Sergeĭ Petrovich D'yakov and his contributions to science

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At the end of the 1940's, and the beginning of the 1950's, in the skies of physical science, there flared up brightly a star which shone for a short time and suddenly was extinguished not having had time in its full glory to plant and create around itself a generation of stars. This was the young Sergeĭ Petrovich D'yakov who entered science and in a ringing voice sang his song which turned out to be his swan song. His song turned out to be a swan song since he had time to bequeath this song to science during his last 7–8 years, after which his life was tragically terminated; in September 1954 he drowned. And those years were difficult ones, concealed by the thick curtain of secrecy. The country was healing its wounds after a destructive war and at the same time hurriedly was creating the nuclear defensive shield. This led to a rapid development of physical science, in particular, the physics of explosion and hydrodynamics. It is specifically in this field of physics that the then still very young Sergeĭ Petrovich left deep tracks. These tracks turned out to be so deep that neither the curtain of secrecy nor merciless time could conceal them and erase them from human memory. It was no accident that in the everlasting textbook of theoretical physics of L. D. Landau and E. M. Lifshitz in the volume on "Mechanics of continuous media"[1] the authors who are very sparing in citing articles, mention the name of S. P. D'yakov several times.

We, who have known D'yakov and his work to varying degrees, have decided to accept the kind invitation of the editor-in-chief of Usp. Fiz. Nauk B. B. Kadomtsev, and tell about the pages in the history of physics written by D'yakov, a bit about the life of D'yakov, about what he had accomplished in science and about how his activity has undergone subsequent development. We have decided to preserve the originality of our preception of D'yakov and his work and to allow each one of us to make a statement without an essential reworking of the text of the reminiscences. We hope that some repetitions, particularly those concerning the personality of D'yakov, will not annoy the reader.

We have assigned the first contribution to V. I. Gol'danskiĭ, the present Director of the N. N. Semenov Institute of Chemical Physics in which D'yakov began his scientific career in 1946 as a junior scientist in the theoretical division which at that time was headed by Ya. B. Zel'dovich. V. I. Gol'danskiĭ is a university classmate of D'yakov and, naturally, became acquainted with D'yakov before the rest of us and appreciated his talent as a physicist.

—No matter how hard I try I cannot restore in my memory the beginning of my official acquaintance with D'yakov. His unusual appearance struck me with our first meeting, apparently, at the chemistry faculty of the Moscow State University, in 1943–1944 when I simultaneously was working in the laboratory of S. Z. Roginskiĭ (then it was temporarily situated not in the Institute of Chemical Physics but in the Colloid-Electrochemical Institute of the Academy of Sciences of the USSR—KÉIN, which is now the Institute of Physical Chemistry) and was concluding my student years in the third for me (after Leningrad and Kazan') university—the Moscow State University.

The luxuriant black curly hair of the young man sauntering along the faculty of chemistry, the bow tie, the overly serious mien (I practically do not remember him smiling), and the tales about his unusual abilities—all this was intriguing, evoked curiosity, and a lively interest in him, and, at the same time, a not always benevolent attitude of those surrounding him, suspicion of a certain tendency towards posing.

Meetings at the university which I rarely visited after graduation, were very infrequent, and were restricted to a few words devoid of much meaning. Therefore I was particularly interested to learn (it seems to me at the end of 1946) that D'yakov is taking a position at the Institute of Chemical Physics in the theoretical division headed by Ya. B. Zel'dovich engaged in supersecret activity for I. V. Kurchatov and Yu. B. Khariton (the mention of whose names, as a matter of fact, was not advisable). For several months we worked in the same room, but in quite different activities. I was not initiated into the problems when decisions had to be made, and in fact made no effort to delve into them, but spent all day sitting at the "Mercedes", played on its keyboard music unfamiliar to me, i.e., and carried out a purely technical role. Those senior in terms of experience and importance after Ya. B. Zel'dovich were D. A. Frank-Kamenetskiĭ and A. S. Kompaneets. But everyone expected a great future to open up before our "wunderkinder"-to Kolya Dmitriev and Serezha D'yakov who, apparently, already at the time, even if not to the full extent, but sufficiently deeply, understood the problems and the essence of the calculations in which they were engaged, and were fully appreciated creative members of our friendly team "from Yakov (i.e., Zel'dovich, transl. note) to D'yakov". Every so often on the doors of our room appeared the current issue of the "door newspaper" with poems and "twaddle", with friendly mutual teasing.

