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"The most remarkable man among the scientists": on the occasion of the 130th birthday of L I Mandelstam

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Abstract. Newly discovered evidence and archival material are presented which give a new insight into the life and career of one of the greatest physicists of the twentieth century — Leonid Isaakovich Mandelstam.

> *L I Mandelstam is perhaps the most remarkable man among the scientists I knew in Russia.*
>
> S I Vavilov [1]

The year 2009, the 75th anniversary of establishing the P N Lebedev Physical Institute (FIAN in *Russ. abbr.*), is also the 130th anniversary of the birth of Leonid Isaakovich Mandelstam, a prominent figure in the history of the Institute and one of the greatest scientists in the first half of the 20th century.

According to USSR Council of People's Commissars Resolution No. 252 dated 5 February 1945 and signed by V M Molotov [2], the following measures were to be taken to perpetuate the memory of the recently late L I Mandelstam: to publish the collected works of the scientist; to establish the Academy of Sciences two three-year awards — one in physics, and one in radio physics, and to grant a monthly scholarship at the Physics Department of Moscow State University (MSU) to three undergraduates and one postgraduate, and at the P N Lebedev Physical Institute to one PhD student and one postdoctor.

Honors on this scale — I know of no other academician who has been honored in such an impressive way — had, of course, to have been paid to an outstanding person. And so Leonid Isaakovich Mandelstam certainly was — a physicist of both national and international recognition, one of the founders of the Soviet school of optics and radio engineering, a person whose theoretical skills were amazingly blended with experimental, engineering, and lecturing talents. To quote I E Tamm: "I have lived a long life but have never seen his like. Mandelstam is a very rare personality. Such a combination of mighty intellect with an extraordinary humanity and purity" (see Ref. [3], p. 198).

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Leonid Isaakovich Mandelstam *
(1879 – 1944)

L I Mandelstam was born on 5 May (22 April, Old Style) 1879 in Mogilev, then Russian Empire, now Belarus. In 1891, following a period of home education, he straightaway entered the third grade of the Odessa gymnasium (Odessa was then a Russian city and now is Ukrainian), from which he graduated with honors [4]. Story has it that even at that young age he often gained the upper hand in disputes with adults, unable to oppose him and struck by his rigorously logical arguments and sharp mind — qualities which, displayed so early, remained with him throughout all his life.

Upon graduation from the gymnasium, he entered the Physics Department of New Russia University, also in Odessa, but was soon excluded in connection with student

* Photographed in 1930.

unrest, and moved to Strasbourg, Alsace (then Germany, now France), where he continued his education at the local university's physics and mathematics department, from which he graduated in 1902.

His teacher — and later his senior friend — there was Professor Karl Ferdinand Braun, 1909 Nobel Prize Laureate [5], at the time the chair of Strasbourg University's physics department and director of the city's world recognized Physics Institute. It was in those years that L I Mandelstam worked his way up from assistant to professor [6]. One of his responsibilities in that period was, importantly, that of research supervisor for doctoral students and foreign scientists.

L I Mandelstam showed himself to be an outstanding experimentalist, a profound theorist, and an extremely talented lecturer. His research interests were in radiotelegraphy and the propagation of light, and his lecture courses covered various topics in physics, the optical properties of materials, dispersion, the resonance phenomenon, telephony, and the physical aspects of radio. Illustrated by his brilliant demonstration experiments, Mandelstam's lectures were invariably a tremendous success.

It is in this period that he devised and implemented the idea of image time scan [7], now used internationally by oscillograph, TV, and computer manufacturers.

Mandelstam's idea is that in addition to the voltage proportional to that under study and applied to one deflecting system of a monitor, another voltage varying linear in time is simultaneously applied to the other deflecting system mounted at a fixed angle to the first. As a result, the time dependence of the process can be visualized and/or the device of which the monitor is part can be checked for usability. The title of Ref. [9] (referred to in Refs [7, 8]) is telling of where the level of engineering was at the time.

L I Mandelstam married in 1907. A son named Sergei was born in that family, who was to become a physicist, head of a FIAN laboratory, and the founder and first director of the USSR Academy of Sciences Institute of Spectroscopy.

