Notes on Levich's biography

These notes highlight scientific aspects, mostly the evolution of research topics and mutual influence between the scientists. Unfortunately, it is impossible to avoid mentioning some grim aspects of the political history of USSR that had strong impact on the academic life at that time.

Before WWII

V.G. Levich graduated from Kharkov Univ in 1937, the same year when L.D. Landau was dismissed from that University and left for Moscow to join P.L. Kapitza in his Institute for Physical Problems. We can assume that Levich joined Landau group in Kharkov before these events, as mentioned in the memories of Yuri Rumer (1901-1985), Landau's close friend and colleague. We do not know whether it was in Kharkov, or later in Moscow, but in 1937 Levich passed all 9 exams of Landau's theoretical minimum, being the 6th in the chronological list (there are 43 theoreticians in total, whose exams were evaluated by Landau himself during the period of 1933-1961).

Landau supervised Levich's first thesis (equivalent of PhD) defended in 1941, despite spending a year in prison on political charges during this period (1938-1939). He was released only due to outstanding Kapitza's efforts. Levich's thesis "On the theory of interfacial phenomena" covers two essentially different topics. The first topic develops Landau's work on two-dimensional crystals, which are understood as Langmuir-Blodgett films. The second one is more macroscopic, as related to the effect of surfactants on hydrodynamic phenomena. This part includes the effects on attenuation of waves and on bubble movement, as well as the interpretation of viscosity of molecular films.

The surfactant effect was partly published already in 1940, the same year when Levich started his work in Colloidal Electrochemical Institute (later the Institute of Physical Chemistry, renamed in 1945). This institution was headed by Frumkin starting from 1939. Levich/Frumkin collaboration has surely resulted from the adsorption phenomena at the liquid/gas interface, which were studied by Frumkin and co-workers starting from 1920s. However, their first joint work published in 1941 already addressed the Ohmic drop near local elements in the course of metal dissolution at metal/solution interface, i.e. a purely electrochemical problem. We can assume that the intersections related to hydrodynamics in electrochemistry were also discussed from the very beginning of this cooperation.

During WWII

Levich continued his research in Kazan (capital of Tatarstan, near the Volga River) after the evacuation of scientists from Moscow in autumn 1941. Both Landau and Frumkin moved to Kazan as well. This resulted in the appearance of the most widely known Levich's results. One of them is presented in his 1942 article on dragging of a liquid by a moving plate, the **Landau-Levich effect**, which is of high technological importance. Another one is covered by a series of 1942-1944 articles on the **theory of concentration polarization**. This formed a basis for the quantitative rotating disc electrode (RDE) technique, which was indispensable for the further development of electrode kinetics, especially at solid electrodes.

1945-1957

This period was strongly affected by two factors: the "atomic project" (actively developed starting from 1943, when scientists started to return from evacuation) and "the fight with cosmopolitanism" (a vile antisemitic campaign started in 1947 and ceased only after Stalin's death in 1953; this document in Russian mentions Frumkin, Levich, and their colleagues directly). Before the start of the latter, Frumkin had been actively involved in the "atomic project" related research, and recommended Levich as a scientific secretary of the major state commission of this project. This,

unfortunately, implied access to some 'important secrets', which was later used by the Soviet authorities as the argument to forbid Levich's immigration.

Despite these troubles, an important electrochemical/hydrodynamic direction was developed during this period (Frumkin started it from the experimental and partly also from the theoretical side in 1930s, with B.P. Bruns and B.N. Kabanov). The initial Levich-Frumkin studies of the charged **mercury drop motion** (1945-1947) turned into the theory of various **polarographic phenomena**, including tangential movements of falling mercury drop and the idea of non-equilibrium 'double layer' in electrode kinetics.

In the beginning of 1947, Acta Physicochimica URSS, the journal publishing translations of the articles from Zhurnal Fizicheskoii Khimii, was discontinued. Therefore, many of the later articles by Levich never appeared in any language other than Russian. This action by the Soviet authorities was presented as a fight with the western influence on USSR.

Two important co-authors of Levich's from this period should be mentioned:

Naum Natanovich (Nakhim Sanelevich) Meiman (1912-2001). A talented mathematician and a friend of Landau, later a leading person in computations for the "atomic project", he was affiliated with the Institute of Physical Chemistry for several years after WWII. Two versions of his initials, N.N. and N.S., can be found in publications.