Ya. B. Zel'dovich and I liked to go to our neighbors-in the Institute of Physics Problems for dancing. Serezha also

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made an appearance there, but neither the jazz music, nor the frisky capers of Ya. B. Zel'dovich inspired by this music, were to his taste, and he did not conceal this. I remember that once Zel'dovich who was even made angry by this spitefully asked: "Well, Serezha, you probably would have preferred dances of the buffoons at the time of tsar Alekseĭ Mikhailovich (mid-seventeeth century, transl. note)?" —"Just so", Serezha replied, not yielding to his boss. However, he continued to attend the parties at the Institute for Physics Problems and achieved considerable success in dancing.

Our frequent interaction lasted, as I have said above, for only a few months. Kolya Dmitriev went to "N-sk" following Zel'dovich (and in the door newspaper appeared the doggerel by Kompaneets "And I shall go, where I am sent, suppressing my chagrin. I'll go wherever Khariton drives the proverbial calves"), and Serezha D'yakov was transferred to the Institute for Physics Problems into L. D. Landau's group.

D. A. Frank-Kamenetskiĭ also left the Institute for Chemical Physics, and I, after the defence of my candidate's thesis, was transferred to experiments on neutron physics. Many long years began of our close friendship with A. S. Kompaneets which were broken off, together with his life, a quarter of a century later. But much earlier—after only 5–6 years-one day in early autumn we learned the sad news of the death of Serezha, who drowned in one of the water reservoirs near Moscow. In mournful silence we bade goodbye to Serezha in the auditorium of the Institute for Physics Problems and accompanied to the cemetery the bus with his casket. Several years later I read the book by Leopold Infeld "Evariste Galois" and its epigraph "Whom the gods love die young" (Menander) made me think of Serezha... .

After the departure of Zel'dovich for the city of "N-sk", the theoretical division in the Institute of Chemical Physics for more than 20 years was headed by A. S. Kompaneets who was very much attracted to D'yakov. And it is a pity that we are unable today to ask him to say a word. But he will be replaced by a pupil and a successor in his activity, the head of the theoretical laboratory of the Institute of Chemical Physics, N. M. Kuznetsov who in line of his duty often had to turn to the publications of D'yakov, and who has heard so many good comments about him from Kompaneets.

—D'yakov is one of those relatively few representatives of the school of L. D. Landau whose main interests were at the junction of two sciences-physics of explosion and gas dynamics. Such scientists had a great probability of getting involved in special investigations not subject to publication in the open press. D'yakov was also associated with this classified subject matter, and his published papers, which we are now discussing, are only a part of what he had time to accomplish. And if after our article there will come forth persons wishing to tell something new about D'yakov, then this article will have reached its aim.

D'yakov died very early, at the beginning of the blossoming of his creative powers, and yet having had time to leave an impressive fundamental scientific heritage. D'yakov's principal published papers which next year will have attained their fortieth anniversary are devoted to the fundamental problems of the theory of the structure and stability of shock waves. D'yakov's paper[2] "On the stability of shock waves" is without any doubt a classical one not fading with the years. By a strict and elegant method criteria are found for the stability of a shock wave with regard to curvature of its front, possible shapes of a shock adiabatic curve were determined along which there are sections satisfying such criteria. These results in subsequent years were confirmed and made more accurate in numerous investigations which are still being conducted up to the present time (see the review of Ref. 3). This work gave the desired answers and at the same time posed new interesting problems: along with the regions of stability and instability a puzzling region of parameters was discovered in which initial small deformations of the front of the shock wave (undulating perturbations) do not grow, but also do not decay in time. What is the actual behavior of the shock wave in this range of parameters, is it stable or not-the answer to this question must be sought going outside the framework of the linear theory of stability. To D'yakov who formulated this problem fate did not allow even a few months to solve it. Perhaps, because of this it was solved only recently after more than three decades. The instability of a shock wave according to D'yakov's criteria corresponds to quite characteristic shapes of the shock adiabatic curve which, although not contradicting the laws of thermodynamics, are far from being typical. Therefore the results of D'yakov at first were regarded primarily as a theoretical explanation of why shock waves are stable. However, interest in the problem of stability of shock waves increased greatly in the 1970's after a number of experimental indications of the instability of a front of intense shock waves accompanying ionization and in some other relaxation processes in a definite range of parameters. In interpreting these phenomena the classical results of D'yakov provided a possibility of essentially narrowing down of what is not known and to relate the observed perturbations to the manifestation of instability of the structure of the relaxation zone of a shock wave, and not of a gas-dynamic discontinuity as such (for details see below).