In 1908, L I Mandelstam was elected a member of the Strasbourg Society of Natural Scientists and Physicians, and later of the German Society of Physicists and Natural Scientists — a membership which he denounced when the fascists came to power in Germany.

In 1914, with the smell of war in the air, Leonid Isaakovich hurried back to his home country of Russia — despite proposals to remain, according to his later recollections [10] — and, failing to organize research at New Russia University, accepted a position as a consultant at a radio telegraphy plant in Petrograd. This was followed by a move in the fall of 1917 to what was then Tiflis (then part of the Russian Empire, now Tbilisi, Georgia), where he served simultaneously as a physics professor at the Polytechnical Institute and a professor of women's higher education courses. Late in 1918 he was again in Odessa, where he remained a professor until 1922 [8] and held a consulting position at the Odessa radio telegraphy plant.

Late in 1922 he joined the Radio Laboratory at the Trust of Weak Currents in Moscow, and then followed the laboratory in its move to Leningrad. In 1925, much through the efforts of G S Landsberg and S I Vavilov [11], he was invited to Moscow State University, where he worked at the Physics Department and also held a position at the university's Research Institute of Physics and Crystallography.

In 1928, Mandelstam's own follow-up studies led to the discovery, with G S Landsberg, of the so-called combination scattering of light, a phenomenon in which radiation incident on a material undergoes modulation by atomic and molecular vibrations, thus implying the occurrence of a parametric process in optics.

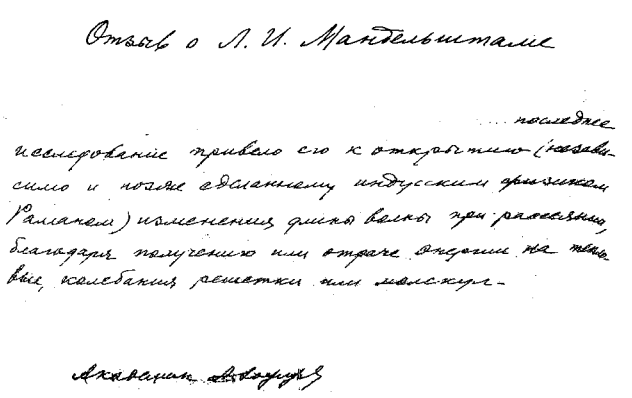

Figure 1. Evaluation report on L I Mandelstam written by A F Ioffe in 1928 (excerpt).

In Mandelstam–Brillouin scattering, an effect whose possibility was unambiguously recognized by L I Mandelstam in 1918 (see Ref. [4], p. 29), incident light is modulated in the medium by the acoustic vibrations of the atoms of this medium. This effect was first observed by G S Landsberg and L I Mandelstam in solids, and by G F Gross in liquids.

Although Leonid Isaakovich discovered combination scattering of light earlier than C V Raman of India (see Appendix 1, Ref. [12], and Fig. 1), it is the latter who was awarded the Nobel Prize in Physics 1930 for the discovery of the effect named after him [5]. The reasons for this mistake were explained elsewhere [13–16]. Here, it is worth noting that information on who the actual discoverer was had been made available before the Nobel Prize was awarded — in the form of a USSR Academy of Sciences official document with a circulation of 1800 to the effect that Russia was the country of the discovery [12].

By and large, though, life in Moscow was not sweet for L I Mandelstam, prompting him to consider returning to Leningrad. To quote from a letter to A F Ioffe from S I Vavilov and others (see Ref. [17], p. 179 and Appendix 2): "You are perfectly aware of the middling level of physics in Moscow over the last 15–20 years.... As a result, a sadly provincial atmosphere formed, with things of real substance given only secondary attention. The work and activity of Mandelstam over the last two years has been the only bright spot against this dim background. Under the extremely experienced and talented direction of L I, it can be said that theoretical physics is emerging in Moscow from scratch.... Today, all our hopes are going to be crushed. We therefore ask you for self-sacrifice, we ask you — to try to convince him to stay in Moscow.... We are speaking here not only on our own behalf but also with and for all sound-minded Moscow physicists."

L I Mandelstam did not move back to Leningrad.

