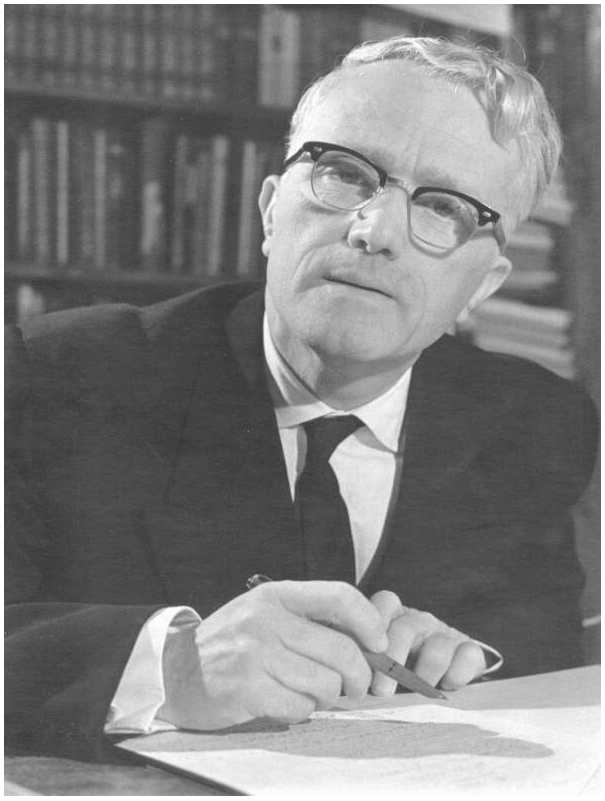

VIKTOR KUPRADZE -110

ვიქტორ კუპრაძე -110

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VIKTOR KUPRADZE

In the Service of Science and the Country

(A Short Survey of the Life and Activities of Viktor Kupradze)

If we briefly evaluate the life course of outstanding Georgian scientist, public figure and statesman Academician Viktor Kupradze, we may call it "an ever-lasting trail". It is much more difficult to evaluate in full measure the services of this unique personality – a great citizen and the author of fundamental studies in mathematics and mechanics. He made an essential contribution to the world science treasury and, participating actively in the intricate social and political life, he served faithfully the Georgian people in the course of many decades. His efforts did not remain unnoticed – people appreciated his deserts, statesman's thinking, concern for the consolidation and development of the state, education of the young generation and responded him with nationwide love.

Viktor Kupradze's nonordinary personal qualities began to form in his family. He was born on November 2nd,1903, in the village of Kela (presently, the village of Ninoshvili) in the family of a railwayman. The surroundings and family rules of life inculcated in Viktor the loyalty to kindness, love for work and learning.

The parents noticed the versatile gifts of their son in his young years and sent him to school in Kutaisi. The young man at once attracted the attention of teachers by his diligence, good progress in studies, tactful attitude to fellow students and teachers. The extensive teaching of mathematics in the school bore its fruit and Viktor was gripped by the desire to master mathematics and its applications.

Incidentally, he also studied diligently literature, history and foreign languages, took care of self-education, showed interest in philosophical works, read periodicals. By participating actively in disputes on various topics he improved his oratorical skills and level of thinking.

Upon graduation from the school, following his own choice and the advice of his teachers he continued his education at the physics and mathematics department of Tbilisi State University. It is a curious fact that at the time students were enrolled at the university by interviewing them.

V. Kupradze was successfully enrolled after the interview with well-known mathematician and teacher Adrea Razmadze.

The severe socio-economical situation of the 1920s and the necessity to support his family made V. Kupradze suspend temporarily his study at the university. He began to work as a translator, tutor, staff member of newspapers and journals, continued the mastering of foreign languages (Russian, German, French). His public activities did not weaken. In 1922, V. Kupradze returned to the University. That was the time when the Georgian university founded by a small group of Georgian enthusiastic scientists was gaining in strength and preparing itself to rise to the level of a leading university. It was the opinion of many world scientists that already by 1924 small Georgia had created, relying on its own will-power and means, the powerful center of knowledge and progress. Georgian manuals in many fields of mathematics had appeared in print, the culture of scientific thought had improved and young people had been given an opportunity to listen to lectures which, being remarkable in form and content, were the paragons of pedagogical art.

Many years later, Viktor Kupradze recollected: "If we agree with the fact that the aims and tasks of the educational work is not only to impart concrete knowledge to young people, but also to prepare them to embark on the path in life being equipped with a certain outlook, tastes and aspirations, then it is exactly such aims that were set and successfully realized by the pedagogical work of Andrea Razmadze." It was in such a creative atmosphere that Victor Kupradze developed into a scientist and educationalist.

