

PRECURSOR OF *PERESTROIKA*

Sakharov's unshakable principles—but even more his willingness to debate them and to speak out publicly for them—prefigured a restructured society.

Vladimir Ya. Fainberg



A little time has now passed since the death of Andrei Dmitrievich Sakharov. Many articles and papers have been published reflecting on this tragic event from various points of view, but time alone will reveal the depth of the loss suffered by our country and humanity and the grief felt by all people of discernment. It will be some time before we cease to feel our bereavement at the crumbling of the foothold that supported us in hard times, in our hour of need.

My image of this man took shape gradually over a period of 40 years. I accumulated many impressions from my discussions, sometimes even disputes, with him on a wide variety of topics ranging from the scientific to the sociopolitical, as well as from the contradictory, sometimes even diametrically opposed, opinions of our mutual acquaintances and friends concerning his personality. Without claiming completeness, I shall try to reproduce the most vivid of my impressions.

Busy inner workings

I first met Sakharov in the theoretical department of the Lebedev Physical Institute of the USSR Academy of Sciences, just after I had graduated from the Moscow Physical Engineering Institute. The year was 1949, and the theoretical department was headed by our mutual teacher, the well-known Nobel Prize winner Igor E. Tamm. Sakharov was already an old-timer in the department, having taken the postgraduate course in 1945 and defended his dissertation in 1947. Our first, brief scientific conversation did not leave any appreciably clear impression on me; he spoke slowly, as if it were difficult for him to choose words and phrases. This characteristic remained with him throughout his life, and only after

several years did it become evident to me that it was a consequence of the busy inner workings of his innumerable thoughts and of his desire to think each one through before voicing it. This was an obstacle in his teaching: He complained to Tamm that his students did not understand him fully. It was for this reason that Sakharov had to leave the Moscow Power Institute, where he had taught in the first difficult postwar years.

Then, literally within several months, I completely revised my opinion of Sakharov. Whenever anyone mentioned his name, it would be to relate what Sakharov said or how he had solved a problem, and always the anecdote would be accompanied by epithets such as "brilliant" and "superb." When, in the early 1950s, I was engaged in classified work, I found that Sakharov had great authority among the leading scientists in atomic research, although he had not yet reached 30. His brain was probably of some special construction, for he solved all problems in unorthodox ways. Andrei A. Kolomensky, a Lenin Prize winner and one of the oldest professors at the Lebedev Institute, who studied with Sakharov at Moscow State University, has particularly mentioned this aspect of Sakharov's thinking to me.

Sakharov's ability to explain complicated physical phenomena from general principles and by using qualitative scaling estimates was surprising. I remember Yuri A. Romanov, a physicist in the theoretical department at the Lebedev Institute from 1949 to 1951, telling me with admiration in 1950 that after he had discussed with Sakharov his idea for calculating the magnetic moments of nuclei, "everything fell into place!" (Romanov went on to become a collaborator at the All-Union Scientific Research Institute of Experimental Physics, to earn a doctorate in physics and to be named a Hero of Socialist Labor.)

There is a wealth of legendary stories about Sakharov in those days (and later), most of them based on his postgraduate exams and on his famous report on a classified subject. On the exams, he found the correct

Vladimir Fainberg is a professor at the Lebedev Physical Institute in Moscow. This article is based on his contribution to the Soviet Academy of Sciences publication *Vestnik* (N3, 49, 1990).



Andrei Sakharov outside the Lublino courthouse in Moscow, at the trial of Yuri Orlov, May 1978. (Courtesy of Elena Bonner.)

solution to a problem but was unable to explain it convincingly to his examiners—Tamm, Eugene L. Feinberg and Serge M. Rytov—who gave him a grade of 4, the top being 5. In his classified report he derived the equation of state in a mere seven pages. Researchers at the Institute of Applied Mathematics were using their most powerful computer at that time, the Strela (meaning “arrow”), to solve the same problem. Their findings confirmed Sakharov’s estimates with a high degree of accuracy. Another story involves the time Victor P. Silin (now director of solid-state physics at the Lebedev Institute) and I took a postgraduate exam in German. At the end the teacher told us nostalgically that she would of course give us the highest grade of E and that we were obviously capable young men, but that our translations in no way compared with the magnificent translations of Einstein’s papers done by Sakharov!