There were also silver linings in the dark cloud of his life in that period, one of them being a letter by P Ehrenfest of 10 May 1928 that insisted on selecting Mandelstam and Rozhdestvensky as members of the Academy of Sciences (see Ref. [18], p. 120). Here is what the prominent scientist, a man of keen intuition for human nature and himself a member of the Academy (see Ref. [3], p. 43; [19, 20]) wrote about Mandelstam: "I have been always amazed by the

extreme clarity and sharp critical insight with which he treated the theoretical problems of physics. More than once I felt envy when I saw him to ingeniously and cleverly solve a problem that was beyond my powers.... I understood why students and young physicists loved him so much and why they grew into scientists when near him.... In my view, the role of Mandelstam is in many respects similar to that of Langevin."

The following quotation from A F Ioffe (see Ref. [17], pp. 52, 53) shows that this comparison is a high evaluation indeed: "The moral and scientific authority of Langevin was beyond dispute. He did not publish much himself but, as everybody knew, it is due to his inspiration that almost all French physicists worked. Almost any paper had to be co-signed by Langevin.... Modest and unsusceptible to envy, he picked up any fresh scientific idea and often imparted to it even more clarity than the author himself could achieve.... This impression was even stronger during his demonstration experiments, for each of which he outlined the historical perspective and described the difficulties that had to be overcome.... He loved his country, its people and its history."

Equally high recognition can be given to the role of Mandelstam in Russia. In fact, there is hardly a physicist in the country worthy of the name who did not feel the inspiring influence of Mandelstam and his disciples.

Turning back to Ehrenfest's letter, it is worth noting that it is exactly L I Mandelstam and D S Rozhdestvensky who became academicians in 1929 (together with N I Bukharin, N I Vavilov, V A Obruchev, S A Chaplygin, and some others). The future Nobel Prize Laureates P L Kapitza, N N Semenov, and Enrico Fermi were elected to the Academy in the same year.

A remarkable paper on quantum mechanics with M A Leontovich gives a more complete idea of Mandelstam's creative work [21, 22]. In fact, the paper provides the entire basis for the theory of particle penetration through a potential barrier and thus indeed for G A Gamow's theory of the α-decay of radioactive nuclei (as Gamow himself later recognized, see Ref. [4], p. 134).

L I Mandelstam was also internationally the first to transfer the ideas of optical interference to the radio frequency band and to suggest using radar methods in astronomy. Before Mandelstam there was no theory of nonlinear waves; today nonlinear oscillations are a subject of study in optics, acoustics, and radio physics. Before him there was not even any such thing as a course in oscillations; today, dozens of universities have such courses included in their curricula. Some of his work and his discussions with M Planck were concerned with the theory of microscopic images. He was the author of dozens inventions. For more details on this, see Refs [4, 23–28].

Mandelstam's joining MSU resulted in a remarkable improvement in physics teaching there, bringing it abreast with the progress in the science. In 1935, according to an article by his students [29], Mandelstam was directing quite a number of research projects he had been able to set up successfully at the university, in particular, on light scattering and sound wave propagation (the latter project he also led in part at FIAN). To quote from the article, he was "a very rare occurrence among modern physicists — an experimentalist and a theorist at the same time."

This was remarkably manifested in his work as a lecturer. "Each one of Mandelstam's lectures is an event of significance far beyond the MSU Physics Department." His lectures attracted a broad and diverse audience where students (in physics and mathematics alike), engineers, and professors could be found. As noted in Ref. [29], his lecture style was to constantly share with students his ideas and guesses and to repeatedly pose new questions to them — in doing so creating an atmosphere "extremely favorable for a scientific community to grow in."

Mandelstam's seminars, although formally intended for senior undergraduates, were attended by all physicists and were in fact the center of physical thought in Moscow [30]. His lectures and talks always captured the audience, leading them to forget everything around them and to take to heart what they heard — much in the way films, theatre, and other forms of art do at their best [31].

As noted in Ref. [28]: "Even people far from physics were often very strongly impressed." M A Leontovich, an article co-author, told: "when he appeared at the university, we were just amazed at the level of his knowledge" (see Ref. [3], p. 158). "...This man spoke for future decades," as V A Fabrikant recollected his own impressions (see Ref. [4], p. 241).

