

CONFERENCES AND SYMPOSIA

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Scientific session of the Physical Sciences Division of the Russian Academy of Sciences and joint meeting of the Academic Councils of FIAN, JINR, INR, and the Scientific Council on elementary particle accelerators, dedicated to the 100th anniversary of the birth of Academician Vladimir Iosifovich Veksler (5 March 2007)

A scientific session of the Physical Sciences Division of the Russian Academy of Sciences (RAS), and joint meeting of the Academic Councils of FIAN, JINR, INR, and the Scientific Council on elementary particle accelerators, dedicated to the 100th anniversary of the birth of Academician Vladimir Iosifovich Veksler, was held on 5 March 2007 at the conference hall of P N Lebedev Physical Institute, RAS. The following reports were presented at the session:

1. **Bolotovskii B M, Lebedev A N** (P N Lebedev Physical Institute, RAS, Moscow) "Academician V I Veksler";
2. **Dolbilkin B S, Ratner B S** (Institute of Nuclear Research, RAS, Moscow) "V I Veksler and the development of nuclear physics in the Soviet Union";
3. **Nikitin V A** (Joint Institute for Nuclear Research, Dubna, Moscow region) "Synchrophasotron studies";
4. **Kovalenko A D** (Joint Institute for Nuclear Research, Dubna, Moscow region) "From synchrophasotron to Nuclotron".

An abridged version of the reports is given below.

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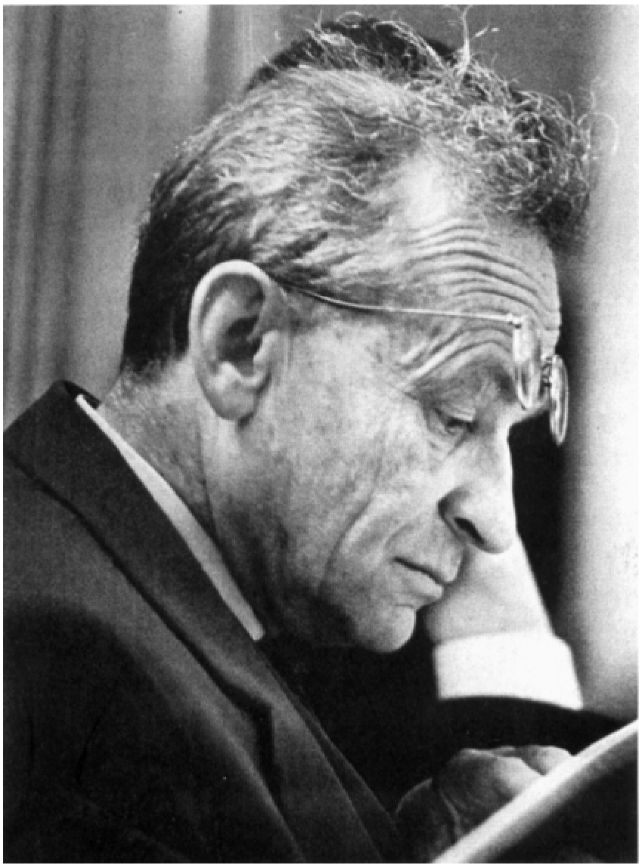
Academician V I Veksler

B M Bolotovskii, A N Lebedev



Vladimir Iosifovich Veksler
(04.03.1907 – 22.09.1966)

Vladimir Iosifovich Veksler was born in the city of Zhitomir on March 4, 1907. His father, David Petrovich Shterenberg, then a young gifted artist, had to emigrate before the child came into the world. For this reason, the future scientist received his mother's surname and kept it for life.

Shterenberg returned to Russia after the Revolution of 1917 and was soon recognized as a popular artist, even if criticized for formalism, in the spirit of that time. He loved his son and took him to Germany several times to be treated for suspected tuberculosis.

At the age of 14, young Veksler felt discontented with the situation in his step-father's family and left it for an orphanage named after A V Lunacharsky, where he remained for the next 5 years. This was the place where his character matured and where he obtained life-long friends.