A hero of socialist labor

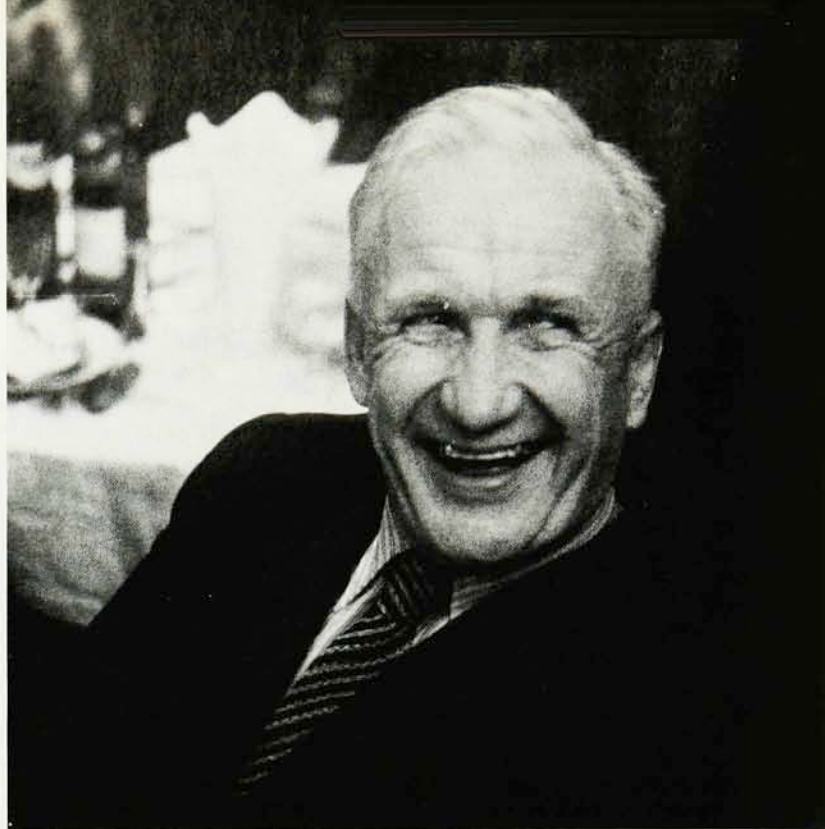
Sakharov and Tamm’s 1950 report on controlled thermonuclear fusion made an especially indelible impression. Tamm told me how everyone in their group was working on the project with tunnel vision, fully absorbed in the atomic problem, and had not a single minute to spare. One evening, I walked Sakharov and produced the idea that one could try to keep (that is, thermally insulate) hot plasma in a closed toroidal volume and, in principle, heat it up to the temperature of a thermonuclear reaction. The joint development of this idea by these two outstanding physicists resulted in the debut of a new area of research: the theory and construction of “magnetic thermonuclear reactors” (Tamm proposed the term).

From the very beginning Tamm and Sakharov, the teacher and the disciple, were on very friendly terms. Their relationship was imbued with mutual affection and

trust, which lasted till the final days of Tamm’s life (he died in 1971). Tamm always spoke of Sakharov very warmly, with high praise for his outstanding talent as a scientist and inventor and for his high moral qualities. In the last years of his life Tamm often returned to “the phenomenon of Sakharov”; he said that Sakharov’s tragedy was that he had to sacrifice his great passion—elementary-particle physics—first to create an atomic and hydrogen bomb and then, after he comprehended the troubles of our civilization, to lead the struggle for the survival of mankind, to which he gave almost all his strength.

From 1950 to 1969, except for rather frequent stays in Moscow and participation in seminars and scientific discussions at the theoretical department of the Lebedev Institute, Sakharov devoted the major part of his time and strength to his work at the All-Union Scientific Research Institute of Experimental Physics, where he made great contributions to devising and creating nuclear weapons, an effort that ensured nuclear parity between the United States and our country. Simultaneously he started new trends in science. In 1952 he put forward the idea of exploding magnetic generators—devices that would convert energy from chemical or nuclear explosions into magnetic field energy. In 1964 such generators produced record magnetic fields of 25×10^6 oersteds. In 1967 he published a paper on the possible instability of the proton—the principal particle of the universe—in which he predicted its lifetime. This bold hypothesis was later developed in the so-called unified models of elementary particles—the grand unified theories. Experimental searches for this unique phenomenon are now under way, and new ones are planned in many countries throughout the world, including the USSR.

