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Rostislaw Kaischew and his trace in the fundamental science. A brief historical overview of the genesis and rise of Sofia School of crystal growth

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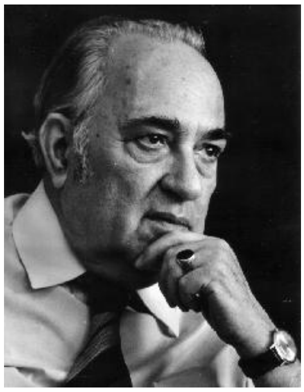
The process of nucleation and growth of crystals is one of the most exotic phenomena in nature. Starting from disordered ensembles and small clusters of single atoms and molecules, matter organizes itself in beautiful figures and shapes with immaculate symmetry and ordering, ideal cubes, pyramids, needles, dendrites. These ensembles of crystal shapes and their divine beauty attend our entire being and consciousness, our entire life, they are everywhere around us. This incredible art of nature is generated spontaneously, without any influence of human mind, thinking, desire or action. Why is this occurring and how? Where the science meets the unfathomable loveliness and marvelous aesthetics of the art of crystal growth? A substantial contribution in answering these fundamental questions of condensed matter physics is given by a very bright generation of Bulgarian scientists in the last century [1-8].

In the 1930s in Bulgaria originated the famous Sofia School of Crystal Growth, founded by the Bulgarian scholars prof. Iwan Nikolow (Nicola) Stranski and prof. Rostislaw Atanasov Kaischew. Brilliantly developed later, it is among the few internationally known substantial Bulgarian contributions in the world's scientific history. How this school has been established? How an internationally acknowledged scientific team, setting up the fundamentals of a novel theory in the field of solid state physics, phase formation and crystal growth is affirmed in times of wars, communist regimes and Berlin wall? How do the names of its founders Iwan Stranski and Rostislaw Kaischew manage to stand abreast with the names of Josiah W. Gibbs, Walther Kossel, Yakov I. Frenkel, Max Volmer and Frederick C. Frank? Exploring these questions and primarily unriddling the genesis of the scientific schools by the psychological and personal image of their founders has great educational, historical and moral standing. This is because the birth and rise of the scientific schools and their ideas mirror the noetic values of mankind at the actual historical time [9-12].

Prof. Iwan Stranski and prof. Rostislaw Kaischew, the founders of the most famous Bulgarian scientific school have a dramatic personal and scientific destiny. Their illustrious academic and research activity plays a key role in Bulgarian science as well as in the development of the most important scientific institutions – the „St. Kliment Ohridski" University of Sofia and the Bulgarian Academy of Sciences [2,4,5].

Iwan Nikolow (Nicola) Stranski



Rostislaw Atanasov Kaischew

Prof. Rostislaw Atanasov Kaischew was born on February 29th 1908 г. In Sankt Petersburg in the family of captain Atanas Kaischew and Mrs. Anastassia Hadjimarinova. Both the genealogical lines of the Kaischew's and the Hadjimarinov's families are rather interesting. The roots of the Kaischew's ancestry have a history time line of more than 250 years in the Rhodope's village of Chokmanovo, near Smolyan – a calm, peculiarly picturesque site in the Rhodope mountain, beyond the vanity and temptation of the modern world, urging the human mind to thoughtfulness, contemplation and existentialism, exciting curiosity and cognition [13,14].

This small mountain village with almost 100 inhabitants (94 in 2011, but 941 in 1934), placed on

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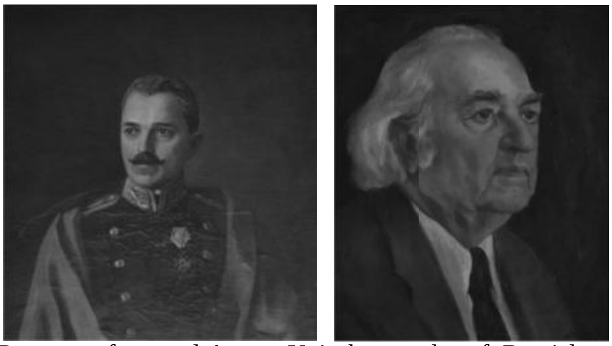
sunny hills around green meadows and with several small churches, has given birth to a remarkable number of scientists, writers, art directors, physicians, musicians, artists. The Chokmanovo village manifests specific intellectual singularity with all the gifted persons born there. Only the people with academic rank and degree, originated from this very small village, are more than 20 [14]. The Kaischew's family also belongs to this unique ensemble of remarcable personalities.

Chokmanovo village and the Kaischew's family house, 2014 г.



Portrays of general Atanas Kaischew and prof. Rostislaw Kaischew in the municipality of Chokmanovo village.

In 1905, the father of prof. Kaischew, Captain Atanas Kaischew is recruited to Sankt Petersburg, where he graduates with excellence „summa cum laude" from the General Staff Military Academy. A few months after Rostislaw was born in 1908, the family returns to Bulgaria. General Atanas Kaischew takes part in the first and second Balkan wars and World War 1, later he is promoted as a Chief of the Military Academy in Sofia, professor in the General Staff Academy and one of the most prominent Bulgarian military experts. The mother, Mrs. Anastassia Hadjimarinova also originates from a famed Bulgarian family of large landowners and merchants from the region of Stara Zagora. In 1913 the family moves to Sofia. Their son Rostislaw graduates from high school in Sofia and matriculates at the Department of Physics and Mathematics of Sofia University. In his third years he attends the lectures in physical chemistry of Iwan Stranski, recently appointed as a professor at the University.

Iwan Stranski Rostislaw Kaischew, 1939

At that time, Stranski involves Kaischew in scientific activity and between them grows a tight collaboration and, later, an amity. Their first joint paper, entitled "On the equilibrium shapes of homopolar crystals", initiated already in the time of the student years of Kaischew, is published in 1931 [15]. After his graduation from Sofia University, Kaischew accepts a Humboldt scholarship, recomended by Stranski, and in 1930 leaves for Berlin to the famous scholar and keen connoisseur of thermodynamics, Francis Simon.

Simon is a person with exeptional individuality and flavor, disciple of Walther Nernst, the founder of the Third Law of Thermodynamics. In 1931 Simon becomes a professor of physical chemistry at the Laboratory of Low Temperatures at the University of Breslau (presently, Wroclaw, Poland). Two years later, in 1933, he moves to the famous Clarendon Laboratory at the University of Oxford, invited personally by Frederic Lindemann. Later, in 1956, he becomes head of the Laboratory. Simon performs extraordinary, pioneering research in the field of low temperature physics. He succeeds to liquefy helium for the first time in the world by means of a system of magnetic cooling, based on adiabatic demagnetizing. Together with his assistant, Nicolas Kurti, he attains experimentally a temperature of 1μK (one micro kelvin), which is considered as a feat of the experimental physics at the time. Simon investigates and introduces the basic method for separation of uranium isotopes via gaseous diffusion and production of uranium-235. He is one of the principal scientists, taking part in the physical design and creation of the nuclear bomb with the so-called „Manhattan Project“ [16].

Sir Francis Simon (the man with the hat at the second row) at the annual meeting of the Bunsen Gesellschaft, may 1928 in Munich, accompanied by Walther Kossel, Kazimierz Fajans, Peter Debye, Fritz London. (G.F.Hund, https://commons.wikimedia.org).