The senior group of which Veksler was a member comprised excellent pupils (all of them later received higher educations). But they were first assigned to industrial enterprises after they completed the 9-year school. Vladimir and a few of his friends were given employment at a printed-cotton factory where he was trained as an electrician's assistant for the electromechanical shop. Even in those early years, Veksler showed a quick wit and interest in his work, especially physics and technology (he assembled a radio-receiving set, a nontrivial thing at that time). The administra-

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tion of the factory recommended him to enter the G V Plekhanov Institute of National Economy. A reorganization of the institute made Veksler move to extra-mural courses at the Moscow Power Engineering Institute. Simultaneously, he worked as a junior laboratory assistant at the All-Union Electrotechnical Institute (AUEI). In 1931, Veksler graduated from the Moscow Power Engineering Institute and was awarded a diploma in X-ray technology; he was accepted for employment in the capacity of research worker at the Laboratory of X-ray Structural Analysis at AUEI.

AUEI was founded in 1921 in accordance with the resolution of the Council for Labor and Defense as the State Experimental Electrotechnical Institute to do applied research for the electrotechnical industry. In the very beginning, however, the work was also focused on promising experimental studies and the theory of electromagnetic processes. AUEI developed a variety of projects covering the construction of high-voltage power lines and equipment, the stability of electrical chains, the physics of gas discharge, the propagation of electromagnetic and acoustic waves, to name but a few. The institute employed and recruited the expertise of many well-known scientists (P A Florensky, L I Mandel'shtam, I E Tamm, B A Vvedensky, P A Krug, S I Vavilov, G S Landsberg, and some others).

Veksler was engaged in developing methods for the detection of X-ray radiation. The classical method of its recording on photographic plates was very well known and widely applied at that time. Veksler proposed an alternative technique using an ionization chamber instead of a photographic plate. A few years of work brought about rather sensitive chambers that ensured as accurate a measurement as the conventional method, an advantage of the new technique being the possibility of continuously monitoring the X-ray radiation intensity. Veksler himself assembled and mounted his devices. He did not confine himself to technical aspects but concomitantly studied and developed the theoretical basis of operation of ionization chambers, including the theories of gas discharge and bremsstrahlung, as well as the interaction between X-ray quanta and gas atoms filling the chamber. Some of his instruments (for example, a cylindrical proportional gas counter) have found a wide application in cosmic ray studies.

In 1935, Veksler defended his thesis for the Candidate of Sciences and was soon appointed to head the laboratory. He rapidly gained authority at the institute as a recognized specialist in his field knowing both the physics of X-ray radiation and equipment used to measure its intensity, to the development of which he made an important contribution. He also knew theoretical and applied aspects of other fields of electromagnetic science.

Life was difficult in the 1930 as the country was recovering after the Civil War and devastation. The institute experienced a shortage of measuring instruments, so that oscillographs were worth their weights in gold. Hand-made devices had to be used. Living conditions left much to be desired, too. Veksler's family occupied a dark damp room in a building refurbished from stables. The walls froze in winter-time. Nina Aleksandrovna, Veksler's wife, fell ill with tuberculosis, and their daughter Katya suffered from pneumonia every winter. Earnings were hardly enough to cover food expenses. One document preserved from those times (order of the Director of AUEI dated 29 January 1935) evidences that the most actively working members of the staff were awarded "for high achievements in 1934". One received a radio set, another a gramophone, yet another a coupon permitting to get an overcoat made... Veksler was given a suit pattern.

In 1937, Vladimir Iosifovich Veksler moved to the Physical Institute, USSR Academy of Sciences (FIAN). In fact, he was invited to the Institute on the initiative of young researchers of the Laboratory of Atomic Nucleus (I M Frank, P A Cherenkov, L V Groshev, and some others). They knew Veksler's works, highly appraised them, and thought that his instruments and methods might be useful for measurements in their studies of atomic nuclei and cosmic rays. In the beginning, Frank asked Veksler to present a report on his work for a small group of nuclear physicists. Then, Vladimir Iosifovich received an official invitation to join FIAN. Veksler jumped at the offer to switch over to nuclear physics at the Physical Institute, the staff of which included many prominent scientists, the more so that he was already familiar with this area of research and could use his experience gained in AUEI.