Boris Vladimirovich Derjag(u)in (1992-1994). He is widely known for his studies of colloid systems, including the Derjaguin–Landau–Verwey–Overbeek (DLVO) theory, which started from the 1941 article by Derjaguin and Landau on the stability of sols. He worked at the Institute of Physical Chemistry (previously, Colloidal Electrochemical Institute) starting from 1936.

1958-1972

This was a period of the foundation and flourishing of the Theoretical Department in Frumkin Institute, see here all research directions and people of this Dept. Concurrently, Levich also published with coauthors beyond the Dept staff. Only a scarce information about these coauthors can be found:

Yuryi Borisovich Ivanov co-authored seminal articles on the rotating ring-disc electrode. His PhD thesis "Some questions on the convective diffusion in liquids" was defended in 1958.

Jaroslav Koutecký (1922-2005) was a scientist from the Czech Republic known for his works on polarography (he worked with Rudolf Brdička), and also for his contribution to molecular science/quantum chemistry. His personal fate was very complex. After the Soviet invasion to Prague in 1968, he left for USA, and later moved to Free Univ, Berlin.

Yuryi Ivanovich Yalamov (1932-2009) was later known as an expert in colloid science, who co-authored many articles with famous Boris V. Derjagin (see above). Levich's works with Yalamov are on the theory of polyelectrolyte solutions.

Boris Izikil'evich Khaikin (1931-1980) completed his PhD thesis in 1963 on the theory of electrode processes complicated by chemical reactions in the bulk. A series of articles with Khaikin is linked to Levich's works of the previous period, addressing various particular cases of the electrode kinetics on the dropping mercury electrode. One of these works is also coauthored by *Stal' Grigor'evich Mairanovskii* (1926-1990), a very keen experimentalist working in the field of polarography. Later, Khaikin moved to the Institute of Chemical Physics in Chernogolovka scientific center, and worked in A.G. Merzhanov's lab that eventually became the Institute of Structural Macrokinetics in 1987. This was a very active branch of chemical physics dealing with combustion and explosion processes. Khaikin's topic was the thermo-diffusional theory of the gas-free and filtrational combustion.

Vladimir Veniaminovich Tolmachev was the first member of Levich's chair of chemical mechanics at the Faculty of Mechanics and Math in Moscow state University. He was a theoretician originating from Bogolyubov's school.

Alexander Mefod'evich Golovin was the former Levich's PhD student from the Moscow Institute of Engineering Physics, invited immediately to Moscow State University when Levich founded his chair Here are Golovin's historical notes (*in Russian*).

Z.Ch. Grabovskii is the transcription of the Polish name Zbigniew Ryszard Grabowski (1927-2017). His original name was Ryszard Adolf Abrahamer, and his father was lucky to get the documents of Czesław Grabowski to escape from ghetto, see this dramatic family story here. Grabowski's fields were mostly photochemistry, chemical kinetics, and spectroscopy. He worked in the Institute of Physical Chemistry in Warsaw. In his early studies, he used electrochemical techniques as well. Grabowski is acknowledged in Levich's Introduction to the 1959 edition of "Physicochemical hydrodynamics". Another co-author, Andrzej Bylina from the same Institute, was unfortunately forgotten and mentioned only in an erratum.

Iosif Veniaminovich Strizhevsky (1919-1996) was a graduate of Moscow Mechanical Institute (the precursor of the Moscow Institute of Engineering Physics), known for his works in two applied fields. First, he worked on the corrosion problems related to underground constructions, pipelines, and other oilfield equipment. Second, he developed electrochemical transducers, i.e. devices using electrochemical responses/signals to transform information. In Strizhevsky's publications, one also finds the name of *E.Ya.(Ia.) Klimenkov*, who seems to be a person from math/hydrodynamics.

Veniamin Petrovich Mi(y)asnikov (1936-2004) graduated from the faculty of mechanics and math, Moscow University, and continued at this Dept, cooperating with Levich's chair until its closing in 1972. He worked in some fields close to Levich's physicochemical hydrodynamics (in particular, multiphase systems) and also was dealing with reactor engineering problems. Later he moved to the Russian Far East and served as the director of the Institute of Automation and Control Processes in Vladivostok.

Evgeny Dmitrievich Belokolos (Yevhen Dmytrovych Bilokolos) is the graduate of the Moscow Institute of Engineering Physics, later affiliated for a long time with Bogolyubov Institute of Theoretical Physics in Kiev, and also with some other institutions in Ukraine. His research field is mathematical physics.