In the pioneering paper by D'yakov in Ref. 4 the structure of a shock wave in a two-phase system gas+solid particles was investigated and it was shown that the concentration of the solid particles in the relaxation zone of the shock wave changes in a nonmonotonic fashion—it passes through a maximum. This seemingly a purely academic result found subsequently an important practical application in calculating the probability of igniting of combustible particles as a result of shock wave action on dusty media. The study of gaseous suspensions, particularly with particles that can burn is very topical and in our time is of an ever-increasing applied significance in connection with problems of accident prevention and protection of the environment. Also in this field of science and technology the basic results due to D'yakov serve as a reference point in complicated numerical calculations of two-phase flows of

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(1925–1954)

concrete systems. And here we should call for comments by G. M. Arutyunyan who literally during several months prior to the tragic death of D'yakov was on a practicum under his direction prior to his diploma work and began working in this direction of the physics of shock waves.

—Concerning the scale of the contribution D'yakov made to the physics of shock waves in two-phase media one can judge by the two examples from his creative output which are given below. A significant contribution of D'yakov to the hydrodynamic theory of shock waves is his work on the structure of weak shock waves in binary gases and in a suspension of microscopic particles (dust particles) in a gas which required taking into account along with heat conductivity and viscosity also the processes of diffusion, thermodiffusion and barodiffusion. This problem of exceptional complexity was correctly formulated and completely solved analytically by him in Ref. 4. Here his out-of-the-ordinary physical-mathematical abilities, his erudition and fine intuition were manifested with special brilliance. Along with Ref. 2, it became the basic one in the entire modern theory of the stability of shock waves in gases and in mixtures of gases (for details see below).

D'yakov made a fundamental contribution to the theory of structure of shock waves in thermodynamically nonequilibrium relaxing media. It is well known,[1] that second viscosity is due to the violation of thermodynamic equilibrium in changing the volume of a continuous medium and ordinarily has the same order of magnitude as the ordinary viscosity η. However, if the relaxation time is not small compared to the characteristic time of the change of volume, then deviations from thermodynamic equilibrium will be great and the dissipation of energy can be great. Since the dissipation is determined by the second viscosity ζ, the value of ζ can turn out to be large. The value of ζ depends on the relationship between the rate of change of volume and the relaxation time. In particular, if the changes in the volume are brought about by a sound wave, then ζ depends on its frequency and one can speak about the dispersion of the second viscosity. M. I. Mandel'shtam and M. A. Leontovich who have studied this problem already in 1937 have shown that[5]

$$\zeta=\frac{\tau\rho}{1-i\omega\tau}(a_\infty^2-a_0^2), \tag{1}$$

where ρ is the density of the medium, ω is the frequency, i is the imaginary unity, a_∞, a_0 are the velocities of sound at frequencies so great and so small that the relaxation process is correspondingly "frozen in" and, conversely is totally completed. From (1) it follows that in processes so slow that $\omega\tau \ll 1$,

$$\zeta=\tau\rho(a_\infty^2-a_0^2), \tag{2}$$

when it follows that ζ indeed grows as the relaxation time τ increases.

D'yakov, in 1954, showed (6), that formula (2) and the condition of its validity can be effectively utilized to determine the structure and the width of weak shock waves in strongly relaxing media. Indeed, in accordance with the hydrodynamic theory of shock waves[1] the pressure in the transition layer of a weak shock wave (i.e., its structure) is determined in accordance with the law

$$P=\frac{P_1+P_2}{2}+\frac{P_2-P_1}{2}\,\mathrm{th}\,\frac{x}{\delta}, \tag{3}$$

where x is the spatial coordinate, P_1, P_2 are the pressures respectively ahead of and behind the front of the wave, and δ is its width determined by the formula

$$\delta=\frac{8KV^2}{\Delta P\left(\frac{\partial^2 V}{\partial P^2}\right)_S}, \tag{4}$$

where V,S are the specific volume and entropy, $\Delta P=\text{and}=P_2-P_1$ is the pressure drop in the shock wave, and

$$K=\frac{V}{2a^3}\left[\left(\frac{4}{3}\eta+\zeta\right)+\varkappa\left(\frac{1}{C_V}-\frac{1}{C_P}\right)\right]. \tag{5}$$

