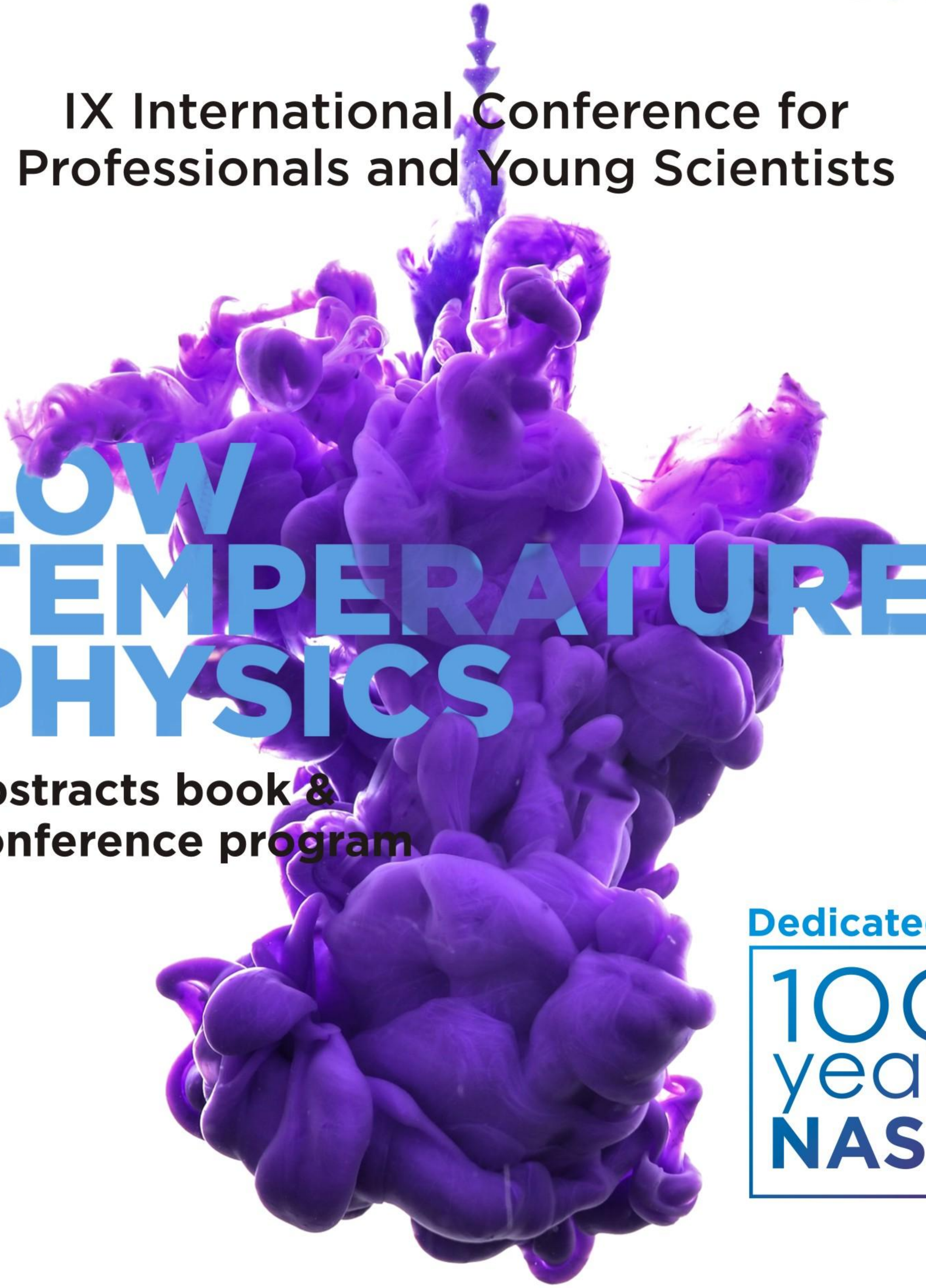

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IX International Conference for Professionals & Young Scientists
LOW TEMPERATURE PHYSICS
ICPYS LTP 2018
dedicated to the 100th anniversary of the National Academy of Sciences of Ukraine

