

Andrei Sakharov today: lasting impact on science and society

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Contents

| | |
|--------------------------------------|-----|
| 1. Introduction | 176 |
| 2. The past that did not pass | 176 |
| 3. Sakharov's scientific ideas today | 178 |
| 4. Sakharov's public legacy today | 180 |
| 5. Conclusions | 181 |
| References | 181 |

Abstract. The 20-year period of 1948–1968, during which Andrei D Sakharov crucially contributed to the creation of the Soviet nuclear shield, was followed by the same length of time from 1969 to 1989, when he was no less patriotic in his human rights activities and in his efforts to save humankind from self-destruction in a thermonuclear war. When free of these commitments, Sakharov always turned to his favorite pastime, theoretical physics, where, working on the ‘roadside’ (to use his own words), he obtained a number of results of continuing importance. Some of these are described in this talk, as are Sakharov's actions and approaches, highly nontrivial and still relevant today, to solving the problems of major public concern.

1. Introduction

“We heard several times how he read Pouchkine by heart, quietly, almost to himself: ‘When a noisy day dies for a mortal...’” He said once: “I want to follow Pouchkine.... It is impossible to imitate a genius. But it is possible to follow him in something different, maybe, higher....” (from the recollections of Raisa Orlova and Lev Kopelev [1]). Speaking about Sakharov's legacy today, I have in mind first of all his methods of solving formulated problems and achieving the required result. Of course, ‘it is impossible to imitate a genius’, but it is possible to learn something from him.

On 23 May 2011, public lectures devoted to the 90th anniversary of A D Sakharov's birth, organized by the Dinastiya Foundation, were held at the Conference Hall of the Lebedev Physical Institute, RAS (FIAN). Youth packed the hall, and this engenders hope.

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During the 20 years from 1948 to 1968, Andrei Dmitrievich was involved in the development of the Soviet nuclear shield, and during the next 20 years, from 1969 to 1989, guided by the same patriotic sense of duty, he was engaged in the protection of human rights and preventing mankind from self-destruction in a thermonuclear war. When free from these commitments, he devoted all efforts to his favorite pastime— theoretical physics. And although his works were performed on the ‘roadside’ (*Diaries* [2], the note on 4 May 1986), many of them initiated the development of whole scientific fields: the peaceful use of thermonuclear fusion, the explanation of the baryon asymmetry of the Universe and the appearance of primary inhomogeneities of matter at the early evolutionary stage of the Universe, muon catalysis, magnetoimplosive generators for producing ultrastrong pulsed magnetic fields... [3]. His daring idea (for that time, 1967) of induced gravitation received a full-scale development in string theory, and Andrei Dmitrievich always talked about this with great satisfaction. The modern state of some of these scientific fields will be discussed below.

I will also talk about the possibility of applying ‘actions à la Sakharov’ to solve a number of acute public problems in modern Russia, such as the salvation of domestic science, the creation of an effective system for protecting childhood and family, the development of public control and the participation of citizens of our country in making decisions, including the implementation of the new technologies of Internet democracy, the combination of mobile communications and the Internet, etc.

2. The past that did not pass

But first of all, we will see what made Andrei D Sakharov one of the most significant figures of the 20th century.

Andrei Dmitrievich's public activity was directed at realizing in life and implanting in the mind of society, politicians, and State rulers the idea of connecting closely the two seemingly unrelated spheres of protecting individual human rights, on the one hand, and international security, on the other. It is in fact, his major message to humankind, which was clearly expressed in his Nobel lecture in 1975. In

principle, we are dealing with a practical global implementation of Fyodor Dostoevsky's famous saying that "the happiness of the world does not cost a tear of a child," which had never and nowhere before been perceived seriously by politicians, reformers, and revolutionaries of various stripes (many shortsighted pragmatics considered and consider Sakharov a 'naive man'). The successful realization of this approach made Sakharov a man of the World, because it is this connecting that allowed humankind to step away from the edge of the thermonuclear abyss. Clearly recognizing that the possibility of falling into this abyss was more than real.

The danger of mutual assured destruction and the nuclear balance between the USSR and USA were, indeed, the most important irenic factors preventing the eruption of a third world war. But, on the other hand, the gradual accumulation of nuclear arsenals made the achieved 'balance of fright' more and more unstable. Ballistic missiles with thermonuclear warheads aimed at each other, which cannot be called back after their launching, the nuclear suitcase, and the finger of the highest leaders in the USSR and USA on the nuclear button—the decision of each of these two individuals determined whether life on Earth continued or not. We all hung by a single hair: any error in early warning systems signaling about a nuclear missile attack by the enemy could lead to global catastrophe.

It is clear that the only solution was to end the confrontation of the two systems and to reach agreement between each other. But this is clear only now. As a rule, later generations understand old events well. (V L Ginzburg joked: "I would like to be as clever yesterday as my wife is today.") Sakharov was also a child of his epoch, raised in the 1930s and believing that socialism was the future of humankind, whereas capitalism was historically doomed. And he only very gradually understood that, whether you wish it or not, it is necessary to agree because the only alternative to agreement is mutual destruction. Notice that the problem of a reconciliation between the two systems appeared to be absolutely insolvable. Recall that all leading ideologists and leaders in the USSR (Lenin, Trotsky, Stalin, Khrushchev, and others) thought in terms of the world revolution and the inevitable destruction of capitalism—imperialism, all of politics and the potential of the USSR being aimed at realizing these ravings. And here Sakharov writes to the 'top' about some intellectual freedom and convergence (a closed letter to M A Suslov in 1967, found in the early 1990s in the archive of the Central Committee of the Communist Party of the Soviet Union by a historian of physics, G E Gorelik (see [4], pp. 422–427). Sakharov was, of course, well known and respected at the very top of the Soviet power pyramid, and his opinions on the problems of defense and the production of nuclear weapons were taken into account. But his 'humanistic' reflections were simply ignored, and he received no answer at all.

