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CONDENSED MATTER & LOW TEMPERATURE PHYSICS 2025

Abstracts book

2th – 6th June 2025
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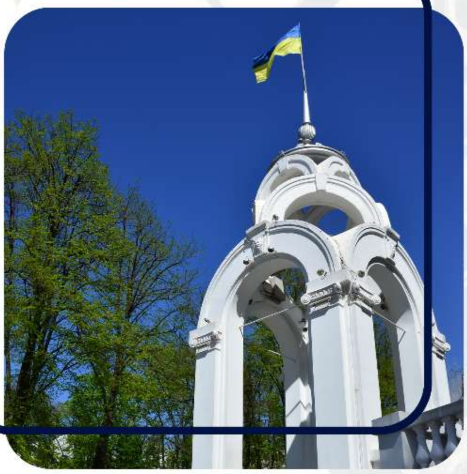

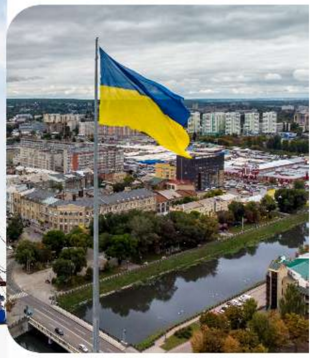

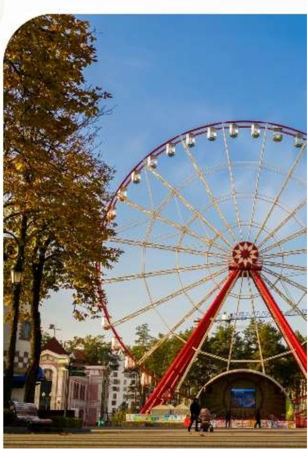

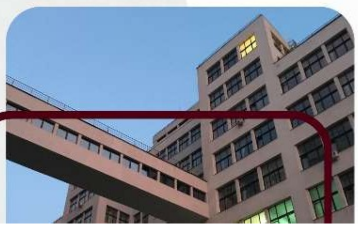

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This book collects 228 peer-reviewed reports presented at the V International Conference "Condensed Matter and Low Temperature Physics" 2025. These materials present the studies of modern aspects of condensed matter and low temperature physics including 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 related fields.

The book will be useful to undergraduate, postgraduate students, and researchers in the field of condensed matter physics.

Ця книга зібрала 228 доповідей, представлених на V Міжнародній конференції "Condensed Matter and Low Temperature Physics" 2025 року. Дані матеріали представляють дослідження у галузі сучасних аспектів фізики конденсованого середовища та низьких температур, у тому числі електронні властивості провідних та надпровідних систем, магнетизм, оптику, фотоніку та оптичну спектроскопію, квантові рідини та квантові кристали, кріокристали, нанофізику та нанотехнології, біофізику та фізику макромолекул, матеріалознавство, теорію фізики конденсованих середовищ, технологічні особливості обладнгання для фізичних експериментів та суміжні галузі.

Книга призначена для студентів, аспірантів та дослідників у галузі фізики конденсованого стану.

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Modification of electrophysical parameters of $CuInP_2S_6$ crystals by betta, gamma and neutron irradiation

A. Molnar[1], **A. Haysak**[1], **I. Haysak**[1], **D. Gál**[2]

[1]Uzhhorod National University, Voloshina Str. 54, Uzhhorod, 88000, Ukraine
[2]HUN-REN WIGNER Research Center for Physics, Po.Box. 49, 1525 Budapest, Hungary
e-mail: alexander.molnar@uzhnu.edu.ua

The modern development of electronics has reached the physical limits imposed by the miniaturization of microchip active elements to just a few nanometers. At such scales, quantum-mechanical and fundamental physical laws become increasingly significant, manifesting, for example, through tunneling effects or limitation of the subthreshold swing. To overcome these limitations, functional 2D materials such as layered ferrielectrics $CuInP_2S_6$ are becoming increasingly important. The primary benefit of this material is that it retains its ferrielectric properties at thicknesses below 4 nm, with spontaneous polarization directed perpendicular to the structural layers. Negative capacitance transistors and neuromorphic computational elements have been created on their basis. Therefore, optimization and improvement of the parameters of this material, as well as the study of possible limits of its application is an urgent task.

As with many electronic materials, $CuInP_2S_6$ crystals exhibit certain disadvantages, including a relatively low phase transition temperature ($T_c \approx 315$ K), ionic conductivity, and other limitations. The present study investigates the influence of radiation defects on the electrophysical parameters of $CuInP_2S_6$ crystals, a subject of particular importance for the further use of devices based on them in the aerospace industry. It is noteworthy that this technique (irradiation of samples) has a long-standing history in the semiconductor industry, particularly in modifying the mobility of charge carriers.

In the present study, we utilized $CuInP_2S_6$ crystals, grown from the melt using the Bridgman method. The chemical composition of the crystals was confirmed by the EDAX method, and their dimensions were measured to be 5x5x3 mm^3. After measuring the temperature dependence of their dielectric constant (as a reference measurement), the sample was divided into three 1 mm thick plates to ensure chemical composition uniformity. The same procedure was then repeated for each of the resulting plates. The samples were then exposed to β and γ particles at the Microtron accelerator (10^{15} cm^2). After irradiation, the temperature dependence of the dielectric permittivity was immediately measured again under the same conditions as in the initial reference studies.

It has been established that irradiation of $CuInP_2S_6$ samples with β and γ particles significantly affects the dielectric constant, both during phase transitions and at ambient temperature. Furthermore, the phase transition temperature and the shape of the ε(T) anomaly remain largely unaltered. It has been demonstrated that an enhancement in the irradiation dose leads to a suppression of the dielectric constant, with the replacement of β with γ particles resulting in a further reduction in ε. This phenomenon is attributed to an increase in the defectiveness of the crystal structure, and the observed difference in the efficiency of β and γ particles are attributed to the different penetration depths of these particles. The defect formation is likely to be charged, and the capture of charge carriers in the $CuInP_2S_6$ crystal is a probable consequence. This is manifested in the reduced electrical conductivity of the samples, which is reflected in the decrease in the high-temperature "tails" ε*(T) above 330 K, which are caused by the conductivity of the samples.

Neutron irradiation leads to more significant changes resulting in both phase transition blurring, a decrease in the phase transition temperature and the maximum value of the dielectric constant. This is most likely due to the transmutation of some elements in the $CuInP_2S_6$ crystals.

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