In the 1950s and early 1960s a steady stream of well-



Igor Tamm in May 1956. Tamm was Sakharov's adviser at the Lebedev Institute. (Photograph by Luis W. Alvarez.)

deserved rewards and official accolades was showered upon Sakharov. He was elected to the Soviet Academy of Sciences in 1953, was awarded the title Hero of Socialist Labor three times (in 1953, 1963 and 1965) and won a Lenin Prize and a USSR State Prize. Yet all this affected neither his outward behavior nor his moral and ethical principles; he remained the same man to the end and, so to speak, stood the test of glory and wealth. (In 1969 Sakharov gave all his savings and prizes, totaling 143 000 rubles, to the building of the Oncological Center in Moscow.)

Speaks his mind

From the late 1950s on, Sakharov came to realize ever more acutely the danger inherent in the accumulation of nuclear weapons by the two opposing superpowers—the USSR and the US—and in particular the increasing ecological threat posed by the testing of these weapons. He was the only expert who openly voiced objection to Nikita Khrushchev, at that time the head of the party and the state, when in 1961 a 60-megaton hydrogen bomb was tested on an island named Novaya Zemlya ("New Land"). His voice was not heard. It was obviously then that it was borne in on him that the probability of a nuclear conflict increases immeasurably when crucial political solutions depend on the uncontrolled will of one leader or a group of leaders heading the party and the state.

The next turning point in Sakharov's life was in 1968, when in his memorandum "Reflections on Progress, Peaceful Coexistence and Intellectual Freedom" he drew attention to the three main problems faced by humanity: the nuclear and ecological problems and the danger of incompetent, authoritative power. Many people read the manuscript, but it was not accepted for publication in the USSR. (20 million copies, however, were printed abroad.) Our country was becoming increasingly stagnant. After almost 20 years, Sakharov had to leave the All-Union Scientific Research Institute of Experimental Physics, and in 1969 he returned to the Lebedev Institute's theoretical

department as a senior research worker.

From 1969 to 1980 Sakharov's life was full of drama. The basic tenets of his principles manifested themselves to the full during this period: in his consistent and uncompromising defense of dissidents; in his fight for radical democratization and fundamental change in our entire economic, social and political system; and in his fight against the nuclear threat and for the survival of mankind. (His book *My Country and the World* has been widely published abroad.) In 1975 he was deservedly awarded the Nobel Prize for his outstanding contribution to the struggle for peace. Andrei Sakharov can justly be called the precursor of *perestroika* in our country.

Sakharov was unshakable in matters of principle but at the same time lent an attentive ear to critical remarks. He always showed respect and tolerance for the opinions of others. I can attest personally to the thoughtfulness he showed toward the staff of the theoretical department at the Lebedev Institute. He never tried to involve anyone there in activities that would at that time have been called "dissident." Moreover, so as not to jeopardize his coworkers, Sakharov promised the head of the department that he would not involve people from the department or from the institute in his political activities.

In the end, however, he was unable to keep this promise, through no fault of his own. On the one hand, the party organization and the head of the department were constantly under pressure from the party committee and from some of the directors of the institute to create around Sakharov an atmosphere of intolerance and isolation within the department and the institute. A campaign was organized to collect signatures on a document libelously protesting his activities. To the credit of the head of the department and the department staff, none of them signed. On the other hand, Sakharov's vigorous political activities outside the Lebedev Institute were reflected inside the institute. I remember his struggle to have the biologist and author Zhores A. Medvedev liberated from an asylum and his attempt to organize a public discussion

on this matter in the institute. Sakharov, as well as representatives from the procurator's office and the Ministry of Health, were to participate. However, there was a peremptory shout from on high: No discussion of nonscientific problems with Sakharov; he should not be given a rostrum for propagating his views.