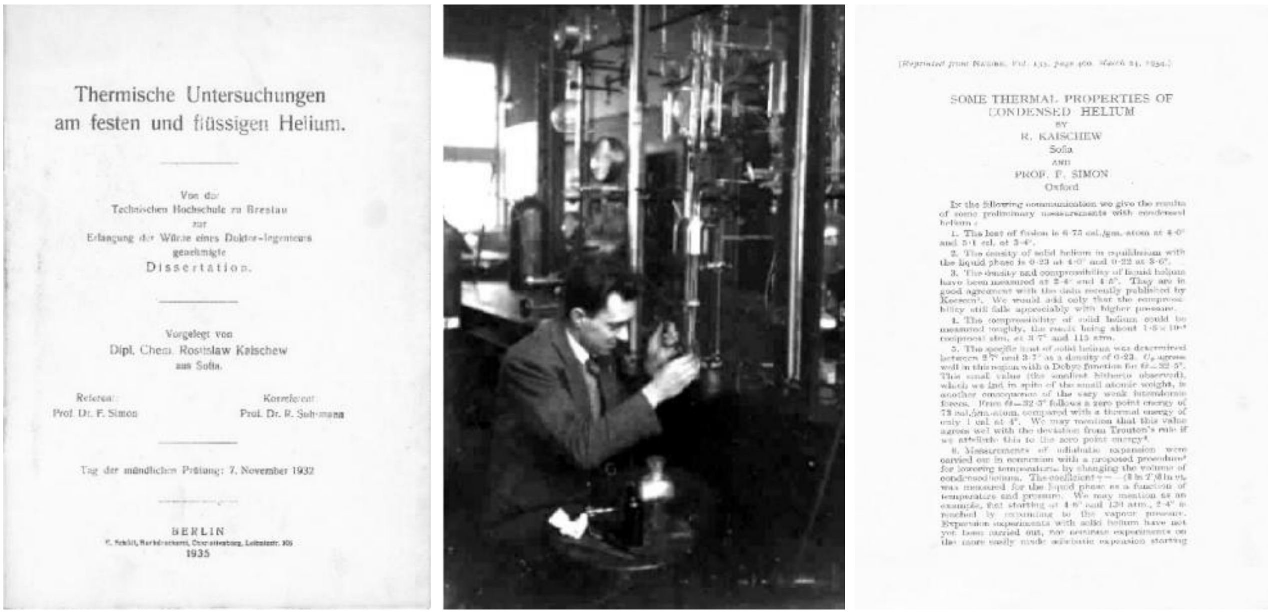
As a disciple of Francis Simon, Kaischew lands in the surroundings of notable researchers and gains a great opportunity for academic development and scientific life. In Berlin he attends lectures by Nernst, London, Simon and Bodenstein. In March 1931 Francis Simon is invited to head the Institute of Physical Chemistry at the University of Breslau and his entire research group, including the assistants Nicolas Kurti and Kurt Mendelson as well as the doctoral students Heinz London (brother of the famous Fritz London who introduced London‘s forces) and Rostislaw Kaischew, moves there.

Rostislaw Kaischew at the University of Breslau, 1931.

Reining in that group are excellent scientific ambiance and sincere, artistic relations. There, Kaischew starts for the first time in the world the study of the basic thermodynamic properties of liquid and solid helium. In these pioneering studies, he determines experimentally the density and the heat of fusion of solid helium in equilibrium with the liquid phase, its specific thermal capacity, compressibility and other fundamental physical quantities. These experiments open up a way to estimate the so-called „zero entropy“ in the Nernst' theorem – a subject of a large discussion at that time. Kaischew‘s results will be used later in the interpretation of the Nernst-Simon formulation of the Third Law of Thermodynamics, in the form that a thermodynamic process, bringing a system to the absolute zero temperature by means of a finite number of steps, is impossible [16].

Kaischew defends his doctoral thesis on November 7th, 1932 with excellence „summa cum laude” and becomes the first doctor of the Institute of Physical Chemistry at the University of Breslau. The results of his dissertation are published in the famous journal “Nature” in 1934 in collaboration with Francis Simon - „Some thermal properties of condensed helium“. Let us point out that it has been possible to publish even preliminary results in “Nature” in these years [17].

During his stay in Breslau, Kaischew maintains active correspondence with Stranski, who is in Berlin at that time. In this way is completed their first theoretical study. The paper ”On the equilibrium shapes of homopolar crystals", published in "Zeitschrift für Physikalische Chemie" in 1931, marks the beginning of the theory of mean separation works [6, 15]. It is shown for the first time in this paper, that only atoms or molecules bound stronger than in the site of half-crystal position (kink), can belong to an equilibrium crystal shape. This definition of equilibrium formulated in a completely new way, different from that of the classical thermodynamics of Gibbs, i.e. by the binding energy of a separate single element of the crystal lattice (atom or molecule) will lay the cornerstone of the entire construction of the new molecular theory of crystal growth.



Thermische Untersuchungen
am festen und flüssigen Helium.

Dissertation.

Vorgelegt von
Dipl. Chem. Rostislaw Kaischew
aus Sofia.

Prof. Dr. F. Simon

Tag der mündlichen Prüfung: 7. November 1932

BERLIN
1935

SOME THERMAL PROPERTIES OF
CONDENSED HELIUM
BY
R. KAISCHEW
Sofia
AND
PROF. F. SIMON
Oxford

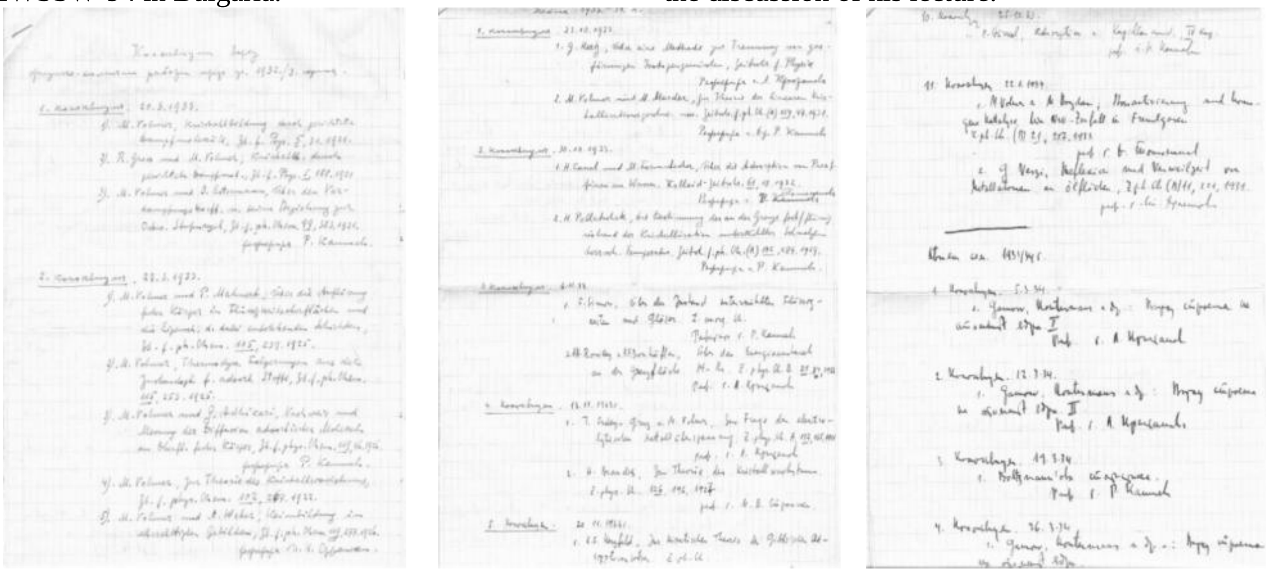
The doctoral thesis of Kaischew, Breslau, 1932 (left), Kaischew at the Low Temperatures Laboratory, Breslau, 1931, (middle), the publication of Kaischew and Simon in Nature, 1934 (right).

The time spent in Breslau, in Simon's group, shapes the basic path of scientific evolution of Kaischew's life characterised by deep involvement in the world of scientific thought. Being a part of a research team in which many of its members Heinz London, Nicolas Kurti and Kurt Mendelson will become Fellows of the British Royal Society, and Nicolas Kurti its vice-president (1965-1967), Kaischew gains a remarkable start for scientific activity and career. Furthermore, he shapes his personality in environment of extremely variegated and often exotic cultural interests. Besides his achievements in the field of low temperature exprimental physics, Nicolas Kurti becomes one of the founders of the so-called "molecular cuisine", moderates a number of cooking shows on BBC and organizes the first colloquium on "Molecular and Physical Gastronomy", held in Erice, Italy in 1992 [18]. Kurt Mendelson becomes famous with his treatise on the origination and construction of the Egypt Pyramids, too [19].

Already affiliated intellectually to the cultural and scientific values of the Western world, Kaischew returns to Bulgaria and enters the Department of Physical Chemistry of Sofia University, headed by prof. Iwan Stranski. Kaischew starts his career as a volunteering assistant, without any emolument. Only six months later, the efforts of Stranski with the Ministry of Education succeed and Kaischew is inaugurated as a full-time assistant at the Department. At that time, the oldest scientific colloquium in Bulgaria is instituted, still existing today as the „Stranski-Kaischew Colloquium on phase formation and crystal growth". This informal forum of discussions, with its first members Iwan Stranski, Rostislaw Kaischew, Stefan Christov, Lubomir Krastanov, Dimitar Totomanow, will play later a key role in the creation of entire generation of researchers. The topics of the discussions are not restricted to phase formation and crystal growth, but cover a broad range of contemporary, cutting-edge problems of condensed matter physics and physical chemistry.