The gifted and intelligent youth quickly won the liking on the part of professors and teachers. Andrea Razmadze said the prophetic words about him: "An interesting youth, clever and diligent. He will go far." It can be said that Viktor Kupradze developed into a scientist in collaboration with outstanding Georgian mathematician Nikoloz Muskhelishvili whose works had produced a great impression on him.

His interest in the applied aspects of mathematics, and in particular his awareness of the prospects of solving physical problems by the mathematical apparatus made him take a firm decision to choose the applied trend in mathematics and already in his student years he won the reputation of a promising student. He actively participated in the scientific seminar. It is remarkable that this seminar was also the starting point of the career of outstanding Georgian mathematicians Ilya Vekua, Vladimir Chelidze and others. He also collaborated with well-known mathematicians Georgi Nikoladze and Archil Kharadze.

Still a student, Viktor Kupradze wrote his first scientific paper "Green, Klayne and Neumann Functions for Some Simple Contours", in which he investigated the problem suggested by N. Muskhelishvili. The paper was published in the Bulletin of Tbilisi State University in 1928.

N. Muskhelishvili afterwards praised his young colleague: "In his student years, he displayed the well-pronounced ability to work on his own. He has thoroughly studied various issues of mathematics and mechanics."

Upon graduation from the university in 1928, the promising young researcher was enrolled in the post-graduate course on the recommendation of A. Razmadze and N. Muskhelishvili. He became an assistant of A. Razmadze in mathematical analysis and an assistant of N. Muskhelishvili in theoretical mechanics. He also read lectures at the Tbilisi Polytechnical Institute.

In writing the testimonial to Viktor Kupradze, his scientific supervisor N. Muskhelishvili in particular wrote: "The post-graduate student has mastered quite well the main academic disciplines. He has invariably shown the ability to independent, creative and critical thinking. I can say with confidence that under proper conditions he will become an outstanding specialist in applied mathematics". However, such conditions could not be provided for the post-graduate student because of his miserable

financial position and the poor economical situation in Tbilisi. In the opinion of N. Muskhelishvili, the study at the post-graduate course under the Academy of Sciences of the Soviet Union was at the time the best way out of the difficult situation – the country would receive a talented scientist.

In 1930, V. Kupradze was sent on a scientific mission to Leningrad, where he continued his study at the post-graduate course of the Physics and Mathematics Institute of the USSR Academy of Sciences. His research was supervised by academicians Aleksey Krylov and Vladimir Smirnov. Viktor Kupradze found himself in the circle of young mathematicians and mechanicians S. Sobolev, L. Kantorovich, S. Mikhlin, G. Goluzin and others.

The study and research work at the newly founded Seismic Stability Institute soon yielded a good result – the first scientific paper written jointly with Sergey Sobolev was quite impressive. It was dedicated to the investigation of a topical problem of oscillation theory concerning the wave propagation in the earth's crust as a result of an earthquake. It goes without saying how important this study was for designing earthquake-proof structures.

A surface wave of a new type, which emerges as a result of disturbance at the elastic body-fluid interface, was discovered by mathematical tools. The authors called this wave an "interacting wave". The paper was found interesting in the Soviet Union and abroad. This trend of research proved to be quite fruitful. The paper was followed by a series of papers dealing with problems of electromagnetic wave diffraction. In 1938, the author of these results was awarded the prize at the All-Union Competition of Young Scientists. This is how N. Muskhelishvili, who carefully watched the scientific progress of his young colleague, appraised these works: "V. Kupradze has given us a solution of the highly important and difficult diffraction problem. This problem has been attacked for more than a hundred years, but its general solution has not been obtained until the works of V. Kupradze. Now we have got a very simple solution of this difficult problem".

The obtained results formed the foundation of V. Kupradze's doctoral thesis, which he successfully defended in 1935 at the V.A. Steklov Mathematical Institute of the USSR Academy of Sciences and was awarded the Doctor's degree in mathematics.

A special mention should be made of the public, teaching and organizational work of V. Kupradze in the 1930s. The comprehensive general education, pedagogical talent, tactfulness, rationalism in planning the working time, honesty, dignity of the 29-year old Georgian scientist were noted in Leningrad, too, and he was involved into active academic and organizational activities. He was appointed the academic secretary of the V.A. Steklov Mathematical Institute and some time after became a senior researcher there.