Khristo (Christo) Boyanov Boyadj[zh]iev from the Institute of Chemical Engineering, Bulgarian Academy of Science, was a trainee in Levich's Dept in mid 1960s. He defended his PhD thesis "The influence of surfactants on the hydrodynamics and mass transfer in laminar films" in Moscow in 1968, and continued to work with V.S. Krylov up to the untimely death of the latter in 1985. Their joint topic was non-linear mass transfer

Eduard Markovich Podgaetskyi defended his PhD thesis "Electrochemical systems with adsorption corresponding to nonlinear isotherms" at the Institute of Electrochemistry in 1973. He worked at the Institute of applied Mechanics.

Nikolay Grigor'evich Mazur is affiliated with the Schmidt Institute of Earth Physics, Moscow. He defended his PhD thesis in the Institute of Electrochemistry in 1972. His topic was mostly mathematical, related to Lillie-Bonhoeffer model, which was assumed to describe excitation propagation in the nerve fiber, as related to the development of bioelectrochemistry.

Boris Mozesovich (Mikhailovich) Davidovich (1945?-2020) graduated from the faculty of mechanics and math, Moscow University. He is most known for his important role in the development of math-specialized secondary schools. He was a long-time teacher in one of the two most famous math

schools in Moscow, school No 57. He is the co-author of the 1998 book on mathematical analysis for specialized schools.

Sergey Khachaturovich Aityan is a person with mathematical background, who completed his PhD thesis (1975) related to the theory of membrane transport in Frumkin Institute, and later DSc thesis (1986) on the same topic. He works in USA starting from early 1990s, mostly in the field of computed science. He was affiliated with Lincoln Univ in 2004-2022, and started in Northeastern University in 2023.

Lev Isaevich Krishtalik (1927-2022) was a leading experimental electrochemist of the Frumkin Institute, who collaborated actively with Theoretical Dept in the field of electron transfer theory.

Anvar Kasymovich Madumarov was a graduate of the Faculty of Physics, Moscow University (1966). In addition to the article from Levich's list, he co-authored at least two articles with Yu.I. Kharkats. One of them in Molecular Biology (Rus) 1972. V. 6. P. 347-353 has very general title "On the theory of enzyme catalysis" and co-authored by M.B. Vol'kenshtein and R.R. Dogonadze. He defended his PhD thesis on the concert mechanisms in catalysis in the Institute of Chemical Physics in 1973. Than he most probably moved to Tashkent.

At this stage we failed to find any information about V.A. Lopatin and V.M. Rybakov, who were also among Levich's co-authors.

1972-1978

At this point, one has to explain the usual USSR practice with respect to people who applied for permission to emigrate. These people were immediately dismissed from their positions and banned from any further employment. They had to wait for their permission without a job, and without any unemployment benefits as well. This is just what happened to V.G. Levich, who had been waiting for his permission from 1972 to 1978. His sons got permissions earlier, but with very serious troubles. Scientists from all over the world tried to help Levich via various public manifestations of his recognition. One of these manifestations (J. Electrochem. Soc. 120 (1973) 277C) was as follows:

JOURNAL OF THE ELECTROCHEMICAL SOCIETY

REVIEWS AND NEWS — SEPTEMBER 1973

Benjamin G. Levich Named Recipient 1973 Palladium Medal Award

Benjamin G. Levich, Institute of Electrochemistry, Academy of Sciences of the U.S.S.R., has been selected by The Electrochemical Society as its 1973 Palladium Medalist.

The Palladium Medal was established in 1951 by the Corrosion Division of the Society, and is now one of the four major awards of the Society. It is awarded every two years in recognition of distinguished contributions to the field of Electrochemical Science and Corrosion. The Award consists of a Palladium Medal and a nickel replica thereof, both bearing the recipient's name and the sum of $1500.

Previous winners have been Carl Wagner, Max Planck Institut fur Physikalische Chemie; N. H. Furman, Princeton University; K. F. Bonhoeffer, Max Planck Institut fur Physikalische Chemie (posthumous award); A. N. Frumkin, Academy of Sciences of the U.S.S.R.; H. H. Uhlig, Massachusetts Institute of Technology; N. Hackerman, Rice University; P. Delahay, New York University; T. P. Hoar, Cambridge University; and most recently, Leo Brewer, Lawrence Berkeley Laboratory, University of California.

Born in 1917, Benjamin G. Levich graduated from the Physics Department of Kharkov University in 1937 and received the degree of Doctor of Philosophy in Theoretical Physics under Professor L. D. Landau at Kazan University in 1943. He has, since then, been associated with the Institute of Electrochemistry of the Academy of Sciences of the U.S.S.R. as Professor of Theoretical Chemistry, Head of the Institute, and Corresponding Member of the Academy, and with the Department of Theoretical Physics of the Moscow Institute of Engineering Physics as Professor of Theoretical Physics. He is currently a Vice-President of the International Society of Electrochemistry.