The time between 1933 and 1936 is the most valuable period of the research collaboration between Kaischew and Stranski. This remarkable scientific communion and empathy result in a ceaseless friendship. Thus, in a sequence of five papers in 1934, are presented the basic ideas and models of the theory of mean separation work [6, 20-24]. The new theoretical model of Stranski and Kaischew considers for the first time the equilibrium and the growth of the new phase at the molecular level, from the viewpoint of the kinetics of elementary steps in phase formation and crystal growth. Furthermore, it complements in a perfect way the classical Gibbs thermodynamic model of phase formation, demonstrates the identity of the two models and thus attains a great physical importance. 60 years later these envisaged model concepts will be visualized at the atomic level by the brilliant Scanning Tunneling Microscopy experiments of Joost Frenken, presented at the first "East-West Surface Science Workshop", EWSSW'94 in Bulgaria.

In 1935 Kaischew leaves for three months to Kharkiv, to the Physical and Technical Institute of Ukraine, recommended by Martin Rueman, senior assistant of Simon. There Kaischew works on the adiabatic effect of nitrogen expansion at liquid helium temperatures. During his stay in Kharkiv, he gives a lecture on the method of mean separation work, presenting the results obtained under the guidance of Iwan Stranski. There he meets for the first time the famous theoretical physicists Lev D. Landau and Evgeni M. Lifshitz, who take part in the discussion of his lecture.



The original record and part of the lectures presented at the Colloquium of Physical Chemistry in 1932/1933 at the Department of Physics and Mathematics of Sofia University.

After five years career as a full-time assistant at Sofia University, Kaischew attains the possibility for a sabbatical year abroad. So, he leaves for Germany in 1937 with a Humboldt scholarship to prof. Klaus Clusius at the Institute of Physical Chemistry of Munich University. Clusius is a student of Arnold Eucken of Göttingen, and later is the leading scientist and the head of the German experiments on the production of heavy water. Together with his assistant Gerhard Dickel he develops the method of separating isotopes by means of thermal diffusion. In the Clusius group, Kaischew retains his interest in the field of low temperature physics and investigates the crystallization of carbon monoxide by slow condensation from the gaseous phase and the conversions of condensed hydrogen halides by means of polarization microscopy. These studies are published in the "Zeitschrift für Physikalische Chemie" in 1938 and 1939. This sabbatical year in Munich spent in the bachelor company of two other scholarship fellows and his friends Sazdo Ivanov and Georgi Bradistilov is one of the happiest periods in the life of Kaischew. With his return to Sofia at the end of September 1938 comes the end of his romantic student's life. From now on, he starts his own, individual way, the most important and most interesting part of his life leading to the creation of the Sofia School of crystal growth.

Looking into Kaischew's life in science, it is important to consider the more general question, that of the birth and rise of scientific schools. Is it an individual feat and goal of a single highly erudite person, just a prodigy, or a natural, synergetic process of self-organization of highly capable and motivated team of researchers following the same scientific ideas in the presence of a distinguished leader with strong personality and character? How does the generation, development and recognition of a scientific society which designates the tracks of scientific vogue in a given field depend on the enviroment in which it exists? A retrospective survey on the Sofia School of crystal growth would throw a light on these heuristic questions.

Science is a luxury exercise of the human soul, set up with time, assiduity, curiosity and moral. It is a state of constant dreaming. Allegiance to science and the affiliation to the academic world is, in itself, a great human privilege, based on the desire and ability to study oneself in relation to the structure, logic and aesthetics of the world outside. It is a far, long-distance mental horizon overreaching the everyday existence and the personal life. However, the individual ability of contemplation and reasoning is not sufficient for the construction of cognitive image of the nature. The retrospection shows that fundamental human knowledge is often formed not by individual achievements and discoveries, but by scientific schools that provide direction, style and meaning of the scientific research. The formation and development of these schools determines the understanding of fundamental laws of the ambient world for prolonged periods of time. This process of self-organization of knowledge is an archetype of the human soul, occurring as a result of the capability of thought to arrange and construct various logical and physical models and to project their evolution in different temporary and spatial directions. Therefrom stems the essence of the scientific schools, namely heuristic classification of knowledge in a particular scientific field, creation of highly competent scientific environment, setting the direction and dynamics of the discussions in the field, and formulation of the scientific paradigms at a particular historical moment. In this way the scientific schools outline and decorate the ranges of human knowledge in historical context [9-12].

A basic feature of every scientific school is its ability to attract and educate young researchers. It should be emphasized that the scientific schools do not represent simply an aggregation or a team of gifted researchers. Teams of scientists exist in many research laboratories around the world. The presence of various scientific ideas, theoretical models, experimental observations and experienced researchers is by far not a sufficient condition for genesis of a scientific school. Going back in the history of human knowledge, we observe that the formation of scientific school is a rather complex phenomenon, grounded on an ensemble of scientific paradigms, competence, imagination, academic freedom and particular taste for research. These characteristics, however, are still not enough. The presence of a glamorous, authoritative and influential personality is compulsory to attract researchers, to focus scientific curiosity and most of all to guarantee academic freedom and unrestricted discussions for all researchers. This excites a strong synergetic behavior along with cognitive and mental processes leading to a very distinctive heuristic state of the scientific school. In that state, as a result of interaction and integration between knowledge and intuition of separate investigators, the specific scientific school has the opportunity to create a more general (to some extend) picture and scenario of the phenomena in a given field, to depict the outlines of the future scientific reserarch and finally to rationalize the scientific curiosity.

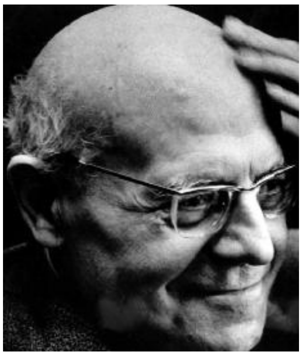
Let us point out that the outstanding feature of such ensemble of sinergy-associated shcolars cannot be obtained by simple gathering or just assembling of well-known theoretical and experimental models, all created by individual skilled researchers. The only real recognition of any scientific school is its influence on the international scientific community and the worldwide credit for its achievements. Furthermore, the great scientific schools are distinguished not only by their contribution to specific field of knowledge, but also by their impact on the entire human knowledge and human values [9-12].

In line with the above psyhological path of the genesis of scientific schools, the birth and evolution of the Sofia School of crystal growth could be classified scientifically, thematically and historically in three time periods, each of them having its specific scientific achievements and own research glory and drama. It is important to stress, however, that Kaischew's great supervisory power and style are natively governing the scientific ambience in all these periods. In some cases his attendance is a strong motivation for the researchers, in others it is a wall against mediocrity, speculation and conjecture, and in others it is just a great emotional reminiscence of the old times of nascence of the School.

The first period (1927 – 1944), marked by the initial development of the molecular theory of crystal growth, has a remarkable pre-history. The time when Kossel and Stranski introduced the concept of 'kink' or 'half-crystal position' that would play a fundamental role in the study of the nucleation and growth of crystals, is a time of impetuous rise of new ideas and discoveries in the physical sciences.

In 1927 the Belgian Jesuit cleric Georges Lemaître creates the Big Bang theory for the birth of the Universe. The principles of the quantum theory are formulated in 1925 - 1927 and accepted by the international physical community, after dramatic discussion, at the 5th Solvay Conference in 1927. The electron microscope is invented by Ernst Ruska in 1933, Paul Dirac predicts the existence of antimatter in 1928. Entirely new model concepts about the crystal structure are developed by the solid state physics. In 1918 Erwin Madelung studies the interactions in the crystal lattice of sodium chloride and defines the "Madelung constant", relating the electrostatic potential of interaction to the parameters of the crystal lattice. Max Born and Otto Stern introduce in 1919 the definition of surface energy by means of the energy of creation of new surface at splitting the crystal along a certain, well-defined crystallographic plane.


Walther Kossel


Iwan Stranski

The Wulff theorem for the polar diagram of the specific surface energy of a crystal is introduced in 1901 (it has been proved much later by Herring, 1956) [7,8,25,26]. All these impressive scientific discoveries prepare the creation and development of a new molecular-kinetic theory of crystal growth as one fundamental theoretical model in the solid state physics. The introduction of this theory is not an accidental phenomenon. It follows however the heuristic logic and appears as a part of the whole remarkable ensemble of scientific achievements generated during the thirties and forties.