It is remarkable that this happened at the time when the head of the institute was world-wide known Russian mathematician Ivan Vinogradov and at the institute there also worked celebrated mathematicians N. Muskhelishvili, V. Smirnov, M. Lavrent'yev, S. Sobolev and others.

V. Kupradze read lectures at the higher educational establishments of Moscow and Leningrad. The popular academic journal "Advances in Mathematical Sciences" ("Uspekhi Matematicheskikh Nauk") was founded with his active participation. He was elected a member of the editorial board of the journal. In 1934, he was a secretary and member of the editorial commission of the organizing committee of the 2nd All-Union Congress of Mathematicians. V. Kupradze's great organizing ability became once more apparent at the time of transference of the All-Union Academy of Science – a highly complicated system – from Leningrad to Moscow.

The 1930s were a crucial time for the successful development of the Georgian mathematical school. The settlement of organizational and academic matters needed the efforts of V. Kupradze, who already was a well-known scientist, science organizer and public figure. In 1936 he returned to Tbilisi (though still remaining a staff researcher of the V.A. Steklov Mathematical Institute) and, together with I. Vekua and N. Muskhelishvili, headed the organization of the mathematical institute in Georgia. V. Kupradze was appointed the first director of this institute and was also invited to the post of professor at Tbilisi State University and the Industrial Institute. From 1937 onwards he carried out his scientific, lecturing and public work only in Georgia.

World War II was a very grave ordeal for Georgia, too. Every citizen was obliged to make a contribution to the common cause. V. Kupradze used his broad erudition and noble impulse for the benefit of the Motherland. Though he had an exemption from the army enlistment and could avoid participation in the war, he agreed to take a special appointment and began to work in the Crimea as a deputy chief editor of a front-line newspaper – he prepared propaganda materials in the German language that was distributed among the enemy.

He in fact was in the battlefield of military operations. To endure the life in such conditions he consoled himself with thoughts about scientific problems that were awaiting solution. After severe wartime trials, V. Kupradze was demobilized and returned to Georgia. He was appointed pro-rector responsible for the scientific research at Tbilisi State University, where he got engrossed in scientific and lecturing work and founded a seminar on the theory of electromagnetic waves and spatial problems of the elasticity theory.

In 1944—1953 V. Kupradze worked as Minister of Education in Georgia. Being a prominent scientist with rich life experience, he showed concern for the development of education in Georgia along the correct lines, encouraged gifted young people to go to work at the leading research centers and gave a stimulus to the establishment of new educational institutions.

V. Kupradze made a great contribution to the improvement of the teaching level and professional skills of secondary school teachers. In 1946, seven-year schools were remade into ten-year schools, while the latter were remade into 11-year training schools. The teaching of the history and geography of Georgia was introduced, text-books on these subjects were published, a number of initiatives were undertaken for the versatile development of pupils. An efficient help was rendered to teachers. V. Kupradze's exacting and at the same time tactful attitude to the profession of a teacher was well-known. He himself was a model of a splendid teacher and obliging pupil.

In 1954-1958 V. Kupradze was rector of Tbilisi State University. He led the renovation of scientific and educational processes at the university, headed the chair of differential and integral equations and, concurrently, headed the higher mathematics chair at the Georgian Polytechnical Institute. All institutions of higher learning were eager to make maximal use of his exceptional erudition and intuition in order to settle their daily matters.

Let us go back to the events which occurred after the 1940s. In 1943, the title of Honored Man of Science and Technology was conferred on V. Kupradze. In 1946, he was elected Full Member of the Georgian Academy of Sciences. Since 1948 he had been a member of the Presidium of the Georgian Academy of Sciences, and since 1963 academician-secretary of the mathematics and physics sector of the Georgian Academy of Sciences.

In 1962, he was elected President of the Georgian Mathematical Society and in 1980 a member of the National Committee of Soviet Mathematicians. Viktor Kupradze was a member of the editorial boards of a number of international prestigious scientific journals. He was frequently invited to read lectures at the leading research centers in the USA, Poland, Germany and other countries. In 1981, he was given the title of an honored citizen of Tbilisi. In the course of many years V. Kupradze was holding high-rank party and governmental posts (for example in 1954-1963 he was Chairman of the Supreme Soviet of Georgia), he was entrusted to represent the country at supreme international fora. His deserts were repeatedly rewarded by the government – he was decorated with six orders and a multitude of medals. He regarded his knowledge, public work and the rostra from which he addressed people as levers of his efforts to strengthen the country, develop science and educate the future generation.