In a distinguished career, Dr. Levich has engaged in an extraordinarily broad range of studies of both fundamental and practical scientific importance. His most notable achievements have been in the field of physicochemical hydrodynamics—the study of the effects of fluid motion on chemical and physicochemical transformations and of the effects of physicochemical factors on the motion of fluids. Here he has led in the development of a new area of research, whose relevance to engineering science he has consistently appreciated. With a clear understanding of the principles underlying physics and chemistry and with unusual physical insight, he has utilized bold approximations and incisive mathematical analysis in dealing with a variety of heat and mass transfer problems of concern to chemical engineers and electrochemists, striving continually for lucid interpretations and useful generalizations.

To cite only a few examples of his work, he has studied the motion and break-up of drops, jets, and bubbles in fluid media, the transfer of heat in liquid metals in turbulent flow, the damping of waves by surface active materials, and the coagulation of dispersions in turbulent flow, each of these with due regard for its practical ramifications. His studies of convective diffusion in heterogeneous systems have been particularly outstanding and, in the field of electrochemistry, have formed the basis for many of the important developments of recent years. His theory of rotating-disk and ring-disk electrodes provided a new and now widely used technique for the quantitative study of adsorption, film formation, corrosion, electrodeposition, and reaction kinetics and mechanisms in general. Similarly, his mathematical analysis of current distribution in electrolytic cells has led to new concepts and understanding in the interpretation of localized corrosion phenomena and in the design and usage of electrolyzers, batteries, and fuel cells.

In other aspects of electrochemistry, Dr. Levich has made important contributions to the quantum mechanical theory of electron and proton transfer where he has been particularly concerned with the elucidation of the effects of coupled electronic and nuclear motions. In his mathematically elegant approach to these complex phenomena, he has paid specific attention to the role of ion solvation and to the part played by the energy levels of metal and semiconductor electrodes in electrochemical kinetics. Here, as in much of his other work, he has provided insight into the fundamental processes on which a large and valuable technology is based.

Dr. Levich's scientific career has, to a large extent, coincided with the rapid growth of research in the area on the border between physics and chemistry and with the increasing application of the results of this research to engineering technology. In his books and in his numerous publications, Dr. Levich has contributed notably to these developments to the point that today his work forms the basis for hundreds of investigations being carried out throughout the world. His studies, moreover, have set a high standard of ingenuity, clarity, and utility for the workers who have followed him.

Another manifestation was this special issue J. Electroanal. Chem. 82 (1977) No 1-2.

After 1978

Levich's late activities had nothing to do with electrochemistry. He was formally affiliated with Tel-Aviv University long before his arrival to Israel, and his first publications with Israeli coauthors appeared already in 1976. This co-authorship was continued later, when he moved to USA. The available information about his coauthors of this period is as follows.

Alexander J. Babchin had a chemical engineering specialization in Russia. His PhD work (Moscow, 1966) was devoted to rheological properties of photographic emulsion layers. He worked in Technion for some period after emigration, and later he moved to Canada. He mostly worked for companies.

Michael A. Piliavin was affiliated with Weizmann Institute in mid 1970s, and then moved to USA, where he worked in optical technology companies.

Alexander L. Frenkel, a graduate of Novosibirsk University (1969), completed his PhD in the field of relativistic cosmology in Bogolyubov Institute for Theoretical Physics (Kyiv, Ukraine) in 1976. He

emigrated to Israel in 1979, worked in the Levich Inst in New York in 1981-1989, and finally received a permanent position at the Dept of Math of the University of Alabama.

Gregory (Grigoryi, Grisha) I. Sivashinsky moved to Israel in 1971, being a graduate of the Faculty of Mechanics and Math of Moscow State University. His first 1970 article "On the development of detonation in a non-uniformly preheated gas" was coauthored with Ya. B. Zeldovich. Gregory completed his PhD in fluid mechanics in Technion in 1974, and spent all his life in Tel-Aviv University, dealing with the problems of combustion and flame instability. T. Slang, the co-author of one joint article with Levich, has two preceding works with Sivashinsky.

Yan Kishinevsky, the coauthor of the last Levich's article published post mortem in 1990, was affiliated with New York Power Authority. He moved to Burns and Roe Enterprises, Inc later.

See below some memorial notes from Nature that mention the Benjamin Levich Institute, which is still very active.