Such is the dynamics of the physical research in the world, when the Department of Physics and Mathematics of Sofia University becomes one of the international scientific centers, where the molecular-kinetic theory of crystal growth emerges and develops (1927 – 1941). At that time Kossel and Stranski introduce the separation work of the crystal building units as a measure of the crystal lattice energy and determine the separation work for an individual structural element in the special, "kink" position on the crystal surface. These quantities are crucial for understanding the proposed new model of crystal growth at the molecular level. They form the basis of the theory of mean separation works, developed later in the thirties, which demonstrates the first kinetic treatment of the equilibrium and growth of crystals. A remarkable advantage of this theory is that it gives for the first time a clear notion of the basic phenomena in crystal growth at the molecular level by considering a maximally simplified model crystal, namely the Kossel crystal. Furthermore, the new theory opens the way to estimate the interaction energies between the particles setting up the crystal lattice. One of the most beautiful outcomes of the theory of Stranski and Kaischew is that it reveals and proves the identity of the classical Gibbs thermodynamic approach with the kinetic treatment of phase formation. On that background, the most fundamental and intriguing problems in nucleation, equilibrium shape and growth of crystals, thin film formation and epitaxy may be studied in great detail.

Stranski and Kaischew publish their great theoretical papers in the field of phase formation and crystal growth during the period 1931 – 1936. As already mentioned, in their first joint paper, published 1931 in Zeitschrift für Kristallographie, „On the equilibrium shape of homopolar crystals", they show that only atoms, bound more strongly than those in the kink position, can belong to the equilibrium shape [15]. On the basis of these calculations, the method of mean separation works is introduced, which reveals a remarkable agreement of the theoretical with the experimentally observed shapes of various metal crystals, grown via condensation from the gas phase. The introduced mean separation work, a quantity determined from the disassembling of the outermost rows of growth units at the periphery of a two-dimensional crystal, provides the possibility to formulate, by means of kinetic reasoning, the Gibbs-Thomson equation for the equilibrium of small, finite-size crystals, as well as the Gibbs-Wulff theorem for the equilibrium shape of crystals. With the mean separation works, it becomes possible to determine the supersaturation dependence of the energy barriers for attachment or detachment of growth units (atoms or molecules) at various positions on the crystal surface. In this way, the probabilities of nucleation and dissolution of arbitrarily sized two-dimensional and three-dimensional nuclei on a crystal surface can be calculated. Thus, the crystal nucleation and growth rates are determined for the first time from kinetic point of view. Kaischew publishes the first papers on the kinetic treatment of the nucleation of crystals and gaseous bubbles together with Stranski in 1934 [6].

One of the most famous and striking achievements of the Sofia School of crystal growth during this period is the unveiling of one of the basic mechanisms of nucleation and growth of thin epitaxial films. The mechanism of layer-by-layer growth of ionic crystals of NaCl is unravelled in detail in an original paper of 1939, summarizing the PhD thesis of Lubomir Krastanov, done under the supervision of Iwan Stranski. Although the phenomena of epitaxial growth are not directly discussed in a proper way in the paper, the mechanism of nucleation and growth of lattice planes of heteropolar ionic crystals, proposed therein, represents a realistic physical model of heteroepitaxial growth. This gives a reason to Ernst Bauer in 1958, in his classification of the basic growth modes of thin epitaxial films grounded on the subtle competition between the surface energy of the substrate, the film, and the interface between them, to name the Stranski-Krastanov growth mechanism this extremely frequently occurring mechanism of heteroepitaxial film formation [27-29].

This mechanism explains the initial stages of transition from two-dimensional, layer-by-layer growth mode (Frank-Van der Merve) to three-dimensional (Volmer-Weber) mechanism of heteroepitaxial films formation. Thus, depending on the ratio of cohesion and adsorption energies of the atoms of the crystalline phase and on the misfit between the lattices of substrate and film, one or several two-dimensional, entirely completed monolayers are formed at the epitaxial interface, followed by the nucleation of three-dimensional clusters. This very frequently encountered mechanism of growth of thin epitaxial films follows directly from the remarkable paper of Stranski and Krastanov in 1939.


ОТЛАГАНЕ НА ЙОННИ КРИСТАЛИ ЕДИНЪ ВЪРХУ ДРУГЪ

AUSSCHEIDUNG VON IONENKRISTALLEN AUFEINANDER

Inaugural-Dissertation


ВЪРХУ ТЕОРИЯТА ЗА ОТЛАГАНЕ НА ЙОННИ КРИСТАЛИ ЕДИНЪ ВЪРХУ ДРУГЪ.

Увод и поставяне на задачата.

The “great trinity” – Rostislaw Kaischew (left), Iwan Stranski (middle) and Lubomir Krastanov, the dissertation of Krastanov (middle), and the original Stranski-Krastanov paper of 1939 (right).

The achievements of Stranski, Kaischew and Krastanov, the “great trinity” (see the picture) in the field of phase formation, presented so far, mark the beginning of the Sofia School of crystal growth. Kaischew is appointed as a private docent (associate professor) at Sofia University in 1941, regular docent in 1944, and professor in 1947. During that time, as well as for a long time after, he is involved in extensive teaching and university activity. In the period 1944 - 1962 he is head of the Department of Physical Chemistry at Sofia University. His lectures on physical chemistry, delivered many years keep on being a basic source for the education of young researchers and doctoral students in this field. It can be stated that at the end of the 1930s, having published the main papers on the model of mean separation work, Kaischew is a well-established scientist already. From this time on begins the second period in the rise of the Sofia School of crystal growth, covering the time from 1944 to 1990.

The endowment of Kaischew to organize scientific investigations, to formulate problems, to introduce significant topics, to assess and involve gifted people in research teams around himself and most of all to make science according to West European standards develops and expands in admirable way when the Department of Physical Chemistry is constituted at the Institute of Physics of the Bulgarian Academy of Sciences (BAS) in 1947. As head and founder of the Department, he appoints his first collaborators: Jordan Malinovski, Boyan Mutaftchiev and Dimitar Nenov, as well as the laboratory assistant Valentin Hitov. Later, Alexey Scheludko, Georgi Bliznakov and Evgeni Budevski join them. These Kaischew’s disciples become the core of the established later, in 1958, Institute of Physical Chemistry of BAS. In the following years some of them, doing pioneering research, succeed to launch brand new directions in the physical chemistry of surface phenomena (A. Scheludko), photographic processes (J. Malinovski), electrochemical kinetics (E. Budevski), quantum theory of electrode processes (S. Christov). These new research lines comprise the image of the Bulgarian physical chemistry during the twentieth century. As mentioned, the Department of Physical Chemistry of the Institute of Physics has been transformed in the autonomous Institute of Physical Chemistry in 1958, and prof. Rostislaw Kaischew is appointed as its first Director. Herewith begins the best organized, scientifically and thematically structured period in the development of the already existing Sofia School of crystal growth.

The foundation of the Institute of Physical Chemistry follows the line of natural expansion of successful scientific investigations. The aim was to concentrate and motivate tightly the research in the fields of thermodynamics and kinetics of phase formation and crystal growth on the ground of already well-established scientific teams and their proven achievements. Five departments are formed under the leadership of prof. Kaischew: Department of Phase Formation and Crystal Growth, Department of Surface Phenomena and Dispersion Systems, Department of Physical Chemistry of Photographic Processes, Department of Electrochemistry, and Department of Kinetics and Catalysis. The initial subject line of the Institute follows the development of the existing theory of phase formation and the model experiments planned to prove the fundamental concepts in the field of crystal growth. Leading role at this stage of the history of the Institute plays the remarkable and versatile scientific erudition of Kaischew, allowing infallible and intuitive treatment of the core of scientific problems. His direction follows the sense and the clear formulation of the problems, the collaborators are always included in the process of discussion and decision making – a feature, which is often lacking in the scientific management of researcher teams.