FIAN was founded and headed by Academician S I Vavilov, whose personal interests lay in physical optics. But he was a broad-minded person and supported the development of other promising studies at his Institute. Vavilov was one of the few at that time who regarded the physics of atomic nucleus, cosmic-ray physics included, as a priority study area. Therefore, he had invited D V Skobel'tsyn to lead these investigations. In 1936, Skobel'tsyn came to FIAN every week from Leningrad to advise on on-going research.

Vavilov formed a high opinion of Veksler after a talk with him. I M Frank recollected: "The natural endowments of Vladimir Iosifovich were so spectacular that Sergei Ivanovich Vavilov, being an experienced director, could not help noticing them". To make things easier for Veksler, Vavilov first proposed him to occupy a postdoctoral position, and even offered himself as scientific adviser of his studies.

There existed those years the so-called Elbrus Complex Scientific Expedition which included a group of physicists exploring cosmic rays at altitudes from 2,200 to 4,200 m above sea level. The measuring equipment was prepared and tested in Moscow (FIAN). It was delivered to the mountains in early spring; measurements then started and continued till late August. Veksler was appointed straight off to lead a group studying cosmic rays during four pre-war years (1937 – 1940).

Cosmic rays and, in particular, their composition were poorly known at that time. Some physicists believed them to consist of electrons. Observational results obtained on Mount Elbrus extended the knowledge of cosmic radiation; specifically, it was found to contain a large number of secondary particles identified as slow mesons. In 1940, Veksler defended his thesis "Heavy particles in cosmic rays" for the Doctorate of Sciences. One of the official opponents was Skobel'tsyn who highly appraised Veksler's method and the results of his study. Skobel'tsyn wrote in the reference: "the thesis may be described as an outstanding work... The author was the first in the world to report a new phenomenon — that is, the presence of a large amount of secondary slow mesotrons, confirmed now by other researchers. This result is certainly of great interest especially because it refers to phenomena that could not be predicted by the existing theory".

Skobel'tsyn specially emphasized Veksler's great erudition emerged in his knowledge of nuclear physics and cosmic rays. Indeed, Veksler knew the problem so well, despite his involvement in cosmic ray studies for only 4 years, that it could not escape the attention of the man with long-standing experience in the field, who rarely lavished praise on his students. Whenever Vladimir Iosifovich took interest in a problem, he quickly delved into the heart of the matter and found himself at the forefront of relevant research.

The war put an end to the work of the Elbrus Expedition. FIAN was evacuated to Kazan' where physicists had to work under the spur of necessity to help the army. Veksler and a group of specialists started to develop a device for detecting aircraft location from engine noise. They designed equipment for military sound detectors. The advent of radars put soon an end to this work, since they determined a plane's position much more precisely and independently of weather conditions. However, Veksler's idea based actually on the coincidence method used in nuclear physics proved valuable for hydroacoustics.

V I Veksler and E L Feinberg proposed a variation of their method for hydroacoustics in 1944. Feinberg showed that hydrolocation of submerged objects may be effected by a string of hydrophones if the correlation of signals coming from different hydrophones is taken into account. Veksler and Feinberg received an Author's Certificate for the invention of a direction finder, later called a correlator. Correlation methods for the treatment of information eventually found wide application.