From the seminar audience. Sakharov devoted much of his mental and physical strength to his patriotic activity. But he also found time for scientific work and attended the Tuesday all-Moscow seminars held in the theoretical department. Between 1969 and 1979 he published six scientific papers. His participation in the seminars was almost always useful. I'll give two typical examples.

The speaker at one 1974 seminar spoke on the state of research on laser-induced thermonuclear reactions. At the end of the talk Sakharov asked a very unusual question: "What do you think one neutron in your installation will cost?"

"I haven't thought about it," answered the speaker.

"About half a kopeck," said Sakharov. "If we bear in mind that for a nuclear reaction, the neutron density must be greater than $10^{15}/\text{cm}^3$, it is easy to estimate how much the installation will cost!" The discussion ceased immediately.

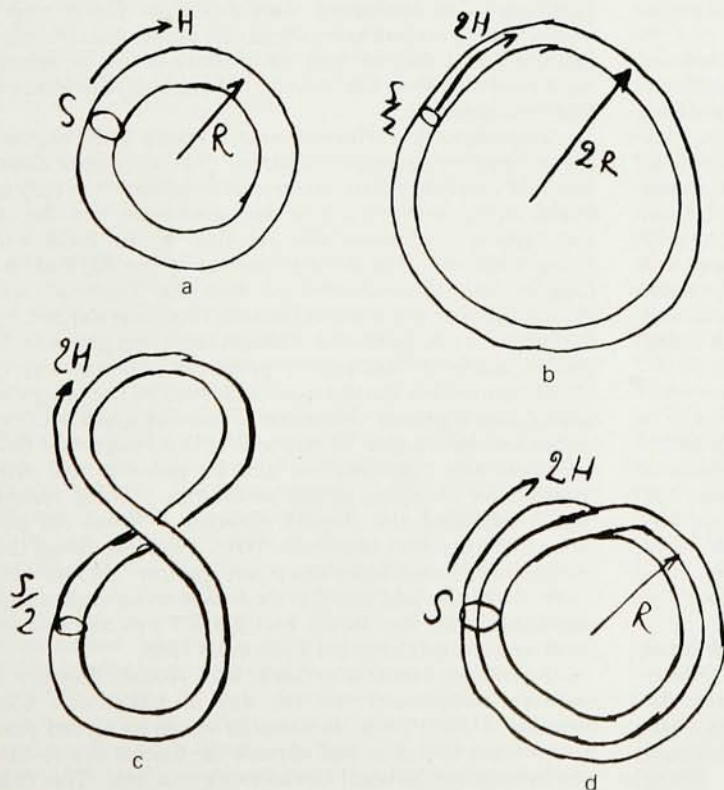
Another time the seminar speaker was Victor M. Galitsky, a corresponding member of the USSR Academy of Sciences, who spoke on the hydrodynamic theory of nuclear collisions. I was sitting near Sakharov and saw him draw some intersecting circles on a scrap of paper. He seemed not to be listening very attentively to the speaker. Unexpectedly he asked, "Is your adiabatic exponent equal to $1/4$?"

"How did you know?" countered Galitsky in astonishment. "I was just about to address that." Sakharov answered that he had calculated it for himself.

Exiled for opposing a war

By the end of 1979 the international situation had worsened. That December our troops advanced into Afghanistan and a senseless nine-year war began. A few days after the invasion began, Sakharov issued a statement, for the benefit of the foreign press, in which he severely condemned our military action, calling it a tragic mistake. Sakharov's reaction followed logically from his belief that when a totalitarian government possesses nuclear weapons, involvement in military conflicts poses a strong danger, since it brings with it a threat of nuclear war and all its catastrophic consequences. ("Recall the Caribbean crisis in 1963," he said, "when the world hung by a thread and everything depended on the will of one man—N. S. Khrushchev!") He emphasized that our foreign policy at that time was based on the belief that after the outbreak of a nuclear war it would be capitalism that would be annihilated.