Kaischew's scientific and administrative management transform the Institute of Physical Chemistry into a leading scientific structure in Bulgaria, where the development of the school of crystal growth founded by Stranski and himself is maintained. How should an internationally respected scientific institution be constructed to become an academic standard in the Bulgarian science? As already mentioned, two basic prerequisites are necessary for that – availability of a competent and leading personality and capable assistants. Kaischew owns both. His talent and willingness to fascinate young people for research is remarkable. Kaischew lures his collaborators not with rapid career or monetary promises, but with the sense of what they are doing. The strength of this talent is revealed not only by his purely personal qualities, but most of all by his ability to point out and demonstrate the horizon of any scientific research. The particular problems are turned to merely steps towards the main task of the scientific study. This feature of Kaischew‘s scientific style is a strong motivation for his collaborators. Kaischew does not allow for mediocrity and sets extremely high scientific criteria at the Institute of Physical Chemistry. This large-scale scientific style would be impossible without another feature, which is ever less frequently encountered in our time. This is his uncompromising honest attitude towards the results of any research. His erudition does not allow scientific dodging. But maybe most impressive is his aptitude to acknowledge his own fault, when something turned to be different from his ideas. Kaischew never published incomplete results or results without clear physical interpretation. Furthermore, Kaischew requires himself to be deeply and tightly convinced in the physical rationality of the models providing the results. A good example of this attitude is the so-called "rebellion of the young". At the end of the 1950s part of the young collaborators - Malinovski, Scheludko, Budevski, Bliznakov - express their discontent, because they have worked hard and accumulated a huge amount of experimental results, which however are not published, because not everything has been explained and interpreted. Kaischew reacts emphatically: "Out of question, you may publish! I do not object. But without me!" [4]. It is difficult to find a better proof of scientific style and honourability. This is the ambiance, in which begin the most important years in the development of the Sofia school of crystal growth.

The scientific style of Kaischew, built up in Europe and directed towards fundamental scientific problems, is in clear conflict with the formal scientific policy of the communist regime in Bulgaria in the 1960s, known as "science for the people". Kaischew succeeds to find a compromise and to preserve the fundamental studies at the Institute. In a very clever way, he constitutes a special department for applied research, thus formally consenting with the required public image of "studies for the practice and for the national economy". In this way his collaborators doing fundamental research are not compelled to deal with, often preposterous, applied and industrial problems. However, the most important achievement and great benefit of this fine and complicated process of juggling are the very good relations between the collaborators dealing with fundamental and applied research. He persuaded all scientists in the institute that the applied studies can be successfully performed only in close relation and interaction with the fundamental investigations. This was also proven by a number of excellent works done by the Department of Electrochemistry that solved in spectacular way many technologically essential problems. Possessing a good understanding about the significance and the long distance horizon of fundamental science, Kaischew succeeded to keep it at the Institute and to ensure calm and comfortable environment for research. In this environment, his most gifted disciples Evgeni Budevski, Jordan Malinovski, Boyan Mutaftchiev, Ivan Gutzow, Svetoslav Toschev, Dimitar Nenov and later on Dimo Kashchiev, Ivan Markov, Stoyan Stoyanov, Alexander Milchev, Christo Nanev form their own research style and notable scientific achievements. In this way, a remarkable reputation for the Institute is built up in the country and internationally, too. One of the most distinguished students and a coworker of Kaischew, Boyan Mutaftchiev after emigration in France conducts in the 1980-90s a number of Laboratories and research teams in the field of phase formation and crystal growth at the French National Center for Scientific Research, CNRS, (Centre National de la Recherche Scientifique) in Marseille, Nancy and Paris. The raising of collaborators with their own scientific face and profile is a particularly important quality of Kaischew style, which proves to be very significant for the creation of scientific school.

In this atmosphere at the end of the 1950s and the beginning of the 1960s starts up the development of unique experimental methods for studying morphological changes of crystal surfaces and determining their growth rate, the double-pulse method for kinetic investigations of electrochemical nucleation, the capillary technique for electrochemical growth of single crystals. All these novel methods play a key role in the later long-time experimental investigations of various aspects of the nucleation and crystal growth phenomena. New studies are initiated revealing the impact of adsorption of foreign particles during the growth of crystals and the role of the active centers for condensation in the formation of crystal nuclei.

One of the most remarkable achievements of the Kaischew School in the 1960s are, however, the brilliant experiments on electrocrystallization, revealing the mechanisms of crystal growth by two-dimensional nucleation and spiral growth. The capillary method of growth of silver single crystals with separate dislocation-free crystal faces, created by Kaischew, Budevski and their collaborators, as well as the obtaining of crystal faces intersected by a single screw dislocation allow to demonstrate, study and prove in a spectacular way the two basic mechanisms of crystal growth, namely, the layer-by-layer growth by two-dimensional nucleation and the screw dislocation growth [6,30-33]. These experiments settle one of the most famous scientific discussions open by Sir Charles Frank during the Bristol conference of the British Royal Society in 1949 about the role and significance of these two fundamental mechanisms of crystal growth. These experiments of the Sofia School are presented today in every textbook on crystal growth.

In the middle of the 1960s, Jordan Malinovski and Ivan Konstantinov started new exciting investigations of the mechanism of the photographic processes in silver bromide single crystals. They made a notable contribution in the study of the “latent image” in the photographic processes, i.e. the invisible image, formed by irradiation of photosensitive materials, which is visualized later by means of chemical or physical development. The unique results demonstrate the essential role of the so-called photo-holes the generated by light irradiation modification of silver halides. The formulated new theory is acknowledged in the photographic science as the “Malinovski symmetric scheme”, which accounts for the contribution of both electrons and photo-holes.

This impressive development of the studies in the field of phase formation and crystal growth at the Institute of Physical Chemistry gives birth in 1967 of two new, separate Laboratories – the Central Laboratory of Electrochemical Power Sources and the Central Laboratory of Photographic Processes. Founders and leaders of these laboratories are the most brilliant disciples of Kaischew – Evgeni Budevski and Jordan Malinovski. These two internationally recognised scientists initiate entirely new directions in the fields of electrocrystallization and photographic processes. It has to be noted however, that the new scientific organizations appear undoubtedly as a result of Kaischew’ scientific role and style, academic spirit and uncompromising, tight scientific criteria. These laboratories, graduated from the Kaischew School with “summa cum laude”, turn to be the prodigy of the Institute of Physical Chemistry. Another of the most promising colaborators, Georgi Bliznakov, heads the Institute of General and Inorganic Chemistry in 1960, and the Department of Kinetics and Catalysis moves there. Later, in 1983, this Department is transformed into a separate Institute at the Academy of Sciences. With the creation of these individual scientific institutions begins the time of expansion of the Sofia School of crystal growth.

In the 1960-70s the closest collaborators of Kaischew succeeded to attract young physicists and chemists, talented and well-motivated, just graduated students, to the Department of Phase Formation and Crystal Growth. They join the Kaischew team with a great ardor and eagerness to grow up in knowledge. The Kaischew team of this Department is called by their colleagues from other academic institutions “the Kaischew gang”. They have the attitude that they belong to a different scientific environment, maintaining high scientific criteria, free communication, good-humored curiosity and profound knowledge. A particular role plays the still active Colloquium on Phase Formation and Crystal Growth founded by Stranski, as mentioned, as far back as in the 1930s. This Colloquium keeps on being the academic location for specialized discussions of a broad range of ideas not merely from the field of crystal growth, but also from materials science, soft matter physics, biophysics and computer modelling.

Enirely new leading lines of investigations are formed in the following years at the Institute of Physical Chemistry. Studies on formation and development of morphological instability of the growing crystals, the atomistic theory of nucleation in electrocrystallization, theoretical and experimental studies of non-stationary effects in nucleation, the mechanisms of epitaxial growth, atomic structure and properties of epitaxial interfaces, surface diffusion phenomena turn to be dominant accents. An expression for the non-stationary nucleation rate is derived, which is widely used in the understanding of the results on crystallization kinetics. A general theorem of nucleation is proven, connecting the nucleation work, supersaturation and nucleus size. Being generally accepted in the literature and it is used in studying the formation of bubbles, droplets and crystals, since it does not involve any theory to determine the nucleus size. Studies are initiated in the field of glassy state, crystallization of glass and new materials of glassy ceramics.

Investigations of the processes of phase formation by means of computer modelling start at the Institute of Physical Chemistry in the 1980-90s. For the first time it is possible to solve exactly a number of “insolvable” problems that could not be approached theoretically due to the unavoidable approximations needed for the formulation of the theory. With this novel and powerful method, complex phenomena in thermodynamics and kinetics of crystal growth are studied, such as two-dimensional phase transitions, atomic surface roughness, growth of epitaxial films, two-dimensional surface alloyng at epitaxial interfaces, thermodynamic properties of atomic clusters, nanocrystals, structure and properties of quantum nanowires and nanocomposite materials, diffusion transport phenomena, structure of interfaces, macromolecular and biological systems.

The third period in the development of the Sofia School of crystal growth starts in the 1990s, coinciding with the withdrawal of prof. Kaischew from active scientific work and administration as a Head of the Institute in 1989.