Working under the difficult conditions of evacuation, Vladimir Iosifovich did not confine himself to applied studies necessary for the acting army. He attached equally great importance to basic research into atomic nucleus, cosmic rays, and high-energy physics. In particular, he considered it paramount to continue high-altitude measurements for cosmic ray physics. The Elbrus research station was close to the military operation area, and another place was to be sought for the purpose. In was found in Central Asia (Chechekty tract, at the center of the Eastern Pamirs), lying 3,860 m above sea level. The site housed the Pamirs Biological Station of the Academy of Sciences. It was decided to set up a high-altitude cosmic ray station nearby. Work started in 1944, and the first measurements were made at about the same time. Veksler took the part of the organizer and leader of the project. Construction of a large building for the FIAN expedition was begun in 1946, and year-round measurements became possible starting in the summer of 1947.

Veksler headed the Pamirs expedition in 1944 – 1946; he thereafter left it (and the Laboratory of Cosmic Rays at FIAN) to N A Dobrotin to be fully engaged in accelerator physics (as narrated below).

Experiments headed by Veksler at the Pamirs station of FIAN markedly extended the knowledge of cosmic ray composition and interactions between elementary particles at high energies. Prior to those studies, cosmic rays were believed to consist of high-energy electrons. An electron entering a substance was supposed to trigger the so-called electron – photon avalanche, and this process was considered in much detail in a number of theoretical works. Measurements at the Pamirs brought about the discovery of a new type of showers and the understanding of the fact that their formation depended on both electromagnetic and nuclear interactions. Not only did electron and photon 'multiplication' occur in such showers but also multiple births of other particles that actively interacted with the atomic nuclei of the substance took place. They were later called electron-nuclear showers.

In fact, nuclear cascade studies opened up a new research area, high-energy physics, clearly distinguishable from nuclear physics. The latter deals with primary particles with an energy from unity to dozens of megaelectron-volts. Such energies were then available at the high-voltage accelerators and cyclotrons invented in the 1930s and widely used in laboratories of different countries, including the USSR. However, cyclotrons of a classical design accelerated particles only up to nonrelativistic energies; even now, intricate focusing techniques allow a maximum of 1 to 2 gigaelectron-volt energies to be attained with these facilities. As early as that time, a higher-energy region was anticipated, promising a totally new physics. However, particles with cosmic ray energies were needed to realize these expectations, which were difficult to achieve because the intensity of cosmic rays is very low and drops exponentially with energy. No wonder that a man with the character and abilities of Veksler was strongly motivated by the urge to create 'artificial' cosmic rays free from this 'natural defect'.

Vladimir Iosifovich invented on his own, even though he always shared his ideas with colleagues. There would be talk among cosmic ray researchers that Veksler was busy thinking over a certain new project. He had no formal collaborators. The first reaction to his novel ideas was rather skeptical; they were far beyond generally accepted concepts.

As mentioned above, FIAN (brought back to Moscow by that time) was headed by S I Vavilov, a man of brilliant erudition with an acute feeling of scientific novelty. As soon as he superficially familiarized himself with Veksler's ideas, he liberated him from all other duties and sent Veksler to a holiday home where Veksler had to write an article in two

V I Veksler and his wife Nina Aleksandrovna Sidorova at the Pamirs (Chechekty, 1947).

weeks. As a result, Veksler published two papers in *Doklady AN SSSR* (*Soviet Phys. Doklady*), one dealing with his invention of an electron (i.e., relativistic) cyclotron, the other opening up a new era in high-energy and accelerator physics.

The new accelerator, called the microtron, was based on a simple and elegant idea. An important disadvantage of classical cyclotrons was the progressive delay in the circulation frequency relative to the accelerating field frequency with growing energy. Veksler found out how to use this drawback to his benefit. He noticed that the circulation period in a uniform magnetic field showed linear dependence on the total energy, and proposed creating a large energy increment during each turn at which a particle fell behind the field by exactly one period, thus reproducing the acceleration conditions of the preceding turn. True, the idea was only realizable for highly relativistic particles (electrons). Moreover, powerful microwave electronics were needed to ensure a sufficiently large phase shift (hence the prefix 'micro' in the word 'microtron'). But microwave technologies had just begun to emerge at that time. The relatively low magnetic field required a large-sized accelerator. In the course of time, these difficulties were overcome by the joint efforts of FIAN and the Institute for Physical Problems. An elegant design was proposed for a workable accelerator of medium-energy electrons, which played an important role in solving many applied problems. Also, the replacement of a single accelerating gap by a linear accelerator placed in the magnet section and the omission of a few periods at one turn suggested the so-called recirculator concept. It underlies one of the best electron accelerators in the world (CEBAF, USA).