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These notes are work in progress and will be updated whenever additional information becomes available. Please, feel free to contact us (et120659 [at] gmail.com) if you would like to share any relevant pieces, such as photos of Levich's collaborators and their biographies.

Benjamin Levich (1917–1987)

BENJAMIN Levich, the most highly placed 'refusnik' scientist to be allowed to emigrate from the Soviet Union, died on 19 January. Levich was known internationally for his work in physicochemical hydrodynamics, which he was the first to establish as a separate scientific discipline. His research activities included gas-phase collision reactions, the quantum mechanics of electron transfer and the development of a rotating-disk electrode as a tool for research.

By 1972, he had attained the post of Professor of Chemical Mechanics at Moscow State University (the chair was created especially for him), and was a corresponding member of the Soviet Academy of Sciences. But in that same year, after consultations with his wife Tanya and his sons Alexander and Evgenii, he decided to apply for emigration to Israel.

Immediately his teaching post was abolished, he was demoted to the rank of a 'scientific worker', and shortly afterwards his younger son Evgenii was illegally transported to a military camp in the Soviet Arctic. Levich was informed that he would never be allowed to emigrate, because of his knowledge of state secrets.

A campaign for the Levich family was organized by Dr Brian Spalding of Imperial College London. This campaign attracted considerable attention, particularly when it became known that western publications including *Nature*, distributed in photostat form in the Soviet Union, had all references to Levich deleted from them. But the campaign was suddenly halted with the news that Levich had reached a gentleman's agreement with the emigration authorities: if the public outcry ceased, Alexander and Evgenii would be allowed to emigrate at once together with their wives, and Benjamin and Tanya would follow a year later. But when the time came for the senior members of the Levich family to emigrate, the Soviet authorities denied any knowledge of such an agreement.

In 1977, a conference on physicochemical hydrodynamics was held in Oxford, in honour of Levich's 60th birthday. Such an honour is virtually a matter of routine for scientists of his rank in the Soviet Union, but, in his circumstances, no Soviet honours could be expected. The conference was so successful scientifically that it was decided to launch a regular series of Levich conferences. The second was held in Washington, DC in 1978, and within three weeks, Benjamin and Tanya Levich arrived in the west. They settled first in Israel, where Levich had a chair reserved for him at Tel Aviv University, and in 1979, he accepted the Albert Einstein chair of physics at New York City College, commuting regularly between the United States and Israel. Shortly after he took up this post, however, his wife Tanya had to have massive heart surgery, from which she never fully recovered. She died in 1984.

Vera Rich

These notes were published in Nature, 325 (1987) 485 (text copied above) and 327 (1987) 176 (right column).

Name change to recognize Levich's contribution

New York

Dr Benjamin Levich, once the highest ranking Jewish refusnik scientist in the Soviet Union, and latterly a holder of one of the five Albert Einstein professorships at the City University of New York (CUNY), will be permanently commemorated at New York City College — the CUNY campus where he taught in his last years. City College's Institute of Physico-Chemical Hydrodynamics, which was established in 1979, when Levich came to New York, and which has from the beginning been known informally as "Levich's institute", is now to bear his name officially. This change of name was announced last week at a memorial colloquium for Levich, who died earlier this year.

The "Benjamin G. Levich Institute of Physico-Chemical Hydrodynamics" will continue working in the field pioneered by Levich, which relates the physical properties of a flow to the chemical processes taking place in it. As the papers presented at the colloquium showed, Levich's research sparked interest in aspects of the subject ranging from helicity on vortex flows to the transport phenomena of two-phase systems and to the reflection of pulses from random media — a subject with significance for seismic surveying.

Just 10 years ago, far from commemorating Levich's name in the field for which he had done so much for Soviet science, the Moscow authorities set about removing his name from the literature altogether. Not only were his books withdrawn from circulation, but references to his work were excised from Soviet publications — and his name was blanked out from articles in Western journals before photocopies were distributed. This unusually severe reaction was probably because of his position as a corresponding member of the Soviet Academy of Sciences.

In 1977, when Levich was 65 — a birthday which in normal circumstances would have been honoured by a special conference in the Soviet Union — his colleagues and supporters abroad decided to hold a birthday conference *in absentia* in Oxford. This proved so successful, from the scientific point of view, that it was decided to hold regular biennial Levich Conferences in physico-chemical hydrodynamics.

When he was eventually granted permission to emigrate, Levich accepted a professorship at Tel Aviv University, Levich supervised research both in Tel Aviv and at City College, and the link between the two institutions will continue at least for a time, as his son, Dr Evgenii Levich, also has academic commitments to both.

Vera Rich