Chapter 1
Introduction

1.1 Why L.I. Mandelstam's Biography Is Interesting

Leonid Isaakovich Mandelstam was an outstanding physicist, not only in his home country, but in the context of world science. In the book "Russian Physics of the Nobel Level", L.I. Mandelstam is mentioned among nine scientists who could have received the Nobel Prize, but have not [242]. Some of them did not receive the Nobel Prize because it cannot be given posthumously. Others (including L.I. Mandelstam and G.S. Landsberg, who decisively contributed to the discovery of combinational scattering of light) have not received the Nobel Prize under the force of circumstance. The Indian physicist Sir Chandrasekhara Venkata Raman received the Nobel Prize for the discovery of the combinational scattering of light. This effect is named in honor of him.

Not only this makes the biography of Mandelstam interesting. A scientific community arose around L.I. Mandelstam. This community is commonly called the Mandelstam School. This was one of the foundational schools in Soviet prewar physics. In total, there were four such schools: the A.F. Ioffe, D.S. Rozhdestvensky, L.I. Mandelstam, and S.I. Vavilov schools [80, 81, 359–362].

A.F. Ioffe's school was based in Saint Petersburg (then Leningrad) Institute of Physics and Technology. The Nobel Prize winner Zhores Ivanovich Alferov was Director of this Institute from 1987 till 2003. The Faculty of physics and mechanics (Leningrad Politechnical Institute) trained potential members of the Ioffe school. This school yielded many outstanding physicists, in particular, Igor V. Kurchatov.

Dmitrii Rozhdestvensky organized a scientific community which received the name "Rozhdestvensky's school in optics". This school arose at the Physics Institute which belonged to Petrograd University. The State Optical Institute arose on the base of this school.

S.I. Vavilov's school is not so sharply defined. This is a school of optics physicists. It arose at the physics department of Institute of Physics and Mathematics (Academy of Sciences), then at the Institute which had been formed on the base of this department, that is, at the Physics Institute of the Academy of Sciences (FIAN).

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Mandelstam's school was formed back in his Odessa period (1918–1922). There he was joined by a devoted disciple, with whom for life. This was Igor Evgenievich Tamm (he became a Nobel Prize winner in 1958). However, the main events took place in Moscow. As is stated in the biography of Mandelstam that opens the first volume of Mandelstam's "Complete Works", "in 1925 the most fruitful and intense period of Leonid Isaakovich's scientific activity started. In a very short time, the scientific credibility of Mandelstam and his extraordinary personal charm unified the talented young scientists (G.S. Landsberg, I.E. Tamm, et al.) at the Research Institute of Physics, Moscow State University, and his lectures and highly informative seminars, outstanding in their content and form, which Mandelstam always very well prepared, attracted many talented young people—students and graduate students—to him. Under Mandelstam's guidance and being inspired by his ideas many young scientists started their research in a number of disciplines: radiophysics, optics, the theory of oscillations and molecular physics" [1, Vol. 1, pp. 27–28].

L.I. Mandelstam is also interesting within the framework of the general trends in the development of Russian physics. By tracing his personal trajectory, one can discern the specifics of the USSR scientific culture (the 1930s–1940s). Mandelstam was one of those physicists who brought the German scientific culture to Russia.

L.I. Mandelstam graduated from Strasbourg University and started as a researcher at the Strasbourg Institute of Physics. While living in Saint Petersburg and then in Moscow, he was still in contact with some of his Strasbourg colleagues.

L.I. Mandelstam was in the center of major scientific events and communicated with a wide range of Russian intellectuals (Mandelstam's students Igor Tamm and Alexander Andronov, and two Academicians of pre-Revolutionary Academy—Alexey Nikolaevich Krylov and Vladimir Ivanovich Vernadskii—should be mentioned first of all here). Mandelstam combined teaching and research work. The forth and fifth volumes of his "Complete Works" induce an association with German scientists' collected works where the conspectus of lectures figured prominently (these two volumes are constructed on the base of his students' records of his lectures and seminars and Mandelstam's own preparatory drafts). Mandelstam's biography enables one to discuss the interaction of education and research in the USSR, also from the point of view of world science.