In formula (5) a, C_V, C_P are the velocity of sound and the specific heat capacities at constant pressure and volume, and all the quantities entering the right-hand side of (4) (except for P) refer to the state ahead of the wave. D'yakov noted that since in virtue of (4) the width of the transition layer of a shock wave is inversely proportional to its amplitude, then for sufficiently weak shock waves in a relaxing medium the state of the material in the transition layer can be regarded as varying slowly with respect to establishment of equilibrium, and this enables one to treat the process of relaxation in the spirit of the Mandel'shtam–Leontovich method using expression (2) in (5), neglecting in so doing the thermal conductivity and the usual viscosity. As a result the following formula was obtained

$$\delta=\frac{4\tau V^2(a_\infty^2-a_0^2)}{\Delta P a_0^3\left(\frac{\partial^2 V}{\partial' P^2}\right)_S}, \tag{6}$$

the possibility of using which required the establishment also of the condition of slow variation of the state of the substance in the transition layer. Formulated in the general form $\delta \gg a_0\tau$, in virtue of (2) and (6) this condition was made specific in the form of the now well-known criterion

$$\Delta P \ll \frac{4V^2(a_\infty^2-a_0^2)}{a_0^4\left(\frac{\partial^2 V}{\partial P^2}\right)_S}. \tag{7}$$

The method described above has been applied for certain important classes of relaxing systems[7–9] and is at the present time widely known as the "method of the second viscosity concept of Mandel'shtam–Leontovich–D'yakov".

As has already been noted above, the problem of the stability of the front of the shock wave has again appeared at the center of the attention of investigators beginning with 1970 when this phenomenon was confirmed experimentally, while the paper[2] by D'yakov is the further development. A number of generalizations and ideas in this field belong to O. A. Sinkevich whom we now ask for comments.

—At the present time it is becoming obvious that it is specifically the mechanism of stability which guarantees the choice of different evolutionary states in living and nonliving nature. If we dwell only on the instabilities in distributed systems, then in many cases one can pick out the instabilities brought about by internal states and processes in the medium, and instabilities due to active boundaries.

S. P. D'yakov was one of the first who convincingly demonstrated the role of active boundaries in the problem of the stability of plane shock waves with an arbitrary form of the shock adiabatic curve of Hugoniot $P=P(V)_H$ (here P is the pressure, $V=1/\rho$ is the specific volume, and ρ is the corresponding density of the medium) with respect to two-dimensional undulating perturbations. For a plane shock wave propagating in the positive direction of the y axis, when the unperturbed flat surface of the front coincides with the xOy plane, D'yakov investigated in the linear approximation the stability of the initially small perturbations ξ (viscosity and heat conductivity were neglected) of the form $\xi\sim\exp(ikx-i\omega t)$. Since the shock wave moves with an ultrasonic velocity with respect to the gas in front of the wave then naturally the perturbations do not penetrate there. The following boundary conditions were chosen for the linearized equations of gas dynamics: restriction on the size of the perturbation as $z\to\infty$ and the relationships at the front of the shock wave that follow from the usual laws of conservation of the fluxes of mass, momentum and energy. Assuming an arbitrary shape of the shock adiabatic curve, and concentrating attention on perturbations in the entropy-vortex and sound waves, D'yakov from the solution of the characateristic equation obtained the conditions for instability of a plane shock wave with respect to undulating perturbations in the form

$$m\equiv\left(\frac{\partial V}{\partial P}\right)_{\mathrm{H}} j^2<-1,\quad m=1+2\mathrm{M}_2. \tag{8}$$

Here $j=\rho_1 v_1=\rho_2 v_2$ is the mass flux across the front of the shock wave, $\mathrm{M}_2=v_2/a_{S2}$ is the Mach number, v_2 is the velocity of the medium behind the front, a_{S2} is the velocity of sound behind the front of the shock wave, $(\partial V/\partial P)_{\mathrm{H}}$ is the derivative of the shock adiabatic curve, and the subscripts 1 and 2 refer respectively to conditions ahead of the front and behind the front of the shock wave.