The authorities reacted swiftly to Sakharov's statement. On Tuesday, 22 January 1980, when Sakharov went out to go to the Lebedev Institute, where he was planning to attend a seminar, two KGB officers got into his car with him and escorted him to the office of the deputy procurator—General A. Rekunkov. The general read to Sakharov the decision to deport him to Gorki and to strip him of all his government awards. He was then taken to the airport, and from there, accompanied by KGB vice chairman S. Tsvigun, he was flown to Gorki. His wife and friend, Elena G. Bonner, went to Gorki on the same plane.



Magnetohydrodynamic dynamo, one of Sakharov's "pastime problems." Sakharov's sketches show a closed torus (a) of large radius R and cross section S containing a "frozen" magnetic field H in an incompressible conducting medium. The sequence of stretching (b), twisting (c) and folding (d) doubles the magnetic field. The process can be repeated any number of times. (From A. D. Sakharov, *Collected Scientific Works*, Marcel Dekker, New York, 1982; used by permission.)

This was the beginning of Sakharov's unlawful seven-year exile in Gorki—unlawful because it was imposed without a trial and by no court of law. He and his wife were placed in three rooms of a four-room apartment at 214 Gagarin Avenue in the district of Shcherbinka—in a "golden cage," as it was christened with bitter humor by foreign correspondents. (The fourth room was at first occupied by a housemaid, but Sakharov had to decline her services, as she was a KGB agent. Her room was then sealed up.)

Reaction to exile. Sakharov's deportation gave rise to a great international wave of protests. Many international scientific (and nonscientific) conferences and meetings in the USSR were boycotted; a number of international organizations protested to the leaders of our country; some Soviet scientists were not admitted as participants in conferences in other countries; and the activity of many of our missions abroad was boycotted. All this did a great deal of damage to the economy and moral prestige of our country and our academy of sciences, which was unable to defend its member Sakharov.

Leading statesmen and public figures in many countries asked the leadership of the USSR generally, and General Secretary Leonid I. Brezhnev personally, to reconsider Sakharov's exile. There was no response. Sakharov's prestige as an unbending fighter for freedom and civil rights for democracy, peace and disarmament, which was already very high, soared.

Initially, a general atmosphere of shock pervaded our department. Nobody believed that it would be possible to free Sakharov from exile. It was even difficult to prevent his dismissal from the Lebedev Institute. However, after long deliberations we decided to ask academician Vitaly L. Ginzburg to go to the Communist Party of the Soviet Union and convince the authorities of the Central Committee's department of science of the necessity to initiate scientific contacts with Sakharov. Ginzburg not only complied with our request but also obviously managed to convince them, for reason prevailed and research workers from our department were permitted to make scientific visits to Sakharov in Gorki.

Visits to Gorki

The first official visitors were the head of our department, Ginzburg, and the party secretary of our institute, Alexander Golovashkin. Following this, employees of our department paid visits to Sakharov on a more or less regular basis. In the course of seven years, a total of 17 employees visited him in Gorki. These trips gave Sakharov not only scientific support but also a moral boost (as he himself admitted).

During his exile Sakharov published six original articles in the Soviet scientific journals *Soviet Physics JETP* and *Soviet Physics JETP Letters*. In my opinion the most significant of these were "Cosmological Models of the Universe with the Turn of the Arrow of Time" (1980) and "Multisheet Models of the Universe" (1982). These

articles reflected Sakharov's deep interest in general questions about cosmology and gravity, whose close interrelationship has been revealed in the last 10–15 years in the form of connections between the quark-lepton structure of elementary particles and the processes by which the early stages of the universe evolved.

It is difficult to comprehend fully the moral and physical suffering Sakharov endured in exile. His scientific work in this context was truly an act of heroism. At the same time he never ceased his struggle on behalf of human rights, progress and intellectual freedom.

I will mention only briefly my own personal impressions gained during meetings with Sakharov in Gorki. On my first trip, in May 1980, I was accompanied by a young collaborator, Andrei Linde. We stayed in the guest house of the Chemical Institute of the Academy of Sciences in Gorki, near Sakharov's house. I remember telling Linde about Sakharov's capabilities as a man and as a scientist, calling him a genius. Then we went to see Sakharov. We passed through the passport control station in the corridor in front of Sakharov's apartment, where a militiaman (a KGB agent) sat, and then entered the apartment. Sakharov and Bonner greeted us in a very friendly manner. They were upset that we had already eaten breakfast because they had prepared some for us. Then for about four hours we conversed with Sakharov about many scientific matters and news items. At dinner that evening Sakharov and Bonner told us of some of the problems connected with their life in Gorki. We returned to Moscow late that evening.

