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# In memory of Professor Roman Levitskii: 1943–2022

On January 6th, 2023, our long-term colleague, Professor Roman Levitskii should have celebrated his 80th birthday. The present issue of Condensed Matter Physics, covering the recent advances in the physics of ferroelectricity and multiferroics, had been inspired by the Editorial Board's wish to mark this date with a collection of papers on the subject of his major interest throughout his long and fruitful life in science. As the collection had been prepared for print and the present paper was being written, a sad news arrived that after a long battle with diabetes Roman Levitskii passed away on October 28th, 2022. This is a big loss for us and for the entire scientific community of Ukraine. The present issue now becomes a tribute to our late friend and mentor and a bittersweet celebration of his lifelong achievements.

Roman Levitskii was born in 1943 in the village of Cherche, Ivano-Frankivsk region of Ukraine. In 1965 he graduated from the Physics Department of Lviv State University and became a post-graduate student at the Department for Solid State Theory of this University. His scientific career started in 1969 from the position of a junior research fellow at the Lviv Department of the Statistical Theory of Condensed Matter of the Institute for Theoretical Physics of Ukrainian Academy of Sciences. The Department, later transformed into the Institute for Condensed Matter Physics (ICMP), had just been formed. Roman Levitskii had been amongst the very first members of its staff and then became one of its most prominent figures. In his candidate dissertation (1971), supervised by Prof. I. V. Stasyuk, Roman Levitskii considered the problems of a dynamical theory of hydrogen bonded ferro- and antiferroelectrics [1, 2]. He defended his doctoral dissertation in 1990 and became a professor in 1997. In 1990 he organized the Laboratory for the Model Spin Systems Theory (Department since 1995) at ICMP and headed it until 2003.

Prof. Roman Levitskii's scientific achievements ranged from developing abstract mathematical approaches and investigating complex model spin systems with different types of interactions [3–7] to applying the developed techniques and describing experimental data for real objects, in particular, the ferroic crystals. For instance, the reference approach to the description of systems, where both short-range and long-range interactions are present, was proposed [8, 9], which allows to appropriately take these interactions into account. A consistent theory based on the Glauber dynamics approach and on the Zubarev nonequilibrium statistical operator techniques was developed for a description of the relaxational microwave dynamics of hydrogen bonded ferroelectrics [10, 11]. Both approaches were successfully applied for the description of the phase transitions, thermodynamic and dynamic characteristics of the ferroelectric and antiferroelectric crystals of the $KH_2PO_4$ family and of the $CsH_2PO_4$ type [12, 13] within the framework of the proton ordering and proton-phonon models [14–17]. The properties of the low frequency vibrations, including the soft mode, were explored. It was shown that the presence of strong short-range correlations in the system leads to renormalization of proton tunnelling as well as to suppression of the soft mode energy.

In the latest decades, the interests of Prof. Levitskii and his team that consisted of his former postgraduate students shifted to the phenomena associated with the influence of internal deformational effects, such as piezoelectric or electrostrictive couplings between polarization and strains, and of the external factors, such as electric fields or mechanical stresses of various symmetries, on the phase transitions and physical properties of ferroactive crystals. The investigations were first concentrated mostly on the hydrogen bonded ferroelectrics of the $KH_2PO_4$ family [18–22] and on the crystals, described by the Ising model with the asymmetric double-well potentials, such as Rochelle salt [23–25]. Deformable versions of the pseudospin models for those crystals were developed. The role of the H-bond geometrical parameters in the pressure-induced phenomena in the ferroelectric and antiferroelectric crystals of the $KH_2PO_4$ family was explored [18]. The physical importance of taking into account the piezoelectric coupling in the model calculations was most conspicuously demonstrated in the studies of the dynamic dielectric response of the ferroelectric crystals. This permitted to consistently describe, within a single approach, the entire frequency evolution of the dynamic dielectric permittivity, starting from the statics, via the piezoelectric resonances and crystal clamping onto the microwave relaxation region [24].

The major results of those studies as of 2008 were summarized in the monograph "The field and deformational effects in complex ferroactive compounds" by I. V. Stasyuk, R. R. Levitskii et al. [26]. The active investigations, however, did not stop there. The attention of the group led by Prof. Levitskii switched to other ferroic systems, such as GPI [27–29], $RbHSO_4$ [30], $PbHPO_4$ [31], and $CsH_2PO_4$ [32]. Deformable pseudospin models for those crystals were developed, and the influence of external electric fields and mechanical stresses on the phase transitions and on the physical characteristics of the mentioned systems was explored. Various caloric (electro-, baro-, piezocaloric) effects in the considered crystals were studied using the suggested non-linear modification [33] of the respective models. The combined effects of substitutional disorder, competing interactions, and piezoelectric coupling in the mixed ferroelectric-antiferroelectric systems of the $Rb_{1-x}(NH_4)_xPO_4$ type, exhibiting the proton glass region, were studied using the proposed unified deformable model [34, 35] with the introduced random strain-induced field.

Amongst other fields of science that Prof. Levitskii took interest, there stood out the application of the physics research methods in medicine, in particular, the usage of flourescence spectra of human blood serum in the diagnostics of purulent-septic complications of various diseases.

Prof. Levitskii was a very prolific mentor, as well as a perseverant organizer of scientific cooperation, and he unceasingly remained true to his passion. He was a scientific advisor to 12 aspiring post-graduate students, who later successfully defended their dissertations. Many of them continued to work in his group ever since. His influence on the formation of their scientific outlook and their approach to theoretical investigations is undeniable and lasting. His legacy of nearly 600 publications, of which about 100 papers in the Scopus database, was cited nearly 500 times [36] as of today, and will continue to be cited.

We express our deepest condolences to his family.

R.I.P.

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## List of main publications of Professor Roman Levitskii


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