There is reason to believe that the development of the microtron led Veksler to his main discovery, namely, the principle of phase stability. He could not help understanding that the problem of deviation from strictly resonance conditions is highly accentuated in the microtron because a particle even slightly not acquiring enough energy at one turn (i.e., undergoing an insufficient phase shift) would immediately fall out of the above ideal scheme: hence, probably, the idea of automatic phase maintenance.

Today, the principle of phase stability is interpreted as related to particle capture by a wave. The phase velocity of the wave being equal to the speed of a passing particle, the latter (in its own frame of reference) is subject to an almost constant field close to the potential one. At a sufficiently large amplitude, humps of potential energy keep the particle in a trough between them, thereby ensuring the constancy of phase averaged over the period of oscillations (the so-called synchrotron oscillations) in the potential well. Such inner phase stability being guaranteed, the wave velocity can be increased in time and space; all trapped particles then undergo acceleration. The obvious limitations (the impossibility of exceeding the speed of light and the undesirability of sharp jumps) are known as Veksler's constraints. Other factors, such as generation of sufficiently slow waves of the field and extrapolation of the basic principle to cyclic accelerators, were considered trivial from the physical (not technical!) standpoint and thus of secondary importance. Very soon, variants of the main principle applicable to accelerators with a constant magnetic field (phasotrons or synchrocyclotrons), alternating magnetic field (synchrophasotrons and synchrotrons), or without any field (linear accelerators) were proposed.

Vladimir Iosifovich always gave preference to qualitative considerations over strict theory. This and the apparent simplicity of the principle inevitably predetermined skeptical attitudes towards his ideas. The situation is fairly well illustrated by a decision of a jury at the competition of scientific works held at FIAN: "If the work of V I Veksler is correct, it is not for us to award him; if it is wrong, it does not deserve the prize all the more... Anyway, it is interesting and should be supported."

A legend circulated at FIAN says that a well-known physicist 'proved' the impossibility of phase stability on the very day the first synchrotron was put into operation. Veksler's ideas were theoretically substantiated by E L Feinberg and Veksler's pupils E L Burshtein, A A Kolomenskii, and M S Rabinovich. However, the ideas were universally accepted only after Edwin McMillan of Lawrence Berkeley Laboratory, USA independently reported a similar work.

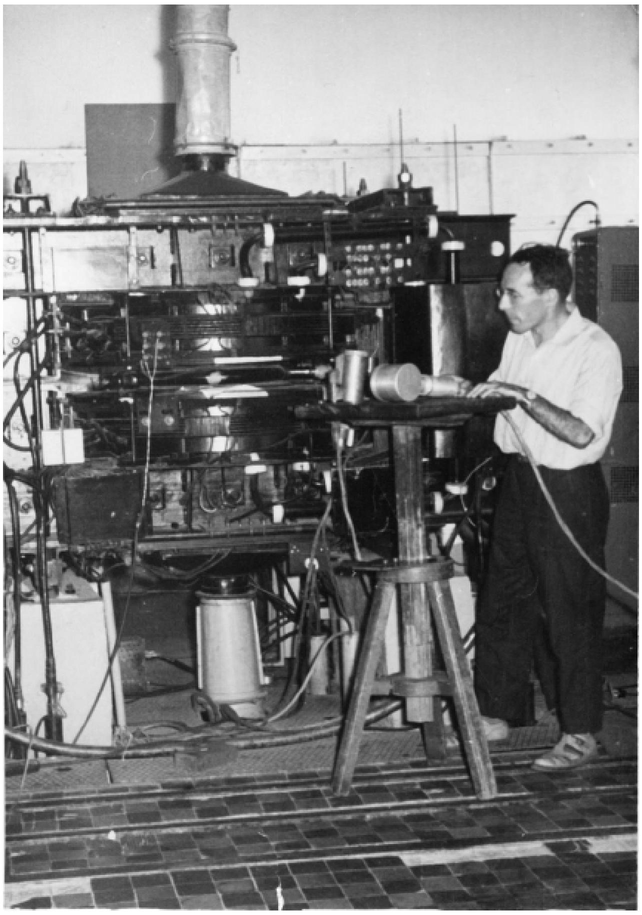
This publication created a dramatic situation, not only because of the personal pain it caused Veksler. The story of the experimental discovery of combination light scattering by L I Mandel'shtam and G S Landsberg and the awarding of the Nobel Prize in Physics 1930 for the description of the same phenomenon to an Indian physicist C Raman was still fresh in the memory of FIAN scientists. It should be noted in parentheses that this event, coupled with the discovery of Vavilov – Cherenkov radiation and Veksler's work, led Western scientists to change their condescending attitude toward Soviet physics.