His talks at the Academy of Sciences were also highly appreciated. One of them titled "An interference method for studying the propagation of electromagnetic waves" and delivered on 28 May 1938 was perfectly described by A E Fersman as "a poem" (see Ref. [4], p. 52). An excerpt from V I Vernadsky's diary reads: "An interesting and brilliant talk.... I listened to it the way one rarely has a chance to do.... His work is very important and his method has a great future.... He amazed me at that time by the consistency and clarity of his thought" [32]. It should be remarked parenthetically that the method in question found successful applications in guiding vessels across northern seas and in mine sweeping.

Under the leadership of G S Landsberg, the Spectroscopy Commission was appointed within the Academy of Sciences, which was very active during the war years, particularly in the composition study of alloys (including steels) and benzenes of great need for the front. As the next step, the USSR AS Institute of Spectroscopy was created [33], which is of high importance today.

After FIAN's move from Leningrad to Moscow, Mandelstam became the scientific leader of the institute and collaborated "in unanimous and unbroken harmony" with the acting director S I Vavilov (later President of the USSR Academy of Sciences) (see Ref. [4], p. 219).

The same source contains a review by Leonid Isaakovich of the dissertation written by P A Cherenkov [34]. The review devotes a good deal of attention to S I Vavilov. In Mandelstam's words: "The role of Sergei Ivanovich in the discovery of the effect is so great that it should be pointed out each time the effect is being talked about." Importantly, there was a question from L I Mandelstam during the dissertation defence as to *where* the radiation in question comes from in this effect. It took seven years for this question to be answered [35].

The reader may have noticed that the heading of and epigraph to this paper is an excerpt from S I Vavilov's diaries [1]. Here is how Vavilov goes on to list Mandelstam's qualities: "...superhumanly sharp physical thought, moral integrity under the most severe conditions, kind and light-hearted personality and high general culture."

The director of FIAN was not the only one to highly appreciate Mandelstam. "Friendship and cooperation with Mandelstam" was "great personal happiness" for G S Lands-

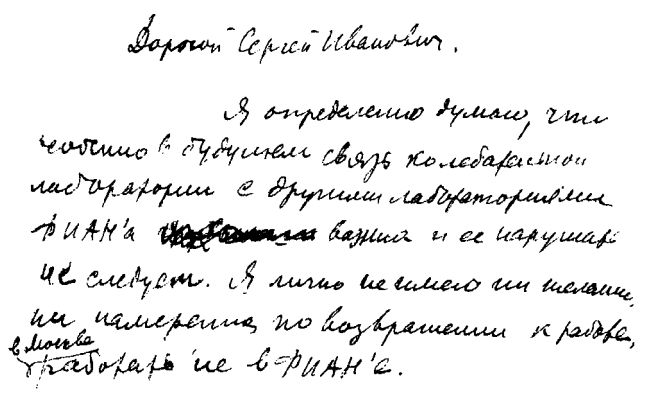

Figure 2. Letter from L I Mandelstam to S I Vavilov of 13 March 1943 (excerpt).

berg (see Ref. [11], p. 102). I E Tamm, in his letter to the Mandelstam couple, wrote: "I felt with perfect clarity that you were the closest people in the world for me" [36]. A letter from England cited in Ref. [37] says in particular that "Kapitza keeps asking with greatest interest and warmth about you and has sincere respect and affection for you." As P L Kapitza said posthumously of Leonid Isaakovich: "...with him we lost the best Soviet physicist and a refined man" (see Ref. [4], p. 306). V I Vernadsky, as seen, for example, from his unpublished thus far later diaries, constantly returned in his thoughts to Mandelstam and his scientific school [10].

The beginning of the Great Patriotic War saw him sent to the resort of Borovoe in what is now Kazakhstan, where he became friends with A N Krylov and V I Vernadsky. It is there that his two talks titled "Optical works of Newton" and "On Krylov's research work" were prepared for delivery at the sessions of the Academy of Sciences.

In one of his letters from Borovoe he wrote that he had "no desire nor intent to work other than at FIAN" (Ref. [38], p. 2, and Fig. 2) and, in another place, that the institute should not be deprived of its Laboratory of Vibrations, whose external links were bound to help in obtaining useful results, "particularly in the future".

