Georgiĭ Abramovich Grinberg (on his eightieth birthday)

Ya. B. Zel'dovich, P. L. Kapitsa, N. N. Lebedev, M. A. Leontovich, N. N. Semenov, D. V. Skobel'tsyn, V. M. Tuchkevich, V. Ya. Frenkel', and Yu. B. Khariton

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Scientific developments unfold particularly rapidly where two fields overlap: physics and chemistry, physics and astronomy, physics and biology, and so forth. Perhaps the oldest pair in this group is that of physics and mathematics. These fields contributed much to each other during their relatively independent histories and eventually gave birth to a new field: mathematical physics. This is a comparatively young field, whose right to an independent existence was still being denied at the beginning of this century by A. N. Korkin, a professor at St. Petersburg University. But it is specifically Leningrad that can be credited with the birth of mathematical physics in Russia. The field began to grow particularly rapidly in Leningrad as the result of work by Academician V. A. Steklov and his school. At the University, the traditions of Steklov's school were strengthened by Academician V. I. Smirnov and his students. Another center of mathematical physics is the Ioffe Physicotechnical Institute in Leningrad, and for no less than six decades this Institute has been the workplace of Georgiĭ Abramovich Grinberg, who founded the Department of Mathematical Physics there, is the director of this Department, is the most senior person working at the Institute, and is a corresponding member of the Soviet Academy of Sciences. July 16, 1980, is his 80th birthday.

Grinberg was born in St. Petersburg, and intellectual pursuits were traditional in his family. His father, A. P. Grinberg, who was a mining engineer, and his mother, E. M. Grinberg, had received broad educations and had devoted much time to the education of their own two sons (G. A. Grinberg's older brother, A. A. Grinberg, was himself an eminent Soviet chemist and a full member of the Academy of Sciences of the USSR). From his childhood on, G. A. Grinberg showed an interest in technical things. The years of his youth were also the years in which this century was young and when it seemed that this would be the century of electricity. Like many of his peers, Grinberg became interested in experiments with Leyden jars, induction coils, etc. This technical aspect of his interests became apparent at a very early age. In addition to these experiments on electricity, however, Grinberg took up "experimental mathematics"—what Gauss had called "Nummerwarte," i.e., the search for relations among the integers. Evidently the first of these interests prevailed, and when Grinberg left high school in 1917 he enrolled in the Electromechanical Faculty at Petrograd Polytechnical Institute. In late 1918, while Grinberg was in his second year, the Physicotechnical Department of the State Roentgenological and Radiological Institute was founded in the physics laboratory of professor V. V. Skobel'tsyn. This was one of the first physics institutes organized by the Soviet Government. The Department was directed by A. F. Ioffe, professor of the Polytechnical Faculty. Having heard about the work going on in the Department, Grinberg visited Ioffe's office in the spring of 1919 and declared that he was interested in the new physics. Their conversation left Ioffe impressed with the depth of this young man's knowledge of physics. Among other books which he had studied, Grinberg mentioned a text by Khristiansen, where Maxwell's electromagnetic theory was set forth. Ioffe was quite familiar with this book, which had been edited by professor N. A. Gezekhus, one of Ioffe's teachers at the Technological Institute. We mention this book because it largely determined Grinberg's initial scientific interests and prepared him for independent research in electrodynamics, which he undertook a year after this conversation with Ioffe.

At the end of their conversation, Grinberg added that he had done all the laboratory work in physics prescribed by his academic program (he had done this work under the supervision of D. V. Skobel'tsyn, who at the time was a new instructor at the Polytechnical Institute) and that he dreamed of working in the Department. A week after this conversation, the professor and the student met by chance, and Ioffe asked, "Where have you been? We've selected you as a junior scientist in our Branch." Later, Grinberg was to learn that Ioffe had gone beyond their conversation and had requested and read reports on his work.