Taken together, these circumstances may account for the somewhat dry tone of a letter sent by Vladimir Iosifovich to the editorial board of *The Physical Review* on the advice of S I Vavilov. It read: "The author of the present letter proposed two novel principles of acceleration of relativistic particles, generalizing the resonance method, in his two papers published in 1944 under the title "On certain new methods of acceleration of relativistic particles"... Thus, the above papers totally cover the contents of McMillan's article that contains no reference to my studies."

The immediate response from McMillan gives him credit: "I would like to comment on the situation around my article... in order to explain the unpleasant impression it produced. The journals where your papers were published were unavailable to me in 1944 and practically throughout 1945... Therefore, I was totally unaware of your work when I sent my article to the September issue of *The Physical Review*... I would like to assure you again that my inattention to your work was undeliberate; now that I know it, I would like to confirm that your discovery preceded mine."

The famous Ernest Lawrence, awarded the Nobel Prize in Physics 1939 for the invention and development of the cyclotron, made a special statement recognizing the priority of Veksler, in which he pointed to the logic of scientific discoveries made almost simultaneously in different countries.

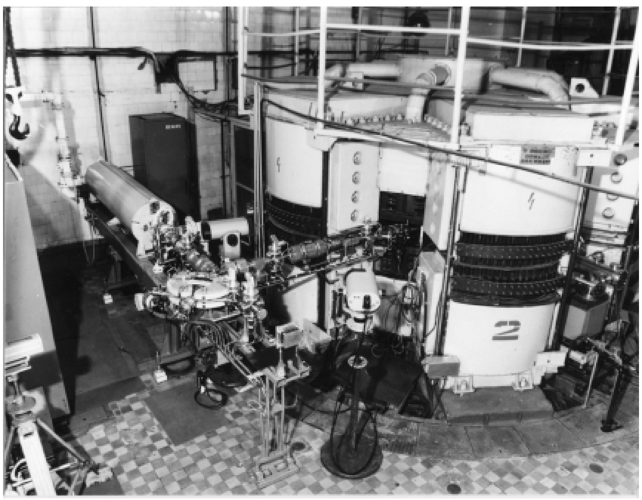
Precedents were not the sole factor adding to the dramatic situation in nuclear physics at that time. In the mid-1940s, accelerators naturally became an important component of the atomic projects initiated both in the USSR and USA, with all the ensuing positive and negative consequences. On the one hand, such complicated and expensive studies could hardly be realized beyond these projects, especially in the post-war Soviet Union. On the other hand, the secrecy of this work posed an insurmountable barrier to data exchange with other actors in nuclear physics research. This may account for the



The first S-3 synchrotron that accelerated electrons up to the energy of 30 MeV (B S Ratner working at the accelerator).

fact that the Nobel Committee for Physics disregarded the discovery made by Veksler and McMillan, even though justice was partly restored later by awarding the prestigious "Atom for Peace" prize to the two scientists.