Mandelstam's personal trajectory was dramatic. On arriving in his home country in 1914, Mandelstam had to start his scientific career again. Russia disclaimed German certificates of docent and professor. Since 1914 and up to 1925 Mandelstam was excluded from normal research work, he either worked in industry or taught (sometimes he worked as both an engineer and a teacher). During the revolution and civil war (and subsequent years of the economic devastation), there were not even the normal conditions for teaching and engineering work. It is worth noting that even after 1925, when Mandelstam became Professor at Moscow State University and had reached a stable social situation, the country was under repressions turning into terror turning into terror. The intelligentsia had to act as the "fellow travelers" who were obliged to prove their loyalty. Some of Mandelstam's former students were arrested and destroyed.

Finally, Mandelstam was of weak health and his health became worse year by year.

In tracing the life path of L.I. Mandelstam, we come to the theme of science, understood not only as a source of knowledge, but also as a source of vital energy, and even faith. At the end the 1920s and especially in the 1930s, Mandelstam had reached a stable (considering the times) social status and good financial situation. However, during the preceding decade teaching and research did not yield him anything financially significant. A feeling of science as a consolidating and creative principle helped him to stand frim. Mandelstam was a man of science; he quickly regained his scientific potential, once he found himself in favorable conditions for scientific activity and a circle of people who planned to start research formed around him. Science's worth is that it brings not only results but also hopes which strengthen the spirit! Here, we come to the interrelations of individual work and communication, specialization and broad horizons, physics and metaphysics.

1.2 What Has Been Written About L.I. Mandelstam?

The canonical biography of L.I. Mandelstam has been written by his friend and permanent coauthor Nikolai Dmitrievich Papalexy (1890–1947) [1, Vol. 1, pp. 7–31, 268]. Its title is "Leonid Isaakovich Mandelstam (a Short Outline of his Life and Activity)", and it has been published in the first volume of Mandelstam's "Complete Works". As is mentioned in the footnote, N.D. Papalexy, who died in 1947, was short of time to finish his "Short Outline".

In the first volume L.I. Mandelstam's "Complete Works", Papalexy's "Short Outline" is supplemented with a review of Mandelstam's activity in the last years of his life. The authors are the following: Grigorii Samuilovich Landsberg (1890–1957), Mikhail Alexandrovich Leontovich (1903–1981), Igor Evgenievich Tamm (1895–1971), Gabriel Semenovich Gorelik (1906–1957), Sergei Mikhailovich Rytov (1908–1996) [1, Vol. 1, pp. 7–66, 8]. In 1965, I.E. Tamm delivered a short paper in commemoration of L.I. Mandelstam [336].

N.D. Papalexy also wrote a Short Outline of Mandelstam's research in radiotechnology. He participated in the majority of that research [268].

In 1979, the collection of papers entitled "Academician L.I. Mandelstam: on the occasion of the centenary of the birth" appeared under S.M. Rytov's editorship. This collection is launched by N.D. Papalexy's "Short Outline" and by those supplements which the first volume contains.

Some letters to and from L.I Mandelstam are also published in this collection. These letters are taken from Mandelstam's collection which the Archives of the Russian Academy of Sciences contain. In addition, the collection of papers dedicated to Mandelstam's centenary contains the analytical articles and recollections describing Mandelstam's basic research and his teaching activity. These articles and

recollections have been written by his colleagues and former students (in particular, Landsberg, Tamm, Andronov, Gorelik, Rytov, Shchegolev [18, 200, 301, 303, 305, 310, 333, 334]).

In 1945, A.A. Andronov with coauthors published a review of Mandelstam's research in non-linear oscillations [18]. S.M. Rytov, who was one of the authors of the biography of Mandelstam, published several articles dedicated to Mandelstam's ideas in the theory of oscillations [300, 302, 303, 305].