In addition to the conditions (8) for the instability of a shock wave D'yakov established that in the range of parameters satisfying the conditions

$$\mu_0<m<1+2\mathrm{M}_2, \tag{9}$$

where

$$\mu_0=\left[1+\mathrm{M}_2^2\left(2-\frac{\rho_2}{\rho_1}\right)\right]\left[1+\mathrm{M}_2^2\frac{\rho_2}{\rho_1}\right]^{-1},$$

solutions exist with undamped perturbations of the front of the wave (stationary in a certain system of coordinates gliding along the front) to which from the side of the flow behind the front are connected sound waves emerging at a definite angle. The range of the parameters

$$-1<m<\mu_0 \tag{10}$$

was included by D'yakov in the region of stability of plane shock waves with respect to relatively small undulating perturbations.

Subsequent numerous studies of the stability of plane shock waves[10–11] carried out by different methods did not alter the boundaries of the range of initiation of instablity (8). Taking viscosity and heat conductivity of the gas into account[14,15] also did not change the position of the boundaries of the region (8). However, making more precise the lower boundary of the region (9) carried out in Refs. 9,10,11,12,16, showed that

$$\mu_0=\left[1-\mathrm{M}_2^2\left(1+\frac{\rho_2}{\rho_1}\right)\right]\left[1-\mathrm{M}_2^2\left(1-\frac{\rho_2}{\rho_1}\right)\right]^{-1}. \tag{11}$$

A subsequent more detailed analysis of the nature of treatment of small perturbations showed that in the stable region if one does not take viscosity and heat conductivity of the gas into account the perturbations of a shock wave may be damped in time according to the power law $t^{-3/2}$ (perturbations in a strong shock wave are damped according to the law $t^{-1/2}$). Taking into account finite viscosity[13] or finite conductivity of the medium behind the front of the shock wave moving in a transverse magnetic field can lead to exponential damping of the perturbations and to the disappearance of the region of spontaneous generation of sound.[19,20]

In the region (9) the existence of undamped (steady-state) undulating perturbations of the front the angles of orientation of the emerging sound waves correspond to resonance reflection of sound by the front of the shock wave.[22–25] In this range of parameters of the problem the shock wave being neutrally stable to small perturbations may turn out to be unstable with respect to perturbations of finite amplitude leading to the splitting of the shock wave into a shock wave of lesser intensity, a contact discontinuity and a rarefaction length.[26–35] The instability of a plane shock wave with respect to one-dimensional perturbations is closely related to the evolutionary nature of the surface of the discontinuity-the front of the shock wave.[22] Subsequently a study was made of the behavior of small perturbations at the nonlinear stage for an unstable shock wave,[25–35] when there is incident on the front of the wave a finite perturbation[27] and spontaneous decay[31,32] leading to two-dimensional perturbations decay of the plane wave into a triple configuration λ—a discontinuity.[31] However, at the present time a complete answer concerning the nature of the phenomena in the unstable region is not yet available.

The problem of the instability of a plane shock wave with regard to two-dimensional perturbations is closely associated with the fact that two-dimensional perturbations can have an infinite growth coefficient

$$\operatorname{Im}\omega\sim K,\quad -\infty<K<+\infty. \qquad (12)$$

Taking into account the finite thickness of the front of the shock wave—the structure of the wave associated with finite viscosity and (or) heat conductivity, with processes of chemical kinetics, and processes of ionization, can lead to a limitation on the increment of the growth of perturbations and to finding a perturbation that survives in the nonlinear stage. One can suppose that the evolution of an unstable shock wave and the final stage into which the unstable state transforms are closely associated with the nature of the initial perturbations—depending on the form of the perturbations the shock wave may be transformed into different states.

An interesting situation can exist in the region of neutral oscillations even in the absence of chemical reactions in the zone behind the front of the wave if one examines its structure. A neutrally stable shock wave can generate turbulence (in this case a continuous spectrum of perturbations arises in a natural manner). The appearance of turbulence can lead not only to a modification of the transport coefficients of turbulent viscosity and of heat conductivity, but also to a change in the form of the hydrodynamic equations describing the behavior of the gas behind the front of the wave: the system of the averaged Navier–Stokes equations which close the equations for the intensity of turbulent pulsations. Since in the region of neutral oscillations the shock wave is unstable to perturbations of finite amplitude the appearance of turbulent pulsations points out the intensity of perturbations (threshold) which can lead to a break up of the wave into other stable configurations. A still greater set of possibilities arises for shock wave in two-phase media and multicomponent plasmas and here the approaches proposed by D'yakov may turn out to be very productive.