Still, the large-scale way of thinking inherited from Kaischew, leads and motivates his collaborators in the establishment of new interdisciplinary topics that expand the scientific activity of the Institute of Physical Chemistry. Several research teams are formed dealing with the crystallization of proteins, electrochemical formation of conductive polymer films and metal-polymer nanocomposites, atomistic simulations of diffusion phenomena at epitaxial interfaces, modelling the structure and thermodynamic properties of nano-sized atomic clusters, quantum nanowires and polymer systems. Applying basic thermodynamic and kinetic models of the classical theory to new objects, such as protein crystals or thin conductive polymer films, quantum atomic nanowires, biopolymers and biological systems, results in revealing– new important regularities in Nature.

The scientific ideas and results of the scientists belonging to the Sofia school of crystal growth are presented in thousands of publications in renowned international journals, book chapters, monographs and review papers. Since the formation of the Institute of Physical Chemistry in 1958, its members have published over 3 400 scientific papers in specialized and referred scientific editions, cited over 35 000 times by other authors. Distinguished disciples of prof. Kaischew, icluding Evgeni Budevski, Boyan Mutaftchiev, Ivan Gutzow, Ivan Markov, Dimo Kashchiev, Alexander Milchev, Georgi Staikov, issued in most renowned scientific publishers their monographs as originating from the Department of Phase Formation and Crystal growth at the Institute of Physical Chemistry [34-40]. Collaborators and disciples of Kaischew in the Department of Crystal Growth, including Andrey Milchev, Stoyan Stoyanov, Christo Nanev, Isak Avramov, Vessela Tsakova, Michail Michailov, have been invited to write book chapters and reviews, devoted to modern fields in surface physics, crystal growth, electrocrystallization, computer modelling of interfaces, crystallization of proteins, etc., based on the investigations in the Institute of Physical Chemistry [41-52]. The inherited scientific style motivates the members of the Kaischew School to keep this publication activity, despite of the grave financial pressure and the public contempt felt by the scientific community in Bulgaria during the last twenty years.

The story of creation and raising the Institute of Physical Chemistry and particularly the Department of Phase Formation and Crystal Growth has one extra dimension besides the purely scientific features. It is due to the remarkable charm and strong personality of Rostislaw Kaischew. Without taking into account this dimension, the narrative of the general development of the Sofia School of crystal growth and the Institute of Physical Chemistry would have an ordinary, commonplace and maybe even trite, character. Following this phychological line, it is worth noting one of the most striking features of prof. Kaischew's character. This is his fine ability to mix the academic discussions with human sentimentality. On the face of it, this sentimentality seems to be in conflict with the exacting academic view of Kaischew, his strong physical and psychological presence, the scientific erudition and strong, tight physical argumentation during the discussions. Simultaneously, Kaischew possessed a very emotional nature and this was by far not pretended. Being immanent to his inner world, this extraordinary sentimentality was aroused from his attitude toward music, mountains, skiing, nature and the personal life of his collaborators. The mixture of academic rigor and fine, delicately discernible emotion turns Kaischew into a fascinating example for all his collaborators. His presence in the soul and being of the collaborators was evident in the everyday meetings and conversations, but exclusively in the time of the unforgettable workshops and symposia in Varna, Gyulechitsa and Pamporovo, organized enthusiastically by all collaborators of the Institute. Kaischew could narrate unobtrusive and captivating interesting stories about his life as young man, his mentors and meetings with celebrated scientists, his travels and wanderings in Rila or Pirin mountains, the musical analysis on Bach, Schubert, Brahms and Chopin, the interpretations of Glenn Gould and Dinu Lipatti. The haughtiness of sagacity, usually emitted by the elderly was lacking in these narrations.

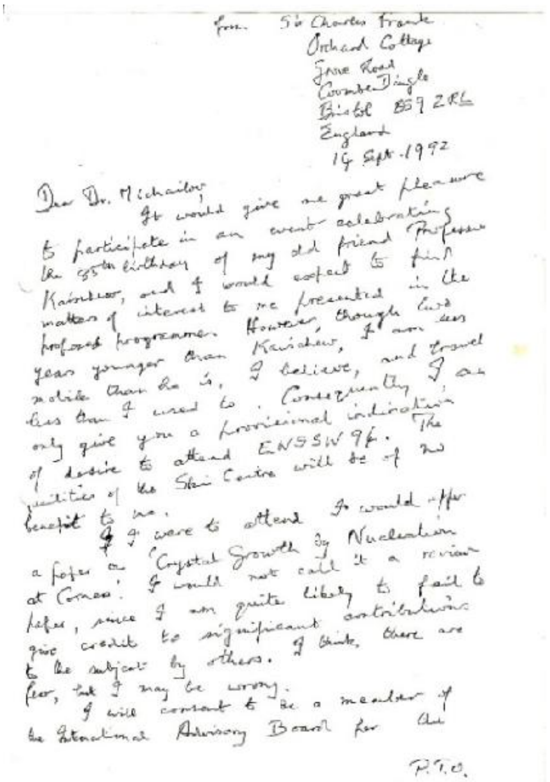
The scientific conversations with him have always been exceptionally interesting. During the discussion of a particular problem, Kaischew was able intuitively to create a specific dramaturgy and to incite curiosity, invoked by philosophical, historical and moral topics parallel with the research problem. He was able to dominate, even to obsess the scientific imagination of the audience. His presence in the Institute created in everybody confidence and feeling of affiliation to a unique research team, an ambiance not existing in the other academic institutions. The members of the Department of Phase Formation and Crystal Growth were dubbed among the colleagues "the classicists" or "the Kaischew gang". Kaischew demonstrated that for him happiness and gladness are a question of character, but the sense lies in the seeking. There were, of course, such people who could not accept his academic enchantment, intelectual power and scientific erudition. Most of all, those were people far below his class, who were simply envious.

The discussions in the Colloquium of Phase Formation and Crystal Growth presented an emanation of Kaischew's criteria and style in science. His comments on the reports and lectures always touched the physical core of the problem and demonstrated a remarkable insight into the scientific value and the limits of validity of the problem discussed. Even without entering into the details of some model investigation with more complex mathematics, Kaischew succeeded to find its place in the general physical image of the phenomenon and, before all, whether the results of the study are in conflict with the physical reality or the scientific paradigm. As a result of this enormous erudition, he was capable of formulating the scale of the investigation. In this way, the researchers could build a notion about the horizon of their particular tasks and thus to find and enhance their own motivation.

The formulation of the molecular theory of crystal growth and the following dynamic developments at the Institute of Physical Chemistry have created a great reputation for Kaischew abroad. In 1992 on the occasion of the EWSSW international conference on surface physics, organized by the Department in Pamporovo Ski Center, I received a letter from Sir Charles Frank (FRS), the famous Frank who created the theory of dislocation growth of crystals, where he writes: "It would give me great pleasure to participate in an event, celebrating the 85th birthday of my old friend, Professor Kaischew".

The respect of Frank was not only expressed in the words "my old friend", it has been a respect to Kaischew's work together with Stranski. It can be seen in the original edition of the British Royal Society „The Growth of Crystals and the Equilibrium Structure of their Surfaces", by W. K. Burton, N. Cabrera, F. C. Frank [7].

In this remarkable survey on more than 60 pages, cited more than 5000 times in the scientific literature, published in 1951 in Philosophical Transactions, only 34 fundamental studies in the field of crystal growth are referenced. Among these carefully selected papers, next to the names of Gibbs, Kossel, Bethe, Volmer, Onsager, Frenkel, Kramers, Knudsen and Max von Laue are the names of Kaischew and Stranski with their papers, published in Z. Phys. Chem. 136, 259 (1928) and Z. Phys. Chem. (B) 26, 31, (1934). With these papers, Kaischew and Stranski were already a part of the world history of phase formation and crystal growth.

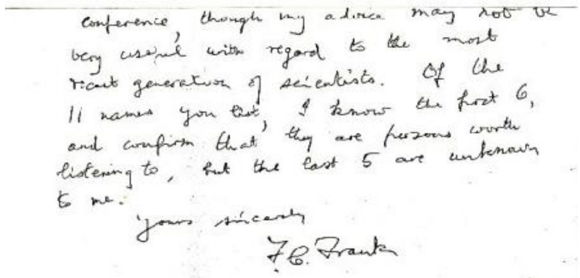

from Sir Charles Frank
Orchard Cottage
Grove Road
Coombe Dingle
Bristol BS9 2RL
England
19 Sept. 1992

Dear Dr. Michailov,
It would give me great pleasure to participate in an event celebrating the 85th birthday of my old friend Professor Kaischew, and I would expect to find in the matters of interest to me presented in the proposed programme. However, though I am less years younger than Kaischew, I believe, and travel mobile than he is, I believe, and I am less than I used to. Consequently, I can only give you a provisional indication of desire to attend EWSSW 94. The facilities of the Ski Centre will be of no benefit to me.