The above mentioned writings became the basis for the authors of the subsequent issues on Mandelstam and his work. These were Iakov Gr. Dorfman who wrote an article published in "Dictionary of Scientific Biography", Yu.A. Chramov who descibed Mandelstam's creative work in his reference-book "Physicists" and in his book about the scientific schools in Soviet physics (see above), V.V. Migulin who published an essay in journal "Priroda" [230] (see also [229, 231]), A.M. Livanova and V.A. Livanov in "The second degree of understanding" dedicated to L.I. Mandelstam [219], the historian of physics P.S. Kudriavtsev in his article about the Physics Department of Moscow State University [187]. It should be noted that Migulin, who was one of the youngest representatives of the Mandelstam school, described his research in radiointerferometry. In Livanova's paper we have her own recollections (she attended Mandelstam's lectures at the end of the 1930s), materials of the Mandelstam family's archives and interviews with Mandelstam's former students. The Livanov and Livanova's book followed the essay written by A.M. Livanova alone [220].

Two books have been published about Mandelstam's teacher the Nobel Prize winner Ferdinand Braun (1850–1918) [149, 192] (for the latter, there is an English version [193]) touch upon the Strasbourg period in Mandelstam's life (1900–1914). This period has been considered by the present author [271, pp. 74–77, 272, 273]. The present author also traced Mandelstam's contacts with the German engineer, mathematician and philosopher Richard von Mises [272, 275] and published the extracts from Mandelstam's letters to Richard von Mises.

The author of the present book has also published a number of articles about Mandelstam's philosophical position and his interpretation of quantum mechanics [80, 272, 275–278].

L.I. Mandelstam's biography is anyway touched upon in the books and articles about his disciples and collaborators [37, 49, 54, 56, 57, 80, 81, 142, 169, 224, 364, 374, 376, 377] and in the commemorations on Mandelstam's coauthors and other disciples. However, there are only a few new facts in these writings.

There are new facts in I.L. Fabelinsky's historical articles and his brochure dedicated to the discovery of the combinational scattering of light [97–102]. As was above pointed out, Mandelstam and Landsberg did not receive the Nobel Prize for this discovery. The Nobel Prize was given to the Indian physicist Ch. Raman, who together with Krishnan observed this phenomenon in liquid. Mandelstam and Landsberg observed it in crystals.

The new facts are present in V.P. Vizgin's articles about the March 1936 session of the Academy of Sciences [359–361], in G. Gorelik's articles about the 1937 philosophy discussions [139–141], in B.A. Minkus' commemorations about the Odessa

period in Mandelstam's biography [235], in Andreev's book about the Research Institute of Physics at Moscow State University [12]. It was mentioned above that Mandelstam had worked for this institute since 1925.

The new facts (concerning presumably L.I. Mandelstam's colleagues) are given in the second edition of E.L. Feynberg's book, and some accents are placed in a new way [103, 104].

To sum up, it worth mentioning that Mandelstam's biography was basically outlined by N.D. Papalexy and some of L.I. Mandelstam's other colleagues in the 1979 book. What has been published later looks like supplements, appendices, comments.

1.3 About Key Points and Blank Spots

Let us mention some key points. In Mandelstam's biography which is published in the first volume of his "Complete Works", it is said that "the late decades of Mandelstam's life (after his move to Moscow in 1925) were the "golden age" of his scientific and pedagogical work. Groups of co-workers and students gathered around him. Many of them reached outstanding positions already during Mandelstam's life and became the guides of Mandelstam's ideas among wide groups of young people. Over this period Mandelstam delivered a number of important courses and seminars on fundamental problems of physics. The public recognition of Mandelstam's outstanding achievements and merits started from this. In 1928 Mandelstam was elected as a correspondent member of the USSR Academy of Sciences, and in 1929 he was elected as a full member. Mandelstam received very important prizes: the Lenin Prize (1931), Mendeleev Prize (1936) and Stalin Prize (1942). Mandelstam was decorated with the highest USSR honours: with the order of Red Banner of Labor (1940) and with the Lenin Order (1944).

