

In memory of Isaak Mikhaïlovich Tsidil'kovskii

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Isaak Mikhaïlovich Tsidil'kovskii, a Full Member of the Russian Academy of Sciences, an outstanding scientist and a recognized authority in semiconductor physics died on October 30, 2001.

Isaak Mikhaïlovich Tsidil'kovskii was born on May 21, 1923 in the Rakitno village of the Kiev region in the family of a teacher. He lived his childhood and school years in the town of Belaya Tserkov' and, having graduated from secondary school in 1940, enrolled in the Kiev Industrial Institute. Great Patriotic War began as I M Tsidil'kovskii had just passed his exams for the first year, and he immediately volunteered to the front. In the Army in the Field he soldiered in the infantry, in the battle reconnaissance, and as a radio operator; he retreated with the army all the long way from the banks of the Dnepr river to Stalingrad and the Kalmykia steppes, and then retraced the long trek as occupied Ukraine and Belorussia were liberated; he took part in the Warsaw operation, and in the storms of Königsberg and Berlin. The last shots of the war sounded when he was in Prague. During the long four years at the front line, he was wounded twice and was several times seriously shell-shocked. In later life, he courageously resisted the consequences of these wounds.

After demobilization, I M Tsidil'kovskii continued his studies at the Physics Department of Kiev State University. His student years coincided with the start of rapid progress in semiconductor physics. Brilliant lectures and colloquia by Professors V E Loshkarev and S I Pekar determined Tsidil'kovskii's choice of the field of research. The initial work done in his student years (experimental study of photoconductivity and a solution of problems in the theory of transport phenomena) was typical of the scientific style of Isaak Mikhaïlovich: he invariably combined thorough preparation of an experiment with a profound theoretical interpretation of the results obtained.

I M Tsidil'kovskii found his own path in physics with his first independent steps made in the Dagestan Branch of the USSR Academy of Sciences in Makhachkala. On the advice of Academician A F Ioffe he began a study of thermomagnetic phenomena in semiconductors. He had to go through every stage of the basic work required of an experimenter — from growing his samples to building his measuring installations. In five years he was able to study a surprisingly broad class of semiconducting materials. Professor Vladimir Panteleimonovich Zhuze, one of the pioneers of semiconductor physics and known for his encyclopedic erudition and extensive experimental experience, worked in Makhachkala at the time and played an important role in Tsidil'kovskii's growth as a mature scientist. Isaak Mikhaïlovich was deeply grateful to Vladimir Panteleimonovich all his life and



Isaak Mikhaïlovich Tsidil'kovskii
(21.05.1923 – 30.10.2001)

dedicated one of his latest monographs, *Effective Mass Concept* (1999), to this unforgettable personality.

The pioneering work on the physics of thermomagnetic phenomena in semiconductors that I M Tsidil'kovskii has done in the 1950s proved conclusively all the advantages of these effects employed as subtle tools in studying the mechanisms of charge carrier scattering in solids. The novel field of solid state kinetics was born largely owing to this work of I M Tsidil'kovskii. Five years of research were summarized in his monograph *Thermomagnetic Phenomena in Semiconductors* (1959), the first literature in the world in this field; it was immediately translated into English and is important for researchers even today.

In 1957, the then Corresponding Member of the USSR Academy of Sciences S V Vonsovskii invited I M Tsidil'kovskii to remove to Sverdlovsk and fill a position at the Institute of Metal Physics. Here in 1960 I M Tsidil'kovskii organized the Laboratory of Semiconductors and Semime-

tals which soon became a recognized center of semiconductor research. In the 1960s, the laboratory led by I M Tsidil'kovskii carried out a large series of studies covering quantum transport phenomena in high magnetic fields, optical and microwave properties of semiconductors, and transport phenomena under the action of high pressure. The pulsed magnetic field facilities designed and built in the laboratory extended the admissible measurement range to 500 kOe. The researchers experimentally confirmed and thoroughly investigated a new type of magnetoresistance oscillations — the magnetophonon resonance, theoretically predicted by V L Gurevich and Yu A Firsov; they also discovered novel oscillational effects in kinetic coefficients due to weak multiphonon or spin–orbit interactions. New prospects opened in the work on the kinetics of the non-equilibrium system of ‘hot’ electrons in strong electric fields. The results reported in Tsidil'kovskii's papers gained recognition from colleagues all over the world, stimulated new experimental methods for investigating the electron and phonon spectra in semiconductors (the ‘magnetophonon spectroscopy’), which were extensively adopted in the largest research centers of high magnetic fields (Oxford, Grenoble, Stuttgart).