Looking back on the visit now, it seems to me that we barely touched on political matters. Yet, as became clear, the KGB had listened in on our conversations—not only in Sakharov's apartment but in the guesthouse, too—for on our return to Moscow, the reaction of the KGB was disappointment. The deputy director of the KGB at the Lebedev Institute informed me that the "General" was dissatisfied with my conduct because I had overstepped my authority: I had promised, without sufficient grounds, to resolve many of Sakharov's problems and had overly complimented his human qualities, even to the extent of calling him a genius. Moreover, I had discussed political matters with him, too. In response to this I suggested that we invite the "General" to join us one day and that together we all listen to the recordings. "What recordings?" exploded the deputy director. "What do you mean?" To my next question—"Where did you get all this information?"—his reply was a *non sequitur*. As I took my leave of him, he told me that there was some unpleasantness in store for me: In the first place, I was now refused permission to go abroad at least until 1988.

I made my last trip to Gorki with Arkady Tseytlin, a research collaborator, on the day of Sakharov's 65th birthday, 21 May 1986. *Perestroika* was in its second year. A new wave of letters and appeals for Sakharov's release was inundating Mikhail Gorbachev's mailbox. This time



Elena Bonner with Sakharov, around 1980.

there were no official checks outside Sakharov's apartment, but the memory of those who had been there before still lingered in the minds of both of us. Nevertheless I did not refuse to take a letter from Sakharov to Gorbachev. From my conversations with Sakharov it became evident that he keenly sensed the approach of decisive changes in our country and was in an optimistic mood, even though he himself had undergone three hunger strikes, followed by violent bouts of eating, and three thefts by KGB agents of the manuscripts of his memoirs. (He laboriously reconstructed them each time they were stolen and finished them literally on the day of his death.) He had also suffered through the conviction and exile of Bonner, whom the authorities graciously permitted to live with her husband in Gorki, as well as through innumerable other "small" unpleasantnesses.

Bonner's support for her husband throughout those years of hardship was the decisive factor that kept him alive, ensuring that he did not become physically or morally broken. His best human qualities were made manifest in Gorki: his genuine lack of superficiality, his joy in the companionship of those close to him, the simplicity of his behavior at home, his hospitality, his ability to listen without interrupting to opinions that contradicted his own and the absence of any bitterness despite almost unbearable suffering and injustice. All this created around him an aura of kindness and integrity. On the other hand, he was hard-nosed, sticking to his convictions while engaged in conversation with opinionated people. Scientific discussions with him were not easy—at each step tricky questions needed to be answered—but

relations with him inspired an additional belief in life, even in those bitter days in Gorki.

On 16 December 1986 the telephone rang in Sakharov's flat. Gorbachev was on the line. The following day, the president of the USSR Academy of Sciences, Guri Marchuk, arrived in Gorki and spent two hours negotiating scientific plans with Sakharov. Then followed the triumphal return to Moscow.

To conclude, I would like to elaborate on one of Sakharov's last remarks to me—that the ongoing influence of *perestroika* in our country and the rest of the world demands deep and broad analysis. It is clear to me that the influence of Sakharov himself is likewise gigantic and that it is only with great difficulty that we lesser mortals can analyze it and give some quantitative estimate of it. There exist in the depths of the soul of every single one of us the capacities for both good and evil, and through Sakharov's influence most sensible people in our land now opt for kindness. This influence has necessarily embittered many of the opponents of *perestroika*, but it has undoubtedly given rise to more kindness in the world, and this has benefited the whole of humanity. Let us hope that this additional reserve of compassion, together with his belief that there will be no reversal of *perestroika*, which he also bequeathed to us, will compensate in some small degree for the loss of this man, this scientist, this citizen.

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I wish to express my deep gratitude to Pamela Solomos for helping to put the translated manuscript of this article into more literary English.