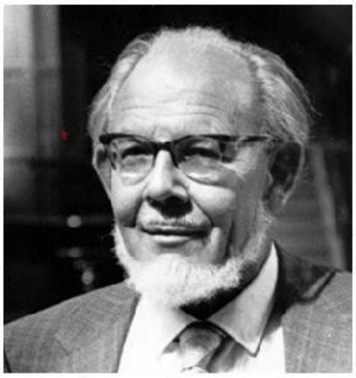
If I were to attend I would offer a paper on 'Crystal Growth by Nucleation at Corners'. I would not call it a review paper, since I am quite likely to fail to give credit to significant contributions to the subject by others. I think there are few, but I may be wrong.

I will consent to be a member of the International Advisory Board for the

P.T.O.


conference, though my advice may not be very useful with regard to the most recent generation of scientists. Of the 11 names you list, I know the first 6, and confirm that they are persons worth listening to, but the last 5 are unknown to me.

Yours sincerely
F.C. Frank

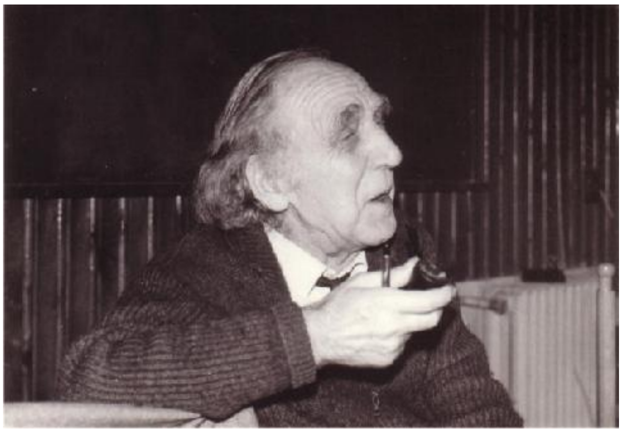

Sir Frederick Charles Frank, RSF

A letter of Sir Charles Frank to Michail Michailov on the occasion of the 85th birthday of prof. Kaischew and his participation in the „First East-West Surface Science Workshop“, EWSSW 1994, in Pamporovo, Bulgaria, organized by the Department of Phase Formation and Crystal Growth.

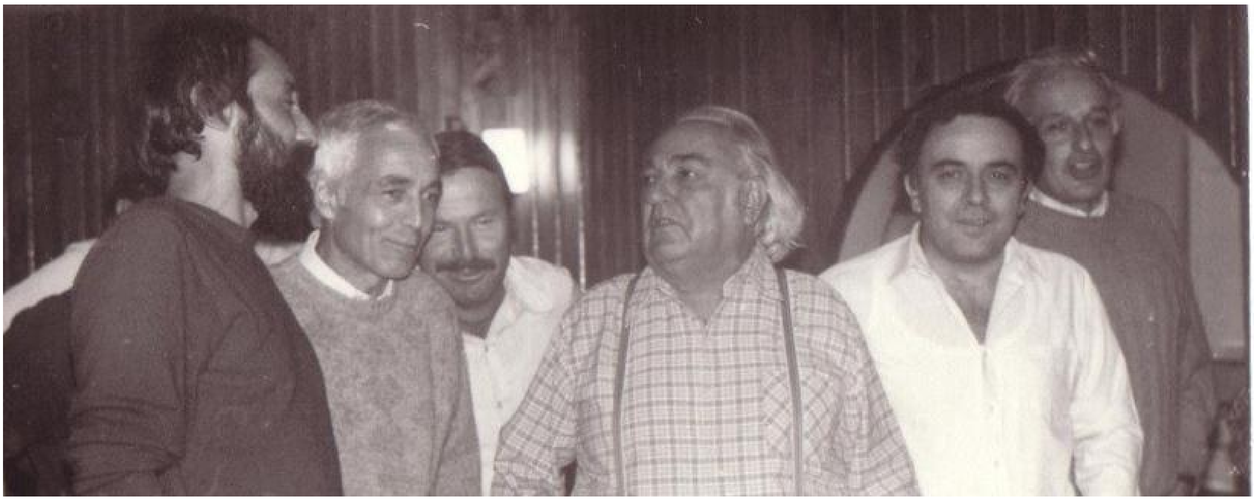
Between many foreign scientists and friends such as the notable Max Volmer, the great electrochemist Alexander Frumkin, the Nobel Prize holder Jaroslav Heyrovsky, Peter Rebinder, the encyclopedic Yakov Zeldovich, there were two who have a special place in Kaischew’s heart and played significant role in his life – Heinz Bethge and Alexander Chernov.

Kaischew and Bethge proved to be persons of similar size and spirit as people and scientists. In the 1980s, Heinz Bethge studies experimentally in great detail and visualizes a number of basic phenomena in crystal growth, including model concepts of the molecular theory, by means of scanning, reflection and transmission electron microscopy, (SEM and TEM) in Halle, East Germany. Particularly, the decoration with gold atoms at monoatomic steps and screw dislocation on the surface of sodium chloride crystals was of great importance. The relation between Kaischew and Bethge was particularly strong and was based not only on their personalities, but also on significant scientific interest. Heinz Bethge was President of the famous German National Academy of Sciences “Leopoldina” from 1974 till 1990. Kaischew was a member of that academy since 1968 and was awarded with the prestigious “Cothenius” medal. The Academy „Leopoldina“ was founded in 1652 and its members were Albert Einstein, Charles Darwin, Otto Hahn, Ernst Rutherford, Max Planck, etc. It was the only scientific institution, common for East and West Germany at the Communism times.

The scientific interests and the close amity between Kaischew and Bethge were the background of the joint seminars, organized by the Institute of Physical Chemistry, Sofia and the Institute of Electron Microscopy, Halle. These scientific workshops organized ardently by the collaborators of both Institutes were held regularly, every three years in Halle and Gyulechitsa. Besides the intimate friendship between the coworkers of Kaischew and Bethge, the seminars ensured a wonderful ambiance for social life and scientific discussions. Always at these meetings, the favorite song of Kaischew “I’m a pirate, I’m a pirate…” was sung traditionally by him in the company of his coworkers.



Prof. Heinz Bethge and prof. Rostislaw Kaischew. Joint seminary of the Institute of Physical Chemistry, Sofia and the Institute of Electron Microscopy, Halle, GDR in Gyulechitsa, 1987.



German-Bulgarian seminar, Gyulechitsa, 1987. The favorite song of prof. Kaischew "I'm a pirate, I'm a pirate…" From left to right: M. Michailov, S. Stoyanov, E. Mihaylov, R. Kaischew, A. Milchev, Chr. Nanev.

Remarkably close were his relations with another great name in the field of nucleation and crystal growth – Alexander A. Chernov. As a brilliant and encyclopedic scientist, Chernov originates from the most rigorous school in theoretical physics, the school of Landau and Lifshitz. Kaischew considered him as his disciple, since he had directed Chernov to join the Institute of Crystallography at the Russian Academy of Sciences and had recommended him to prof. Shubnikov who headed the Institute at that time. In the following years, Chernov achieved an outstanding scientific career in the fields of thermodynamics and kinetics of nucleation, morphological instability and kinetic coefficients in crystal growth, computer modelling, crystallization of proteins and biological minerals. An exceptional quality of prof. Chernov was his capability during discussions on specific problem, even without knowing the answer, to turn the discourse in a direction that would get closer to that answer. In fact this is an element of the Kaischew School and it is not incidentally that Chernov referred to Kaischew as the "Patriarch". Since 1992 Alexander Chernov works in the USA as a research director at the most renowned American research centers as NASA; George C. Marshall Space Flight Center, Huntsville, Alabama; Lawrence Livermore and Lawrence Berkeley National Laboratories, California.

In the 1990s and the beginning of the new century, Kaischew is the main person that attracts a number of renowned scientists in condensed matter physics to influential international scientific forums, organized by the Institute of Physical Chemistry.

Prof. Alexander Chernov and prof. Rostislaw Kaischew.