Despite all these public obligations, all his life V. Kupradze, owing to the staunchness acquired in his young years and, which is more important, owing to his exceptional natural gifts, was occupied with profound scientific research, was in constant search of new trends in science and collected around him young researchers whom he trained as independent successful scientists. These efforts much contributed to the formation of the renowned Georgian mathematical school recognized by leading mathematicians of the world.

V. Kupradze's scientific heritage is devoted to the investigation of the basic problems of the theory of differential and integral equations of mathematical physics. A short account of these issues reads as follows.

1. The radiation principle and boundary value problems of oscillation; problems of the existence and uniqueness of a solution.

The basic boundary value problems for the Helmholtz oscillation equation were for the first time investigated by Viktor Kupradze in case of infinite domains. They are solved by the radiation principle which was formulated by outstanding German mathematician A. Sommerfeld in 1912. In 1934, V. Kupradze managed to substantiate this principle mathematically. He proved the uniqueness of solutions of the basic external boundary value problems for the oscillation equation and reduced these problems to the solution of Fredholm type integral equations. He showed the existence of a solution under sufficiently general conditions. Ten years later, the same result was obtained by G. Weyl. Important results in this direction were also obtained by F. Rellich, I. Vekua, V. Magnus and D. Avazashvili.

2. Electromagnetic wave diffraction problems.

A series of V. Kupradze's works are devoted to the investigation of diffraction of electromagnetic sinusoidal waves around an arbitrary plane contour. These problems were considered by V. Sternberg, H. Freudental and other researchers. V. Kupradze made essential use of the method of integral equations. Of the previous results special mention should be made of

A. Sommerfeld's result for domains of special type. The result obtained by Viktor Kupradze in 1938 was awarded the prize at the All-Union Competition of Young Scientists. It was included into the well-known V. Smirnov's university course on higher mathematics and translated into nearly all languages of the world.

3. Basic boundary value problems of statics and stationary oscillations of the elasticity theory.

To solve these problems, Viktor Kupradze generalized his previously obtained results connected with the Helmholtz equation for a system of stationary oscillation equations of elasticity. He proved the uniqueness theorems, constructed solutions of three types, which he called a simple--, a double-- and an antenna-layer potential. He investigated the fundamental properties of these potentials and derived jump formulas; he proved theorems analogous to the Lyapunov-Tauber theorem, which state that the normal derivative of a regular harmonic double-layer potential is continuous on the domain boundary. Furthermore, he proved an important fact that the above-mentioned boundary value problems are solvable under quite general conditions. One of the first significant results obtained by V. Kupradze jointly with S. Sobolev concerns the wave propagation on the elastic body-fluid interface. The existence of a wave of a new type was established by mathematical means.

To solve the basic boundary value problems of statics and steady-state oscillations of the elasticity theory, V. Kupradze developed the method by which the solution of these problems is reduced to the solution of a system of singular integral equations. Thus it became possible to create a theory that was as complete as the existing theory for classical Dirichlet and Neumann boundary value problems. An example of the application of this method is V. Kupradze's investigation of the first, second and mixed basic boundary value problems for piecewise-inhomogeneous elastic bodies. He showed that the solution of these problems can be reduced to the solution of a system of well-defined linear functional equations and, in some cases, of a system of singular integral equations of the so-called normal type. The latter system was proved to be solvable for arbitrary boundary values in the case of the first basic and mixed boundary value problems, while for the second boundary value problem it was necessary to introduce an additional assumption that the principal vector and the principal moment are equal to zero. V. Kupradze showed other applications of the method. Of particular interest is the result obtained by V. Kupradze for mixed boundary value problems in the case of static and stationary oscillations of a two-dimensional anisotropic elastic body. He reduced the solution of these problems to the solution of a system of singular integral equations of the well-defined normal type.

4. Simple and multiple singular integral equations and their applications.

Each essential result obtained in this direction contributed to the progress in the investigation of important problems of mathematical physics whose solution was reduced to the solution of singular integral equations (or a system of equations) of the above-mentioned type. Significant results in the theory of such integral equations were obtained by F. Gakhov, I. Vakua, V. Kupradze, S. Mikhlin, N. Muskhelishvili, their numerous disciples and other researchers. In 1935, in his doctoral thesis V. Kupradze used this approach to investigate for the first time a three-dimensional problem of diffraction of an elastic plane sinusoidal wave. Some other important results obtained by V. Kupradze in this direction include: the theorem about the equivalence of integral equations of some type, the refined and simplified proof of the well-known theorem of F. Noether, the new method developed on the basis of the well-known results of S. Mikhlin and G. Giraud for the solution of a system of multiple singular integral equations which V. Kupradze afterwards applied to boundary value problems of statics and stationary oscillations of the elasticity theory. V. Kupradze managed to construct solutions for a certain class of singular integral equations and systems of equations without solving the Riemann—Hilbert boundary value problem.