Since 1925 Mandelstam had become the central figure of Moscow State University Physics Faculty. In 1934 the Academy of Sciences (Central Office) moved to Moscow and Mandelstam had taken an active part in the development of the Academy Physics Institute" [1. Vol.1, pp. 32–33].

E.L. Feinberg writes about Mandelstam in a different light. "Mandelstam's po litical position was trenchant and definite: he completely and sharply rejected the Soviet regime and all ideology and practice of Soviet life introduced by the Communist Party" [104, p. 47].

So, Mandelstam who actively and successfully participated in the life of two Soviet establishments (Moscow State University and the Academy of Sciences) rejected the theory and practice of Soviet life. How to understand it?

There are other questions. For example, we have no clear and distinct information on Mandelstam's work for the German radio industry. N.D. Papalexy only mentioned his cooperation with the company Telefunken and "the (for that time) big bonus which was given to him by the company" [1–3, Vol. 1, p. 12]. However, how close was this cooperation?

In 1907, Mandelstam published an article "About directed wireless telegraphy" in which he criticized the English radio-engineer John A. Fleming. Mandelstam again turned to the criticism of Fleming in 1930–33 (a couple of paragraphs in his "Lectures on Oscillations" and his review "Issues of the electrical oscillatory systems and radio-engineering" published in "Uspekhi fizicheskikh nauk").[1] Fleming probably did not know anything about this criticism. At least, the present author has not found any references to it in Fleming's publications and in his letters which the Archives of London University keep. Finally, Fleming is critically mentioned at the end of Mandelstam's 1944 lectures. These were the last lectures delivered by Mandelstam. He lectured no more.

What is the reason for the emphasis which Mandelstam placed on Fleming's approach?

The Odessa period in Mandelstam's life and work (1918–1922) is poorly elucidated.

L.I. Mandelstam was an influential figure in the Soviet Academy of Sciences. What position did he take up by participating in the Academy of Sciences meetings and conferences?

The present book tries to elucidate these and other questions. Mandelstam's biography as represented in it is documentary. This does not imply that I shall ignore the recollections about Mandelstam and his colleagues. It is not possible to write a book about Mandelstam without good attention to his friends' and coworkers' recollections. However, the sources will always be indicated in this book. The recollection will be separated from the sources of superior reliability, namely articles, letters, and administrative documents.

1.4 Sources

The basic source is L.I. Mandelstam's "Complete Works" (five volumes). Sometimes, I shall cite pieces from Mandelstam's German original papers rather than from their Russian translations which the "Complete Works" contain. Mandelstam's article jointly written with Papalexy dedicated to Ferdinand Braun will be used, too. Mandelstam's "Complete Works" does not contain this article.

N.D. Papalexy's articles collected in his "Collected Works" also shed light on Mandelstam's life and his research. The majority of them had been written as a development of their cooperation.

Mandelstam former students' books and articles (first of all Chaikin, Andronov, Vitt, Leontovich, Gorelik, Rytov should be mentioned) give an idea of the style of his instruction and inform about him as Founder of the scientific school. The Mandelstam

[1] In particular in his Moscow lectures, Mandelstam criticized Fleming's explanation of resonance in [110].

collection, which the Archives of the Russian Academy of Sciences keeps, contains his autobiography, his letters and letters to him, the list of his publications and patents, his drafts, etc. Mandelstam's letters are kept in the collections of his friends and colleagues (S.I. Vavilov, V.A. Fock, N.D. Papalexy).

Administrative documents concerning L.I. Mandelstam are kept in the Archives of the Academy of Sciences Institute of Physics (FIAN).

The Archives of Lomonosov Moscow State University contain the documents which allow us to follow his career at the University.

The important source which was introduced by the present author to the history of science studies is a collection of Mandelstam's correspondence with Richard von Mises (the Harvard University Archives, HUG 4574.5, boxes 1–3).