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June 4-8, 2018 | Kharkiv, Ukraine

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This book is the proceedings of the IX International Conference for Professionals & Young Scientists "LOW TEMPERATURE PHYSICS" ICPYS LTP 2018 dedicated to the 100th anniversary of the National Academy of Sciences of Ukraine, and contains 150 peer-reviewed abstracts. These materials present and discuss the studies of modern aspects of experimental and theoretical physics at low and ultralow temperatures, including electronic properties of conducting and superconducting systems, magnetism and magnetic materials, optics, photonics and optical spectroscopy, quantum liquids and quantum crystals, cryocrystals, nanophysics and nanotechnologies, biophysics and physics of macromolecules, materials science, theory of condensed matter physics, technological peculiarities of the instrumentation for physical experiments, and other related fields.

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DIELECTRIC PROPERTIES OF MICRO/NANOPARTICLE SUSPENSIONS AT LOW AND ROOM TEMPERATURES: A THERMODYNAMIC APPROACH

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Suspensions of nanoparticles (NP, d = 1-100*nm*) have been proven to be the beast candidates for efficient heat transfer in the micro coolers, engines, fuel cells, and microelectromechanical systems due to the extremely high thermal conductivity of the nanosuspensions in comparison to the base fluid [1]. Biological fluids are suspensions of micoparticles (MP, $d = 1-100\mu m$) like cells, vesicles, and aggregates of biopolimers. Due to the electric double layer formation at the cell surfaces and interfaces, the electrical phenomena in the biological suspensions are essential for their normal function [2] and, therefore, can be used in medical diagnostics. Complex dielectric permittivity $\varepsilon^* = \varepsilon' - i\varepsilon''$, where ε' is the relative permittivity, ε'' is the loss factor, of the red blood cells differ significantly in healthy blood and in the cancer and stroke patients [3], that can be used in medical diagnostics and estimation of the individual treatment success. During the last decades the nanodiamonds (ND) have been proposed for different sort of cell target therapy, drug delivery, cancer treatment and other medical applications. Suspensions of MP and NP are complex physical systems with a number of coupled physical phenomena. In this study physical behavior of such fluids and their dielectric properties in the microwave electromagnetic fields (MW) is considered.

The physical phenomena at the micro/nano scale in MW fields is described by the enhanced irreversible thermodynamics (EIT) that introduces the Helmholtz free energy $\Im$ as a function of its parameters X,Y, their fluxes $J_{X,Y}$, and their time and space derivatives in the form: $\Im = \Im(X, Y, J_{X,Y}, \nabla J_{X,Y}, \dot{J}_{X,Y})$, where dot corresponds to the time derivative. Therefore, the classical physical laws like Fourier heat, Fick's diffusion, Darcy mass transfer, and other laws possess the generalized form [4]

$$\tau\dot{J}_X + J_X = -k\nabla X + \lambda\nabla^2 X + f(X), \quad (1)$$

where τ is the relaxation time (τ =0 in slow varying fields), λ is the scale related parameter (λ =0 at macro scale), k is the transfer parameter.

In the complex MB+NP suspensions in MW fields a series of novel coupled transfer phenomena appeared due to (1). In this study the coupled heat J_T and mass J_P transfer phenomena are studied. The entropy production is computed and the generalized Dufour, Soret, thermo-, electro- and diffusiophoresis relations are obtained. The measurement data on the dielectric parameters of suspensions of human erythrocytes, aqueous suspensions of ND, and rat erythrocytes with ND at the low and room temperatures [3] have been used for understanding the physical phenomena in the MP and NP suspensions in high frequency external MW fields. It is shown that the hydrated shells of the MP and NP are influenced by the particle geometry, curvature of the interfaces, relaxation phenomena in the MW fields, and ambient temperature.

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