5. Refined models of the elasticity theory (thermoelasticity, moment elasticity and other theories).

V. Kupradze investigated the fundamental and special contact and boundary-contact problems of the above-mentioned theories and constructed representations of solutions in the form which makes it possible to realize them numerically with the aid of computers. Modern powerful computers increase the efficiency of such approaches.

6. Approximate solutions of boundary value problems of mathematical physics.

In the early 1960s, by modifying and generalizing Picone's method V. Kupradze found new effective possibilities of constructing approximate solutions for a wide class of boundary value problems of mathematical physics. This method can be used for plane and spatial, basic and mixed boundary value problems of statics and the oscillation theory in the case of homogeneous and piecewise-homogeneous, isotropic and anisotropic bodies. The essence of the method consists in the following: if the boundary of the considered body and the boundary value of the sought solution are assumed to be "sufficiently" smooth, then Green's formula enables one to represent a solution in the explicit form by means of the boundary data of fundamental solutions (or sometimes by means of Green's function) and one auxiliary function that satisfies a certain functional equation in the external domain of the considered body. The method proved to be very promising and topical. In recent decades, the use of computers in research has created wide vistas for the practical implementation of results of fundamental science. The numerical realization algorithms of the solution of many important problems of mathematical physics and the elasticity theory developed by V. Kupradze and his colleagues were from the very beginning meant for the use of computers. The level of present-day computing facilities makes V. Kupradze's methods of constructing effective solutions even more important. References to these methods are made on a par with the methods of leading scientists of the world.

Rector of the Moscow Institute of Steel and Alloys N. Polusin wrote: "Since 1970, at our institute V.D. has been working on spatial problems of the elasticity theory using the method of integral equations. A lot of problems have been investigated by this method. For instance, computations were performed for unique steel rolling shafts, high pressure chambers used for diamond synthesis, pressure matrices and other equipment."

Georgian physicists are proud today that the so-called method of auxiliary radiators worked out by V.Kupradze, I. Vekua, M. Aleksidze and other leading scientists enjoys popularity in modern investigations – in particular Georgian radio physicists use it to solve modern applied problems of electrodynamics. In the scientific papers of scientists of all developed countries we can find 80000 references to the application of this method. In scientific circles this method is known under different names. In some works it is called the method of Fourier series, the method of decomposition into fundamental solutions, the method of non-orthogonal series and so on. In foreign literature this method is frequently mentioned as the discrete sources method, the generalized multipole technique, Uasura's method and so on without making reference to the original sources.

The rich scientific heritage of V. Kupradze is reflected in his more than 100 works, among which there are 5 monographs:

1. Basic Problems of the Mathematical Theory of Diffraction (1935, Leningrad; 1952, Los-Angeles, in English).

2. Boundary Value Problems of the Oscillation Theory and Integral Equations (1950, Moscow; 1956, Berlin, in German).

3. The Potential Method in the Theory of Elasticity (1963, Moscow; 1965, Jerusalem, in English).

4. Dynamical Problems of the Theory of Elasticity (1963, Amsterdam, in English).

5. Three-Dimensional Problems of the Mathematical Theory of Elasticity (co-authors T. Gegelia, M. Basheleishvili and T. Burchuladze (1968, Tbilisi).

The second revised and enlarged edition of the latter monograph was published in Moscow. Its English translation was published in Holland in 1979.

In 1971, the authors of the latter monograph were awarded the State Prize of Georgia. The monograph won the unanimous recognition of specialists who appreciated its originality, profundity of the results and their importance for the solution of .a lot of problems in the related areas. This monograph added to the recognition to the Georgian mathematical school. As time has shown, this work has remained topical to the present day. The same can be said about the entire scientific heritage of V. Kupradze. This is perhaps the best appreciation of the creative work of the scientist.

It is no less important how contemporaries feel about the scientist and what image of him will remain in the memory of people. 28 years have passed since the death of V. Kupradze, but we can say with confidence that his name once again reminds us of his unlimited devotion to people and his work, of his enthusiasm, oratorical skills, pedagogical talent, concern for the future generation, support of any good intentions. Even in the tragic period of his life, he was the person whose best human quality – to be useful to his people – was directed to serving science and the country.

110 years have passed from the day of Viktor Kupradze's birth, but we can say with full confidence that the heritage of Viktor Kupradze, great scientist, public man and son of his Fatherland will leave the trace in the memory of future generations.