It is worth noting here that it is in this laboratory that one of the first molecular oscillators or masers (see Ref. [39] for the announcement) was to be set up, specifically in 1955 in Room 210 of the institute — the achievement that brought the Nobel Prize in Physics 1964 to N G Basov and A M Prokhorov (the latter of whom, incidentally, was awarded the Mandelstam Prize for other research).

In 1940, the Academy of Sciences, where the high energy potential of uranium was realized earlier than elsewhere, established a special investigating commission [40] which, with V G Khlopin as chairman, consisted, among others, of V I Vernadsky, S I Vavilov, and L I Mandelstam, as well as I V Kurchatov and Yu B Khariton, not yet members of the Academy at the time. However, the commission received little or no state support and so did not achieve much. It took a number of years before support came, but Mandelstam did not see it: he died on November 27, 1944 [41–43].

He was buried in the Novodevich'e Cemetery in Moscow. Because he was an atheist, there are no religious symbols on his tombstone.

For his efforts in research, education, and engineering, L I Mandelstam was awarded Lenin, Stalin, and Mendeleev Prizes, as well as the order of Lenin and the order of Labor Red Banner.

As the above clearly shows, there was every reason for the USSR Council of People's Commissars to issue its Resolution No. 252.

According to this resolution, the five-volume collection of Mandelstam's works was published. Also, Academy of Sciences committees on prizes in his name were set up, and these prizes were indeed awarded, as were scholarships. Among the committee members were A P Aleksandrov, A I Berg, D I Blokhintsev, S I Vavilov, P L Kapitza, L D Landau, G S Landsberg, M A Leontovich, A L Mints, N B Papaleksi, A M Prokhorov, S M Rytov, I E Tamm, V A Fock and some others.

At that time, Mandelstam's adversaries started stirring things up. As A N Krylov noted [44], Mandelstam "displayed frankness, honesty, a total absence of self-seeking and guile, and commanded deep respect from the most influential professors at Moscow University, but over the last two years a joint group of physicists has caused him much distress in scientific matters".

What Krylov meant was stopping the publication of Mandelstam's works and destroying the typesetting of one of the volumes at the printing house. It was M A Leontovich who saved the day. He argued approximately as follows: "Leonid Isaakovich lived long, many of his thoughts were thought by him long ago, and views of many may have since changed. It seems that his works should be published as they are and that those with other views should be allowed to express themselves in full." Ultimately, Leontovich was appointed editor and the publication of Mandelstam's works was brought to completion.

Attacks on Mandelstam and his students increased when he and many of his followers died (see, for example, Refs [45, 46]). As a result, scholarships and prizes in his name ceased to be awarded, even though Resolution No. 252 had not apparently been repealed.

It is perhaps for this reason — and because of the campaign against "cosmopolitanism in physics" that was undertaken at the time — that the name of Mandelstam is found mentioned in an Academy of Sciences letter of 15 May 1953, which includes, in particular, the demand to change the Resolution perpetually associated with Mandelstam's name — a demand which the Supreme Soviet of the USSR was not in a hurry to implement, though [47].

Admittedly, L I Mandelstam was a good find for the anticosmopolitan group. He studied and worked in Ukraine and Germany, and he also worked in Georgia and Kazakhstan and in the cities of Moscow and Leningrad. He was born in Belarus into a Jewish family and was buried in Russia. His wife was the first woman from Russia to obtain a diploma in architecture in France (Paris). He had people from many countries among his friends, but he always looked at personality rather than ethnicity or religion of their relatives. Parenthetically though, people in all countries and at all times think what their authorities at a given moment want them to...

To return to governmental Resolution No. 252, the chronologically latest relevant document I was able to find is dated 19 November 1955 [47]. And letter [48] says that "the main reason for requiring the abolition of the prizes is that there is more than one prize in some fields of science.... For example, ... together with the Gold Medal in honor of

S I Vavilov there remains its double, the L I Mandelstam Prize in physics... and the Gold Medal in honor of Popov makes unnecessary the Mandelstam Prize in radio."