Grinberg thus joined the staff of the Physicotechnical Institute on June 11, 1919. In the fall of that year, the Physicomechanical Faculty was opened there, on Ioffe's initiative, with the support of several other professors of the Polytechnical Institute. It is well known that many of the students of this Faculty combined their studies there with work in the Physicotechnical Institute. Among these students were, from the first graduating class of the Faculty alone, A. F. Val'ter, V. N. Kondrat'ev, N. N. Mirolyubov, and Yu. B. Khariton (who had also begun his studies at the Polytechnical Institute in the Electromechanical Faculty). Grinberg, who was now on the staff of the Physicotechnical Institute, was enrolled at the third-year level in the Faculty and was the only student at that level. A special program was developed for him, and he took courses from professors V. R. Bursian, Yu. V. Vul'f, Yu. A. Krut-

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kov, and V. A. Kistyakovskiĭ, among others. One of the professors of the Physicomechanical Faculty who played a special role was A. A. Fridman, a pioneer in relativistic cosmology. Fridman took up questions of the theory of relativity in the early 1920's, so it is natural to assume that he suggested as thesis topics to Grinberg certain questions in the relativistic theory of elasticity and hydrodynamics (at the time, Fridman was also doing much successful work on the hydrodynamics of a compressible fluid). In 1925, Grinberg published three papers on the subject, thereby making his name known outside the group of Leningrad physicists.

At the Physicotechnical Institute, Grinberg's first scientific activity was in electrodynamics and that research which was being carried out at the Institute at the time by Ioffe and his colleagues (incidentally, Grinberg also carried out some purely experimental work, although only very briefly, in the laboratory of N. N. Semenov). He spent much time on calculations related to Bohr's theory of the atom for the Atomic Commission, headed by D. S. Rozhdestvenskiĭ. He put much effort into topics directly related to Ioffe's research on plastic deformation. He was assigned the task of calculating the kinetics of the changes in the Laue diffraction patterns of a sample under stress, and of determining the changes which occur in the lattice structure and which could be detected from the transformation of the points on the Laue patterns into wedge-shaped regions reminiscent of flower petals (accordingly this discovery by Ioffe was named "asterism"). Grinberg also carried out a calculation which is now classical (and has been incorporated in textbooks) of the stresses which arise in a crystalline sphere upon a sharp change in its temperature (from the temperature of liquid air to that of molten lead). This calculation confirmed the validity of estimates of tensile strength which Born had given for "defect-free" crystals.

In reviewing Grinberg's accomplishments, we will have to keep the list short. We will identify several major directions in his research.

The first direction deals with general problems of mathematical physics. An approach which Grinberg developed for solving various problems of mathematical physics, based on the theory of integral transforms on a finite interval (the approach involves an expansion of the unknown function, the solution of a problem with inhomogeneous boundary conditions, in a series of eigenfunctions corresponding to homogeneous boundary conditions), is a generalization of the Fourier method and is frequently called the "15th-section method" after the number of the corresponding section in Grinberg's fundamental monograph, *Selected Questions from the Mathematical Theory of Electricity and Magnetism*. Grinberg began work on this book during the Second World War, and it is based essentially on his own results from the late 1930's and the 1940's. The book was completed and published in 1948; in 1949 it was awarded the USSR State Prize. Although it first appeared three decades ago, it remains at the desk of anyone working on the corresponding problems.

Grinberg carried out extensive research in connection with the development of methods for designing rf electronic devices and magnetrons. He proposed a new method for studying the rapidly varying operating conditions in these devices (in this method, the problem of the electron motion is solved in the self-consistent field which the electrons produce), and, in particular, he solved the problem of the process of establishment of a stationary regime in a plane diode from the time the voltage is applied to it to the attainment of a steady-state, space-charge-limited current.