Vladimir Iosifovich, with his characteristic optimism and enthusiasm, tried to construct the first synchrotron even



The S-25 synchrotron, which accelerated electrons up to the energy of 250 MeV.

The giant photon accelerator in Dubna (10-GeV synchrophasotron).

during the war, relying on the resources of the Institute alone. It was actually built up under the direction of B L Belousov, but the developers encountered difficulties when assembling and commissioning the machine, the main one being the inability to create the desired magnetic field. The very first magnet did not meet the quality criterion and had to be replaced by a new one. This caused a delay in the commissioning schedule, and the accelerator was ready for operation only in mid-January 1948. It accelerated electrons up to the energy of 30 MeV. Simultaneously, FIAN obtained an opportunity for industrial involvement in the construction of a 250-MeV synchrotron. It was commissioned in 1949 and immediately run for photomeson physics experiments. The machine provided the basis for the largest FIAN laboratory, somewhat enigmatically called the Etalon Laboratory; it was headed by Veksler. Researchers who worked with him at that time recollect that he was always ready to share his ideas and observations with colleagues, but never consented to have his name listed among co-authors of their papers. It may be thought that such attitudes were beneficial for shaping brilliant self-dependent experimenters in the totally new physical discipline, who later received several State Prizes.

A few words are in order about synchrotron radiation, so widely employed today in solid state physics, biology, nanotechnologies, etc. It was theoretically predicted at the beginning of the last century and examined in experiment only at relatively small betatrons in the long-wave spectral region. Being an accelerator physicist, Veksler regarded synchrotron radiation as a obstacle hampering further enhancement of accelerator energy. Nevertheless, it immediately became a subject of special studies and an instrument of research (in particular, for measuring the bunch size in the accelerator).

Veksler had been a recognized authority even before the synchrotron came into operation. He was appointed to lead the project of the giant (for that time) 10-GeV proton synchrotron (synchrophasotron) commissioned in Dubna in 1957. (The next most powerful Bevatron accelerator, in the USA, was designed to operate at 6.3 GeV.) Even now, this machine instills a great impression by its huge dimensions dictated by the then prevailing methods of keeping accelerated particles in a ring vacuum chamber. Suffice it to say that the electromagnet, weighing 36,000 tons, remains the largest one in the world, and the stored magnetic energy is enough to lift this enormous weight about one meter above ground. After a few years, when higher energies were achieved, Niels Bohr, looking at the giant synchrophasotron from the viewing point, said: "He who designed and constructed such a machine had to be a very brave man." Indeed, there were few people as brave as Veksler.

The fruitful cooperation of various research institutions and manufacturing firms, excellently organized by Veksler, helped to overcome accompanying technical difficulties. The commissioning of the synchrophasotron was a major triumph of Soviet science, and Veksler's report at the International Conference on the Peaceful Use of Atomic Energy (Geneva, 1958) caused a sensation. In 1959, V I Veksler together with L P Zinov'ev, D V Efremov, E G Komar, N A Monoszon, A M Stolov, A L Mints, F A Vodop'yanov, S I Rubchinskii, A A Kolomenskii, V A Petukhov, and M S Rabinovich were awarded the Lenin Prize for this work. In 1958, Veksler, Corresponding Member of the USSR Academy of Sciences since 1946, was elected Full Member of the Academy.

The synchrophasotron, the largest accelerator in the world at that time, still operates. A great amount of research at the level of the highest world standards was performed at this facility. Naturally, Vladimir Iosifovich spent increasingly more time in Dubna, where he launched the Laboratory of High Energies and lived till his premature death (22 September 1966). Accelerating installations of the Joint Institute for Nuclear Research (JINR) are reminders of his work in this beautiful city. The picturesque embankment in Dubna and a street at CERN bear his name.