The situation changed only when P A Cherenkov, I E Tamm, and I M Frank were awarded the Nobel Prize in Physics 1958 and when *Pravda* and *Izvestiya AN* newspaper articles were published on this event (see, for example, Ref. [49]), signed by the big names in Soviet science and engineering, from which one learned that "the FIAN discovery of the Cherenkov glow and its subsequent theoretical interpretation are due to close cooperation between two prominent scientific schools, one headed by S I Vavilov and the other by L I Mandelstam."

As a result of the USSR Council of Ministers Resolution No. 32 of 11 January 1990 [50], the awarding of the L I Mandelstam Prize was resumed. In Appendix 3, the prize winners and their prize winning achievements are listed for each year.

M A Leontovich once said that we had many good theorists but few real experimentalists. Mandelstam had a unique combination of talents as a theorist, experimentalist, engineer, and lecturer.

The administrators of MSU at the time welcomed enthusiastically the idea of reestablishing scholarships in honor of L I Mandelstam, as did V L Ginzburg, an MSU alumnus, FIAN researcher, Mandelstam Prize winner, and later Nobel Prize Laureate.

Acknowledgments

Preparing this paper was an instructive and enlightening experience for me. I extend my deep gratitude to those who helped me with useful advice and discussions: B M Bolotovskii, A V Gaponov-Grekhov, N S Kardashev, M A Leontovich, G A Mesyats, V V Migulin, O V Rudenko, V A Sadovnichy, I L Fabelinskii, and R V Khokhlov. Useful conversations with V A Volkov, T S Mandelstam, V M Mysova, and I G Tarakanova are also much appreciated.

Appendix 1

Evaluation of the research, engineering, and educational activities of L I Mandelstam, made in 1928

Leonid Isaakovich Mandelstam is one of the few, if not the only, physicist who works at the same level of depth in theoretical, experimental, and engineering physics.

As a theorist, Mandelstam shows originality in formulating problems, mathematical elegance in analyzing them, and strict rigor in drawing conclusions. His main studies in this area are concerned with the light scattering in optically homogeneous and inhomogeneous media. He has been able to uncover the weaknesses of the classical theory of the phenomena and processes involved. Using the statistical fluctuation method, now key to the most recent theories of radiative energy, Leonid Isaakovich predicted and subsequently discovered a number of new phenomena: roughnesses on the interface between two liquids, particularly near the critical temperature of their mixing, and some effects in the propagation of light from a source lying on a surface. The study of the propagation of light in a homogeneous crystal led him to the discovery (later independently repeated by Indian physicist Raman) that the wavelength of light changes in a scattering event due to the energy transfer to (or from) the thermal vibrations of the lattice or molecules. Mandelstam's papers and those coauthored with his students on the theory of relativity and on wave mechanics are models of clear thinking and rigorous analysis.

In his experiments, in part designed to test theoretical predictions, Leonid Isaakovich demonstrated high skill, ingenuity, and accuracy. Many research methods and measuring devices he developed have come into common use. He always finds simple and direct routes leading straight to the goal set out. His experimental research is related to the theory of light scattering and to that of electromagnetic oscillations — two areas where he commands the greatest authority.

As for engineering physics, Leonid Isaakovich cannot but be regarded the best specialist in the Soviet Union in radio. Working first as a researcher and then as a consultant for the Trust of Weak Currents, he solved a large number of engineering problems and brought all his extensive experience to setting up the production process.

In the short time of being a professor at Moscow University, Leonid Isaakovich was able to create a school of scientists (Tamm, Landsberg, Leontovich) and to profoundly influence research in physics there — much in the way he, then a senior assistant and associate professor, inspired and directed research work at Strasbourg University early in his career.

To conclude, we have in the person of L I Mandelstam a scientist with a deep and original mind, a great master of experiment, a theorist in full command of modern ideas and all the subtleties of mathematical analysis, and, finally, one of the creators of modern radio engineering. His work and achievements are known to every educated physicist and have great significance for our science.