The so-called "Stranski-Kaischew" conferences in Bulgaria bring together leading world scientists in the field of surface physics and crystal growth. Among the regular lecturers and participants are David Landau (Georgia, USA), Kurt Binder (Mainz, Germany), Robert Sekerka (Carnegie Melon, Pittsburg, USA), Boyan Mutaftchiev (Paris, France), Kenneth Jackson (Arizona, USA), Joost Frenken (Leiden, Holland), Theodor Einstein (Maryland, USA), Doon Gibbs (Berkley, USA), Alexander Chernov (NASA; George C. Marshall Space Flight Center, Alabama, USA), Raymond Kern (Marseille, France), Matias Scheffler (Max Planck Institute, Berlin, Germany), Martin Henzler (Hanover, Germany), Ellen Williams (Maryland, USA), Erio Tosatti (Trieste, Italy), Harald Ibach (Jülich, Germany), Harald Brune (Lausanne, Switzerland).

Prof. David Landau, Georgia University and prof. Theodor Einstein, Maryland University at the third „Stranski-Kaischew" Workshop in Surface Science, SKSSW 2005, Pamporovo, Bulgaria..

Particularly impressive was the scientific workshop "EWSSW 94" in Bulgaria, at which Joost Frenken from Leiden University in Holland demonstrated for the first time the diffusion dynamics of individual metal atoms in the vicinity of monoatomic steps on crystal surfaces. The brilliant experiment performed by high temperature scanning tunneling microscopy (STM) revealed that growth and dissolution of crystals is indeed accomplished by attachment and detachment of individual atoms at the theoretically predicted kink positions in the monoatomic steps. Kaischew, who was 86 at the time, deeply moved during the lecture said: "I have never imagined that in my live I would see with my eyes a direct experimental proof of our notion with Stranski about the mechanism of crystal growth. Despite of its simplicity, our model created in 1934 seems to be true". Here, a general distinctive characteristic of the scientific ideas of Stranski and Kaischew, developed in the classical molecular theory of phase formation and crystal growth, is emphasized. It is their simplicity.

Prof. Kaischew at the Workshop in Pamporovo, 1994, devoted to his 85 anniversary (left). Prof. Robert F. Sekerka (left), Carnegie Melon University and prof. Kenneth A. Jackson, University of Arizona, lecturers at the same conference (right).

These notions follow elegantly the concept of Karl Popper about the substance of science and scientific theories stating that "The methods of scientific knowledge are related to our attempts to describe the world by means of simple theories. The complex theories may fail to be proved even when they turn to be true. The science itself may be described as the art of systematic simplification – the art to discern what can be initially excluded".

To the end of his life, Kaischew remained a classical university professor and scientist, keeping the academic tradition in its genuine style, namely searching and trying to understand the general regularities and the fundamental reasons for the processes and phenomena in Nature. He succeeded throughout the years to avoid vanity and popularity of speculative, unprincipled attractive study that brings fast but evanescent fame just because of the lack of scientific depth and meaning. For Kaischew the understanding, assembling and spreading fundamental scientific knowledge was much more significant than the loud engagement in modern, technologically oriented projects which bring attractive financing. He had no taste for monetary success and luxury, lived modestly and did not care for the banal socialists' living standards – lodging, car, country house. He was probably the only Member of the Academy who did not possess a summerhouse. The personal life of Kaischew followed largely the excellent verse by Pasternak - „Быть знаменитым, некрасиво" (it is not lovely to be famous). He used to say to his collaborators and students that "science is made with worn out pants" and that was no airs and graces. The ambiance of his home was build up by the music of Bach, Brahms and Schubert, Vihren mountain peak and Vasilashki lakes in Pirin, the beautiful Chokmanovo in Rhodope, the moderate sadness and nostalgia for the old Europe, the restrained, self-controled indignation to the communist regime. This way of life was amazingly shared by the qualities and values of his wife, Milka Kaischewa, an extremely cordial, fine and highly educated woman, daughter of the famous Bulgarian mathematician, Lubomir Chakalov, Member of the Academy. Mrs. Kaischewa dedicated her entire life wholeheartedly and delicately to create calmness, placidity, silence and warmth for her husband, consecrated and ardent to science.

Rostislaw Kaischew was the last person of the outstanding generation of the „Great Masters" W. Kossel, I. Stranski, M. Volmer and F. Frank who laid the foundations of the modern theory of crystal growth. He knew to the end of his life what he leaves behind, and this was not only the contribution to the theory of phase formation and crystal growth. Kaischew left a scientific school and through it – respect, disciples, friendship, devotion, scientific standards, style of research and academic dignity. All of this under the rule of a communist regime, at a time inauspicious for the footloose investigating spirit. Nevertheless, he succeeded to conserve the meaningful and to decline cleverly the commonplace and mediocre. Kaischew was not merely a scientist, he was an institution. Together with Iwan Stranski, he left one of the few uncontestable, substantial Bulgarian contributions to the world scientific history of mankind.

Each scientific school has its own glorious rise and inevitable fall. The dynamics of these rises and falls is determined not only by the unavoidable drama of the particular scientific paradigm, but also by the dominating values of the time of its existence. During the last two decades, the science and research in Bulgaria are rather subject to Caesar's rules (*Matthew 22:15-22)*, than to the classical genuine moral, ethic and academic values. Nowadays, the dominating aims of knowledge are cynically utilitarian, technologically oriented and directed toward consumerist society. The science increasingly serves technologies of wealth and pleasure. This is a metaphysical, fundametal contradiction with the genuine meaning of the human knowledge, trying to find the place of man in the architecture and ordering of the world, in its wonderful structure, logic and aesthetics. Possibly, because of that the contemporary scientific schools cannot exist in their classical form anymore. They are rather high-tech engineering centers, founded and developed by economic and financial reasons and interests. At the present time, science and research are motivated by the usefulness and not by knowledge. *„Gaudeamus igitur, vivat academia, vivant professores"* turn to emotional, historical mental impressions, memories, retrospections carrying the nucleus of knowledge, but ineligible and eliminated in the name of the benefit. This is the fate of the famous Stranski-Kaischew Sofia School of crystal growth, too. It was however, a remarkable intellectual phenomenon during the twentieth century and its existence, success and resplendency give moral and cognitive sense to many people, particularly to that not tempted by vanity, lucre and riches, sentimental and worthy research academic community in Bulgaria, for which, as stated in the widely held Bulgarian anthem of knowledge, „science is a sun shining within the souls" or, as it sounds in Bulgarian, „науката е слънце, което в душите грей".

Acknowledgment: *The present paper is a modified translated edition of the review chapter devoted to prof. Rostislaw Kaischew and Sofia school of crystal growth in the forthcoming book celebrating 90 years of the Physical Chemistry science in Bulgaria; Prof. M. Drinov Publishing House, Sofia (in press).*

The author is thankful to Willy Obretenov for valuable help throughout the preparation of the English version of the manuscript.

Academic ranks and grades of prof. Rostislaw Kaischew

Doctor, 1932, Breslau University, Germany.
Assistant, 1933, Department of Physics and Mathematics, University of Sofia.
Docent, 1944, (private docent since 1941), Department of Physics and Mathematics, University of Sofia.
Professor, 1947, Department of Physics and Mathematics, University of Sofia Corresponding Member of BAS, 1947.
Full Member (Academician) of the Bulgarian Academy of Sciences, 1961.

Leading positions of prof. Rostislav Kaischew

Head of Chair "Physical Chemistry", University of Sofia, 1944-1966.
Dean of the Department of Physics and Mathematics, University of Sofia, 1955-1956.
Director of the Institute of Physical Chemistry, BAS, 1958-1989.
Secretary to the Section of Chemical Sciences of BAS, 1961.
Vice-President of the Bulgarian Academy of Sciences, 1961-1968.

Membership of prof. Rostislaw Kaischew in international scientific institutions

Member of the German Academy of Sciences, 1957.
Member of the Czech Academy of Sciences, 1966.
Member of the Saxon Academy of Sciences, 1968.
Member of the German National Academy of Sciences "Leopoldina", 1968.
Vice-President of the International Union of Pure and Applied Physics, 1975-1980.

Government and academic awards of prof. Rostislaw Kaischew

Grand gold sign of honor for merits to Austrian Republic, 1983.
"Cothenius" gold medal of the German National Academy of Sciences "Leopoldina", 1987.
Order "Cyril and Methodius" – I grade, 1958, 1963.
Sign of honor from the city of Sofia, 1978.
Sign of honor from the University of Sofia, 1988, 1998.
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РОСТИСЛАВ КАИШЕВ И НЕГОВАТА СЛЕДА ВЪВ ФУНДАМЕНТАЛНАТА НАУКА. КРАТЪК ИСТОРИЧЕСКИ ОБЗОР

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