In related work, he studied the general theory of focusing by means of electric and magnetic fields. As a first approximation here we can cite his calculations on the design of the cyclotron of the Physicotechnical Institute and on the design of mass spectrographs, but television proved a greater stimulus to this work. Ordinarily, the electron-optics problem which was to be solved was reduced to a determination of the charged-particle trajectory in fields of a given configuration, but for the physical problem itself it would have been more natural to seek the fields capable of providing the required motion of the particles in the device being studied or designed. Grinberg formulated this problem in a general form and solved it. He showed how many arbitrary trajectories in the beam it was necessary to specify in order to determine unambiguously the fields which would produce the given particle motion. I. E. Tamm has described this work: "G. A. Grinberg's papers combine a virtuoso mastery of mathematical analysis with the ability to distinguish the key element in a difficult and complicated problem; to dismiss everything of secondary importance; to find a solution of striking insight, elegance and simplicity; and to put this solution in a form (frequently tables or graphs) which could be used directly by experimentalists and engineers.[1)]

This virtuoso technique and this depth of physical analysis, noted by Tamm, were characteristic of Grinberg's work and were reflected in his other work, also. Grinberg developed this ability to reduce complicated calculations to a form suitable for use in engineering practice over many years of rewarding contact with industry. This contact began at the Svetlana factory, where Grinberg founded (and for more than a decade, beginning in 1929, directed) a group in theoretical research, and the Sevkabel' factory, for which he carried out a major program of research on the thermal breakdown of dielectrics, the theory of transients in transformers, etc. In the Kalinin Polytechnical Institute he organized a special research team which carried out several important engineering calculations at the direct request of industry.

In the late 1930's, N. D. Papaleksi and M. A. Leontovich interested Grinberg in the refraction of electromagnetic waves at a seashore. In a fundamental paper on the question, he solved an integral equation (the Leontovich–Grinberg equation, as it is known now)

[1)]I. E. Tamm, Archives of the Academy of Sciences of the USSR, Collection #1654 (Academician I. E. Tamm).

which described the propagation of a wave above a flat surface of ocean and dry land. It was found that the propagation direction of a radio wave far from the shore was the same as its original direction above the ocean, despite the intervening shore refraction.[2)]

In the second half of the 1960's, Grinberg began to study the theory of heat conduction and diffusion for the case of moving boundaries. Problems of this type have a very long history indeed, dating back to research on polar ice by the Austrian physicist Joseph Stefan. Despite their antiquity, however, no general solution method was available; there were only particular solutions for a few simple cases. Grinberg showed that an appropriate transformation would put the Fourier equation in a form such that, first, exact solutions could be found for many types of boundary motion (in both two and three dimensions) and, second, an effective new method emerged for solving the Stefan problem, in which the nature of the boundary motion must be determined in the course of the solution. Later, in 1974, Grinberg developed yet another approach to the solution of these problems, which involved the introduction of special sequences of functions which made it possible to reduce the problem to an infinite system of differential–difference equations of simple structure and from there to integral equations for determining the motion of the boundaries.

We will conclude this review with another scientific field which has continued to hold Grinberg's interest: the mathematical theory of the diffraction of electromagnetic waves. In the course of this work, he proposed, in particular, a novel method which has proved very successful in solving the problem of the diffraction of electromagnetic waves generated by arbitrarily distributed sources in thin, ideally conducting walls (the "shadow-current method"). Such problems can be solved particularly simply in the case of flat walls in a common plane.

In one of his most recent papers,[3)] Grinberg discussed some nontrivial links which he had discovered between the solutions of static problems for the Laplace and Poisson equations and the solutions of corresponding problems in the diffraction of three-dimensional electromagnetic waves by walls of a certain shape. This correspondence was very surprising, in contrast with the inverse situation, i.e., the transition from the wave case to the static case. At the same time such a "turnaround of thought" is very characteristic of the style of Grinberg's work. This approach was largely determined by physical intuition, which helped him find the best method for solving a given mathematical-physics problem (he stated at one point that his field of activity was mathematical physics "with the stress on the second word").

We might add that among the approximately 110 published papers by Grinberg there is important research on the theory of elasticity, plasma physics, magnetohydrodynamics, the theory of integral equations, etc.