Academician A Ioffe

Appendix 2

Letter to A F Ioffe from Moscow on 21 June 1928

Dear Abram Fedorovich,

A matter of great importance for the state of physics in Moscow causes us to write this letter. This is about the impending transfer of Professor L I Mandelstam from Moscow to Leningrad. You are perfectly aware of the middling level of physics in Moscow over the last ten to fifteen years. There have been some people and sufficient financial means, but no leaders required. As a result, a sadly provincial atmosphere formed, with things of real substance given only secondary attention. The Mandelstam's work and activity over the last two years have been the only bright spot against this dim background. Of particular importance for Moscow are his successful efforts at creating a school of theoretical physics. The absence of true theoretical physics was a real disaster for Moscow. Under the extremely experienced and talented direction of Leonid Isaakovich, it can be said that theoretical physics is emerging in Moscow from scratch. It was Mandelstam and the physicists around him on whom all our hopes for the revival of physics in Moscow were pinned.

Today, all our hopes are going to be crushed. Please do believe that these words are no exaggeration. We are fully aware of the direct causes of Mandelstam's transfer, and so of course are you. We are doing all we possibly can to remove these causes and there is every reason to hope for success in

the near future. But our efforts will be to no avail if the transfer does occur. There is in our opinion no one to replace L I Mandelstam. Given the circumstances in Moscow, the person needed here should simultaneously have very great authority, true talent, and extensive teaching experience. Otherwise, no one will be up to the extraordinarily challenging Moscow mission.

There is no doubt that the benefits that the flourishing Leningrad will gain from the transfer of Mandelstam are nonequivalent 'in absolute magnitude' when compared to the irreparable damage that will be inflicted on Moscow.

Hopefully, you will agree that we have every desire to wish that physics — true physics — exists in Moscow. Both the past and the future point to this.

We therefore ask you, Abram Fedorovich, for self-sacrifice, we ask you as a person most instrumental in facilitating the transfer of Leonid Isaakovich, to try to convince him to stay in Moscow.

We know that in inviting L I Mandelstam to Leningrad you primarily followed the interests of Leonid Isaakovich himself, and that leaving him here is only conceivable if conditions change. If and when they do — and even before that — we are hoping for your help.

We are speaking here not only on our own behalf but also with and for all sound-minded Moscow physicists, all of whom see clearly the sad and irreparable consequences of the (unfortunately all too probable) transfer of L I Mandelstam.

S Vavilov, E Shpolsky, T Molodyi

Appendix 3

L I Mandelstam Prize winners

1946 (physics, divided into halves)
V V Antonov-Romanovskii, V L Levshin, Z L Morgenshtern, and Z A Trapeznikova for their work "Studies of alkaline-earth phosphors with high sensitivity to infrared rays";
V L Ginzburg for his work "On the dielectric properties of ferroelectric (Seignette-electric) crystals and barium titanate".

1947 (radio, divided into halves)
L A Vainshtein for his work "Rigorous solution to the problem of an open-ended planar waveguide";
S M Rytov, A M Prokhorov, and M E Zhabotinskii for their contribution to the theory of frequency stabilization.

1949 (physics, divided into halves)
I L Bershtein for his work "Amplitude and phase fluctuations in a valve oscillator";
A I Akhiezer and I Ya Pomeranchuk for their work "Some problems in the theory of the nucleus".

1950 (radio)
E L Feinberg for his work on radio wave propagation along Earth's surface.

1952 (physics)
I M Lifshits for his work on the dynamic theory of crystals.

1991
I L Fabelinskii for his work "Experimental investigation on Mandelstam–Brillouin spectroscopy and the discovery of optical phenomena".

1994
V S Beskin, A V Gurevich, and Ya N Istomin for their work "The theory of magnetosphere and pulsar radiation".

1997
V M Agranovich for his work "Theoretical research on surface spectroscopy".

2000
V A Krasil'nikov for his work "Waves and turbulence".

2003
V S Zuev, O Yu Nosach, and E P Orlov for their work "Physical processes in photodissociation lasers".

2006
A P Brysev, L M Krutyanskii, and V L Preobrazhenskii for their work "Experimental and theoretical research into the nonlinear propagation of reversed-front ultrasonic beams and into the principles of their application in nonlinear acoustics and in diagnostics".

2009
V N Zaitsev, V E Nazarov, and L A Ostrovskii for their work "Nonlinear acoustic phenomena in structurally nonuniform solid media: dynamic nonlinearity, nonlinear waves, and defect diagnostics".

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