Mandelstam's early scientific career is represented in the administrative documents of Kaiser Wilhelm Strasbourg University (Archives départementales du Bas-Rhin, Strasbourg, France).

These documents are supplemented with Ferdinand Braun's collection which is kept in Deutches Museum archives (Museum of the history of science and technology in Munich). J. Zenneck's collection which is kept there is also useful. The Deutches Museum library has a copy of J. Zenneck's "Erinnerungen eines Physikers" ("the Recollections of a Physicist") which describes some events in which Mandelstam has participated [392] (see also [391]).[2]

The Siemens Forum Archives (Munich, Germany) contain the materials about radio-engineering companies for which Mandelstam worked. These were Telebraun and Telefunken. In particular, these Archives have Mandelstam's letter to Ferdinand Braun and F. Braun's letter about Mandelstam to Wilhelm Siemens [400, LK-65].

Mandelstam's interpretation of quantum mechanics is rather popular among Russian scientists. This interpretation is represented in his 1939 Lectures on Quantum Theory. The collection of quantum physics (the Library of American Philosophical Society, Philadelphia, USA) helps us to understand the general situation of the 1930s in the interpretation of quantum mechanics.

J.A. Fleming's collection, which the Archives of London University (UK) keeps, contains his communication and manuscripts and sheds light upon the situation in radio-engineering and the radio business during the first decades of the 1920s. However, the present author has not found any references to Mandelstam.

The present author conducted a number of interviews with the people who were personally acquainted with either L.I. Mandelstam or with the people of his circle. This was an interview (19 December 1992) with Sergei Mikhailovich Rytov, who was Mandelstam's graduate student of a younger generation. As was noted, Rytov was Editor of the 1979 book dedicated to Mandelstam's centenary. Rytov has also performed the basic work of publishing Mandelstam's Complete Works.

Then we mention the interviews with the Nizhny Novgorod physicists who were personally acquainted with Mandelstam's former students A.A. Andronov and G.S. Gorelik. These were Yuri Isaakovich Neymark (2.7.2001), who was one of

[2] J. Zenneck was one of the founders of the Museum of the History of Science and Technology, Deutsches Museum in Munich.

Andronov's last graduate students, Alexandra Grigorievna Liubina (3.7.2001), who was Andronov's student, his colleague and coauthor, and Mikhail Izrailevich Rabinovich (22.05.1992 and 30.3.1993), who was not Andronov's student, nevertheless was a person of Andronov's circle and considered himself to be a representative of Mandelstam's school.

Professors of Moscow Institute of Physics and Technology Stanislav Mironovich Kozel and Mikhail Vladimirovich Illarionov told the present author about G.S. Gorelik (21.12.1997).

The author has also had a conversation with Evgenii Livovich Feinberg, who communicated with Mandelstam's close colleagues and participated in the preparation of Mandelstam's "Complete Works" (23.12.1992).

In this book the interviews with S.M. Rytov and V.V. Migulin conducted by E. Gorelik are used. The American Institute of Physics (Historical Department) keeps these interviews.

E.S. Boyko, the author of two books about A.A. Andronov, handed over her materials about L.I. Mandelstam and A.A. Andronov to the present author.

1.5 The Plan

Often in the biographical writings published by Nauka publishers, the life story of a scientist is given separately from the analysis of his/her scientific results. In the present book, we describe our hero's life together with his creative work. We tend to describe the social and psychological circumstances of any considerable scientific result.

The main stages, however, were indicated by N.D. Papalexy and by the physicists who have supplemented his "Short Outline": (1) Strasbourg period—education and the beginning of scientific career (1899–1914), (2) years of traveling, the beginning in Petrograd (1914) and the end in Leningrad (1925), (3) Moscow State University (1925–1935), (4) the Academy of Sciences Institute of Physics and Moscow State University (1935–1941), (5) Kazakhstan resort Borovoie and the last year in Moscow (1941–1944).

Additionally, the formation of Mandelstam's school will be described, and brief biographical information will be given about the representatives of this school.