We, then young research workers associated with FIAN, were fortunate to witness the birth of Veksler's ideas which were regarded by many as fantasy. In later publications, these views were substantiated by the fact that the technically expensive magnetic field of the accelerators was exploited rather inefficiently, being present where it was unneeded due to the lack of particles. In other words, the electromagnetic field should have been created only in close proximity to the particles being accelerated with the help of additional charges and currents. More plausible is a story about I E Tamm who once made a remark that the Cherenkov effect is reversible — that is, if a fast particle loses energy and becomes decelerated in a medium, then a particle at rest is accelerated when being blown off by a fast medium. This is a self-evident fact, but the essence of the idea is that the dragging force is proportional to the square of the charge, as it should be in radiation processes. Therefore, a bunch of N identical particles is subjected to a force proportional to N^2, whereas its mass grows by a factor of N. The number of particles being great, the acceleration rate sharply increases. The method was called coherent (collective, in later publications) acceleration, from the characteristic dependence on the number of particles, typical of this class of physical processes.

It was clear from the very beginning that a high-current electron beam was the sole medium blowing off a bunch. However, the necessary parameters seemed unattainable in those early days. Coherent scattering of a sufficiently strong electromagnetic wave by a bunch of quasineutral plasma looked more promising. In this case, the large number of accelerated particles would compensate for the relatively small attainable energy. Finally, one more mechanism proposed by Veksler was impact energy transfer from a bunch of a large number of electrons to a small number of protons also concentrated in a compact bunch.

The principle of collective acceleration offered numerous physical applications. A A Kolomenskii and M S Rabinovich recollected that practically every week the somewhat confused Veksler uttered: "I've invented yet another accelerator..." The collective acceleration technique and the conceptually similar suggestions by Ya B Fainberg and G I Budker caused a sensation at the First International Symposium on Accelerators held at CERN. This event gave impetus to the restoration of contacts between accelerator physicists from different countries. The new idea was so unusual that it perplexed one of the venerable physicists. The response of Veksler was quick and rather expressive: "It is known to every one of our students."

The euphoria at the prospects opened up by those suggestions pushed to the background the fact that even an infinitely small bunch is not an elementary particle and therefore must have inner degrees of freedom. The main thing was to keep it intact. Even this, however, did not make collective acceleration technically simple to realize. The initial enthusiasm in many laboratories was quickly supplanted by understanding of the necessity of thorough long-term studies in a quite new area of collective interactions between a large number of particles; in a way, the situation was similar to that in controlled thermonuclear synthesis. One American and one German laboratory, together with Veksler's laboratory in Dubna, worked most persistently. V P Sarantsev, the closest assistant of Veksler, led the construction and testing of several modifications of a smokotron (called so for the similarity of the accelerating electron bunch to smoke rings puffed out by a smoker). Those works long remained secret and were published only after Veksler's death in 1966.

The problem of collective acceleration is still topical, despite the enormous difficulties, both those already overcome and those facing future researchers; it will certainly continue to attract attention, unfortunately without the participation of Vladimir Iosifovich. The most impressive results have been recently obtained when exciting large-amplitude plasma waves by a powerful short laser pulse (the so-called wake-field acceleration).

Veksler did a lot during his life as an experimental physicist, inventor, and organizer of science. Suffice it to mention two largest laboratories he founded in Moscow and Dubna and the Department of New Acceleration Methods at JINR; his work as the Academician-Secretary of the Division of Nuclear Physics, USSR Academy of Sciences, and in the JINR directorate; launching of two scientific journals, *Nuclear Physics* and *Atomic Energy*. This small man of delicate health showed extraordinary energy and insistence. He was not of a dove-like disposition according to one of his disciples. He made mistakes and was sometimes prejudicial and offensive. But he always openly admitted to being in the wrong, even if it was a dispute with a junior researcher. It came to light after his death that he had rendered (secretly!) pecuniary aid to a few students, being undemanding himself. He and his wife had had a difficult youth in the 1920s, being young communist leaguers in the best sense of the word, and experienced a serious emotional conflict in later years, like many others of their generation. It is impossible to describe the life and works of Vladimir Iosifovich Veksler in a short presentation. A whole book is needed, and it should be hoped that it will be written some time.