A recognizable signature of I M Tsidil'kovskii as a scientist was his striving for generalization, his searching for the main causes that predetermine the richness and diversity of electrophysical properties and the specific features of individual semiconductors. In 1972, I M Tsidil'kovskii published a fundamental monograph *Electrons and Holes in Semiconductors* covering the techniques of theoretical evaluations and experimental determination of the basic parameters of electronic spectra. This monograph won him the A F Ioffe Prize of the USSR Academy of Sciences.

In the 1970s, I M Tsidil'kovskii focussed his attention on studying a special class of gapless semiconductors and solid solutions based on them, with a controlled gap width. As early as in 1957 he experimentally demonstrated that the gap width of mercury telluride was anomalously narrow (it was later shown that it was exactly zero). However, the boom in the investigations of the gapless state was stimulated by the practical feasibility of synthesizing semiconductors with a prescribed gap width. Tsidil'kovskii and his group studied the electron phase transitions in gapless semiconductors subjected to high magnetic fields and high pressures, and also specific features of impurity states and the role played by impurity disorder in the formation of the electronic structure in gapless and narrow-gap semiconductor materials. In 1982, I M Tsidil'kovskii received the USSR State Prize for his important contribution to this new field of solid state physics.

Even though I M Tsidil'kovskii never worked on strictly applications-oriented problems, his physicist's intuition and immense experience allowed him to respond to topical trends; he was able to switch rapidly to new objects of research that promised much for applications. Over the last fifteen years his attention was attracted to the unusual properties of semimagnetic semiconductors doped with d-elements as impurities. A series of his publications on the electronic properties of semimagnetic semiconductors was awarded the M V Lomonosov Prize of the Russian Academy of Sciences (1994). The high sensitivity of the electronic states to the external magnetic field, temperature and doping level led I M Tsidil'kovskii to discovering and analyzing various types of metal–insulator transitions triggered both by external factors and by electron correlations. He made important

contributions to the solution of this problem which was fundamental for the entire condensed-matter physics and in fact still awaits a complete solution.

I M Tsidil'kovskii initiated research in high-temperature superconductors in his laboratory and played the most active part both in formulating experimental projects and in the theoretical interpretation of the results. He actively stimulated the rise of a field of research that was new for his laboratory: two-dimensional semiconductor structures, and followed very attentively the work of his students and colleagues in this direction and helped them generously in discussing the results achieved.

Isaak Mikhailovich Tsidil'kovskii successfully combined research and science management. For many years he was a member of the AS Learned Council on Semiconductor Physics, and sat on a number of editorial boards of journals in this country and abroad. I M Tsidil'kovskii founded in 1966 The Urals Winter Schools on Semiconductor Physics, which are run regularly and have gained international status in the last ten years.

In 1987, Isaak Mikhailovich Tsidil'kovskii was elected a Corresponding Member of the USSR Academy of Sciences, and in 1994 a Full Member of the Russian Academy of Sciences. Among his students, four now hold DSc degrees, and more than 30 hold PhD degrees.

The ten monographs published by I M Tsidil'kovskii form a most important part of his scientific achievement. The style of these books reflects the inner need for sharing his knowledge with others, so typical of the Russian intelligentsia: the books are excellently written and combine a conceptual approach, a depth of presentation and at the same time are made readable to a student.

Intense brainwork was the alpha and omega of Isaak Mikhailovich's life, while profound thinking and an intellectual conversation filled his soul with joy and satisfaction. The subjects for these could be most varied — philosophy, a good book or a chess composition to solve. Until the very last days of his life he worked hard, overcoming serious medical problems that were wearing him down. “Nulla dies sine linea” (not a day without a line written) was an ancient wisdom that he followed all his life. Literally a week before his death he completed the preparation for publication of a book on morality and ethics in today's world in general, and in its scientific segment in particular. Two hundred years after Immanuel Kant, his soul was occupied with the same two topics: “the star-studded skies above me and the moral imperative in me”.

His colleagues, friends and disciples will always keep warm and grateful memory of Isaak Mikhailovich Tsidil'kovskii.

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