—Being a theoretical physicist was not the only God's gift to S. P. D'yakov. His talent as a lecturer was another God's gift to him. He had not yet reached the age of 28 when he was giving a specialized course on non-steady-state and nonlinear phenomena in hydrodynamics for us (G. M. Arutyunyan and A. A. Rukhadze), students of the 4th and 5th years of the physico-technical faculty of Moscow State University and the Faculty of Theoretical and Experimental Physics of the Moscow Engineering Physics Institute. In many respects the corresponding chapters of "Mechanics of Continuous Media" by L. D. Landau and E. M. Lifshitz remind one of the contents of S. P. D'yakov's lectures. But that book when he was giving his lectures in 1952 and 1953 had not yet been published and after it had been published to all those who heard the lectures in the special course of S. P. D'yakov it became clear why so often his name is mentioned in that book. The book by L. D. Landau and E. M. Liftshitz "Mechanics of Continuous Media" was published only after the death of S. P. D'yakov.

And the way he lectured in that course! One had to see that very thin young man with a large black head of hair in a brown striped suit at the blackboard! He bore a similarity to Van Cliburn except that he was dark haired, he reminded one of an enthusiastic conductor in the manner of dealing with the blackboard as with an orchestra and with chalk as with a conductor's baton. He was in love with science, as Julien Sorel, and it returned his affection. It is not an accident that he had succeeded to do so much in science and to leave a deep trace of reminiscences about himself.

His loving attitude to everything about which he talked, and his enthusiasm indicated that what he was relating did not come from textbooks and even not from articles just published by other authors, but that he was talking about his own material just obtained by himself and therefore so dear to him. In everything, you could feel that he is presenting a result obtained only yesterday. And he was not afraid because he knew everything so deeply, that nobody, except L. D. Landau, could catch his idea and be ahead of him. But also to him D'yakov was not afraid to tell about his thoughts and doubts, since he was in love with him and often confessed this in lectures in such words: "All that I am telling you has been prompted by L. D. Landau, this was born in conversations with him". And D'yakov was happy that L. D. Landau reciprocated his feelings. He did not boast about this, this followed from the way he pronounced the name of L. D. Landau which he always pronounced with aspiration. And the fact that the affection was mutual is clear from the book by L. D. Landau and E. M. Lifshitz.

As we absorbed D'yakov's lectures and became involved in his seminars, we, little by little, began to understand that he is opening doors for us into a uniquely interesting and unusual world of processes, where the most complex physics phenomena inpetuously and magically are developed in an intricate manner in space and in time. It was becoming evident that the subject which we were about to study in all its nontriviality, richness of content and internal beauty is in no sense inferior to objects being studied in electrodynamics, quantum mechanics or nuclear physics. It is specifically D'yakov's lectures that convinced us of the truth of the words of the great Heisenberg which were heard considerably later that "the mechanics of continuous media he regards to be the most interesting section of theoretical physics". These words could have been spoken by anyone who at that time was attending D'yakov's lectures.

To speak and to write about D'yakov is at the same time both easy and difficult. Easy because his nature was frankly striking and outstanding. And difficult because he was not a simple man and a reserved one. In his relationship with students he was sufficiently open, patient and democratic. In lectures and seminars he took a relaxed attitude often sparkling with wit. For example, everybody remembers his joke about the three necessary qualities of a theoretician (a cool head, a hot heart, and a leaden bottom) when at one of the seminars none of the three persons that approached the blackboard were able to solve some problem. However, he knew when to stop and never crossed the line beyond which his relationship with his students might lose the quality of mutual respect.

The outstanding and refined nature of Sergeĭ Petrovich was manifested literally in everything. Even in his external appearance. He dressed tastefully, but without excess. Always very tidy, somewhat old-fashioned according to those times (had long hair and wore a bow tie). His sense of humor was also nonstandard. It is known that he was an enthusiastic tourist. And when once, he was speaking about his adventures in the sands of Kara-Kum desert, he was asked if it was too hot, he replied: "And what do you think, if at night the temperature dropped to plus 40 °C?"