In 1924, Grinberg began teaching in the Physicomechanical Faculty of the Kalinin Polytechnical Institute, while continuing his work in the Ioffe Physicotechnical Institute. At the Polytechnical Institute, he founded a Department of Mathematical Physics, which he headed until 1955. Grinberg is an excellent lecturer, and his many students from several generations carry with them memories of his excellent courses in electrodynamics, the theory of relativity, electron theory, and mathematical physics. Certain eminent scientists have often been faulted for a lecture style so smooth as to induce sleep somewhat earlier in the day than appropriate (Hendrik Lorentz comes to mind), but Grinberg delivered his lectures with a consummate style: None of his students can recall an instance in which Grinberg "got lost" or even hesitated in a lecture—sins which students are generally ready to overlook on the part of their favorite professors. But this perfection and completeness of each and every one of professor Grinberg's lectures never drew any complaints; on the contrary, his popularity was raised even further. As one clear example of his popularity, we recall the time when the people who had gathered in the auditorium of the Polytechnical Institute for a solemn occasion, the fiftieth anniversity of the Physicomechanical Faculty, showed their appreciation of Grinberg's talk with a long ovation. We regret that he has now given up teaching to concentrate on his research.

An important part of his activities as scholar, teacher, and member of the community has been his effort on consultations; he is always ready to meet with anyone who asks. He quickly grasps the essence of the problem, and it frequently happens that, after a brief talk, the visitor leaves, if not with a complete solution, at least armed with a clear plan for attacking the problem. An illuminating case is the occasion on which the director of one of the laboratories at the Physicotechnical Institute sent a colleague to Grinberg for advice but also made a special plea to Grinberg to try to take his time in pointing out the way to solve the problem. The director feared that this young man, who had been struggling unsuccessfully with the problem for a long time, might lose faith in his own ability if faced with the speed with which Grinberg typically identified the correct approach for solving complicated problems. Although this was a characteristic case, fears of this type are not preventing people from approaching Grinberg for consultation. He has high regard for a correct formulation of the problem, and his advice is always offered tactfully—in the form of a friendly talk between equals in which the idea for the solution seems to come to the visitor without assistance.

Grinberg's services to Soviet science have been recognized by his selection as a corresponding member of the Academy of Sciences of the USSR (in 1946) and important awards from the government: the Order of

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[2)]One of Grinberg's papers on this subject was later completed in collaboration with V. A. Fok (1948).

[3)]There is a preliminary report in Pis'ma v Zhurnal Tekhnicheskoĭ Fiziki [Soviet Technical Physics Letters] (Vol. 5, 1979); the complete text will be published in a collection by the Academy of Sciences of the USSR to celebrate the 100th anniversary of the birthday of A. F. Ioffe.

Lenin, the Order of the Workers' Red Banner (three times), and various medals. In 1949, as mentioned earlier, he was awarded the State Prize for his extensive work in mathematical physics.

Since 1925, his papers have been appearing regularly in Soviet physics and mathematics journals. His capacity for work and the keenness of his mind have not suffered over the years. He is a warm-hearted man, always in good spirits and always ready to offer advice where there is a need, and by no means solely in the field of mathematical physics. Grinberg has won the affection of the people at the Physicotechnical Institute and represents a "living bridge over time"—from the beginnings of the Institute down to the present day. He is held in extremely high regard among Soviet physicists, as evidenced in particular by the publication of a collection of papers under the title of *Questions of Mathematical Physics* by the Academy of Sciences of the USSR with a note on the title page stating that the collection was published to celebrate "the seventy-fifth birthday of G. A. Grinberg, corresponding member of the Soviet Academy of Sciences." This book represented the efforts of about 40 people—eminent physicists themselves; his colleagues in the Academy, in the Ioffe Physicotechnical Institute, and in the Kalinin Leningrad Polytechnical Institute; his students, direct and indirect; and his colleagues from the Department of Mathematical Physics.

On the occasion of his 80th birthday, his many colleagues and comrades wish Georgiĭ Abramovich Grinberg robust health, an unflagging crispness of thought, and more creative success for the good of Soviet science.

GEORGIĬ ABRAMOVICH GRINBERG

Translated by Dave Parsons