Now about D'yakov's modesty. When he was giving his course of lectures, and, as we learned, that he was not yet 28 years old, none of us even suspected that he was already a laureate of a State Prize for papers together with the outstanding physicists Ya. B. Zel'dovich and A. D. Sakharov. And even those who knew him then, do they know about this today?

In the entire appearance, talent and tragic fate of D'yakov there was something Mozartian including the early blooming of his talent. This is indicated by his entire biography which was related to us by D'yakov's friends—N. L. Solomina and L. G. Stepanova.

—S. P. D'yakov was born on 29 August 1925 in Moscow into the family of an engineer bridge-builder. His grandfather was the scientist-forester Sergeĭ Vasil'evich D'yakov mentioned in the Brokgauz and Éfron encyclopedia. At home his parents created an atmosphere of high spiritual interests, which molded the impressionable nature of Sergeĭ Petrovich.

At the age of 14, Serezha conducted the lessons in his class when his teacher was absent due to illness. At the age of 15, Serezha obtained the permission of the People's Commissar on Education to take the entrance examination to the Moscow State University as an external student and at the of age 16 when the war began he became a student in the Chemistry Faculty of Moscow State University. Simultaneously with his studies in the Chemistry Faculty he optionally also completed the program of studies in the Mechanics-Mathematics Faculty of the university, and according to the reports of the professors of the faculty he showed brilliant mathematical ability.

At the age of 17 years, Serezha became an orphan-his father died of tuberculosis, and he became the breadwinner for the family-his mother and his brother. And at the age of 22 he also lost his brother. Serezha earned his livelihood by giving private lessons in mathematics. In his days as a student and as a graduate student he experienced great need.

While studying at the Chemistry Faculty Serezha attended seminars in theoretical physics of Professors D. D. Ivanenko and N. N. Bogolyubov. In 1944 Serezha gave a report on "The statistical method of Gibbs", demonstrating in the process his magnificent oratorical gift; later he successfully gave a report in the large physics auditorium of the Physics Faculty of Moscow State University "On the law of conservation of energy" having filled the lecture hall. In those years Serezha took a great interest in quantum mechanics, and in the work of Schrödinger, Heisenberg, Planck and others.

At the age of 20, Serezha graduated from the Chemistry Faculty ahead of schedule and enrolled as a graduate student in the Physics Faculty in the Department of Theoretical Physics.

At the age of 23, D'yakov defended his candidate's disseratation working already in the Institute of Chemical Physics of the Academy of Sciences. He completed a number of investigations, which unfortunately have not been completely published, on the hydrodynamics of an explosion and on shock waves in continuous media. In 1951–1954 he worked with L. D. Landau in the Institute of Physics Problems of the Academy of Sciences of the USSR, was his collaborator in hydrodynamics and in this field stood at the same level with him.

L. D. Landau and E. M. Liftshitz in many respects based themselves on the scientific results of D'yakov in writing the section "Mechanics of Continuous Media" of their famous course in theoretical physics.

In 1953, D'yakov was awarded the State (at that time Stalin) Prize together with Ya. B. Zel'dovich for participation in the development and realization of the project of the atomic bomb and received the Order of "Mark of Honor".

D'yakov was a musically gifted man, played the piano and the violin, sang and even wanted to enrol in the Gnesin School in the vocal class where he was being insistently invited. He deeply understood classical music, and loved Wagner, Tchaikovsky, Scriabin, Schumann and Schubert.

He had a romantic appearance: tall, slender, a fine spiritual face, lively mocking eyes. He concealed the vulnerability of his spirit behind irony and a lively wit. The artistic side of his nature was manifested in the black bow tie which he invariably wore.

In him science lost a talented scientist with a bright intellect, a richly endowed man, a noble soul. Naturally he could have accomplished still much more and many would have been made happy by his talent and kindness. But it seens to us that even that which he has accomplished is well known to not too many. And we hope that this article will find a response in the hearts of many who knew him and knew his activities, particularly in the field of physics that was classified in those years. And perhaps people will be found who would like to tell about him for everyone to hear. We would be very happy if this happened and are willing to help you in this.

We await your letters.

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