And then miracles began to occur, which only Sakharov could 'produce' and which his physicist colleagues called quite spectacularly as 'the violation of the energy conservation law', 'Sakharov—the talking horse', and so forth.

Having received no answer from the commanders of our country, Andrei Dmitrievich laid out the same ideas in his famous memorandum, *Reflections on Progress, Peaceful Coexistence, and Intellectual Freedom*, which he launched, through his friends in May 1968, as samizdat, understanding that the document would be published abroad. He signed the memorandum with his real name, not hiding from anybody. And this was done by a top-secret academician working at the

top-secret Arzamas-16 (Sarov) nuclear center. In early July 1968, the Memorandum was published in the West, and this was a shock to the Kremlin, the Ministry of Medium Machine Building, and Sarov. "Why did you decide to appeal abroad?" asked my father, L V Altshuler, who also still worked in Sarov in 1968 and was long on friendly terms with Sakharov. "I decided to appeal to those who are ready to listen to me," Andrei Dmitrievich answered mathematically accurately (L V Altshuler, *Next to Sakharov*, in books [5, 6]).

And such examples of 'going beyond the scope of given circumstances' are plenty. Special insistence was required to save individuals ("And you want to save a friend, but cannot think out how"—Yuly Kim, poem "19 October"). But, they 'thought it out', and first and foremost Sakharov. And if the regime did not give in, the task was to make the action grow like a snowball, assuming a worldwide character. In essence, this was the method of all human rights movements. Even today, to save a child in modern Russia, we child rights activists are forced to use the same methods of 'global response' because, under conditions of total 'departmentalism' and the absence of a workable legal system, we simply do not have any other methods for convincing officials. Talking about the past, it is necessary to emphasize the special role, the unbelievable energy, and the insistence of Yelena Bonner in the task of saving individuals,¹ as Andrei Dmitrievich writes in his *Recollections* [7].

Indeed, during many years of his human rights activity, Sakharov constantly acted as a patient teacher, carrying forward by his words and deeds the seemingly simple but in reality absolutely nontrivial idea that the tragedy of an individual is a calamity no less than the tragedy of millions. And the famous scientist, human rights activist, and Nobel Peace Prize laureate went to Siberia to see a repressed dissident, stood in the rain in front of the court buildings, and started an indefinite hunger strike for the rights of 'some girl'. I well remember that these 'trifling' Sakharov's actions caused irritation even among some people close to him—they sincerely did not understand him. However, it was by such actions that Sakharov changed the entire system of international security.

All manner of absurdities are being told about Andrei Dmitrievich, both sincerely and 'made-to-order'. One of the most lasting and certainly made-to-order legends is that a quite decent Russian Soviet genius was seduced into anti-Soviet activity by some Yelena Bonner. To refute this stupidity, I recall several episodes from Sakharov's life 'before Yelena Bonner'.

November 1950, Stalin's no-joke epoch, the town of Sarov near Gorky. The work of the KB-11 nuclear center was inspected by an important commission from Moscow. In particular, the commission had conversations with leading scientists, asking a standard question: Do you agree with the politics of the Communist Party? All the reasonable people routinely answered 'yes', but two, Sakharov and L V Altshuler, did not agree with the Party's politics in the field of biology (it was two years after the destruction of genetics and the triumph of Lysenkoism). The recently unclassified KB-11 documents edited by R I Ilkaev and published at the Russian Federal Nuclear Center 'All-Russian Research Institute of Experimental Physics' (RFNC-VNIIEF), contain, notably, the conclusion of this commission: "The heads of laboratories

¹ Yelena Georgievna Bonner died after a grave disease in Boston on 18 June 2011. (*Author's footnote*)

such as Altshuler, Sakharov, and others who do not inspire political trust and come out against the Marxism–Leninism foundations of Soviet science should be dropped from the leadership of research bodies” (see [6], p. 460). It is clear that if such instructions were had been fulfilled, no bombs would have appeared in the USSR.

22 November 1955. The well-known conflict with Marshal of Artillery M I Nedelin, when, during a banquet after the successful testing of the hydrogen superbomb, Sakharov proposed a pacifistic toast that shocked the participants at the banquet.

1962. A significant conflict with N S Khrushchev caused by Sakharov’s demand to put off ‘the double test’.

1964. The speech at the General Meeting of the USSR Academy of Sciences against the election of N I Nuzhdin, who was a creature of T D Lysenko and was supported by Khrushchev, to the members of the Academy. I E Tamm, V A Engelgardt, and M A Leontovich also protested against the election of Nuzhdin. But Andrei Dmitrievich addressed the academicians in a hard tone, which was quite unusual for such meetings, and said that Nuzhdin was responsible for “the shameful backlog of Soviet biology,” “for the ostracism of real science and true scientists, for persecutions, mockeries, the deprivation of the possibility to work, dismissals — up to arrests and the deaths of many scientists.” Nuzhdin was not elected. Khrushchev was mad with rage and decided to dissolve the Academy, excluding all research institutes under it. At that time, the Academy was saved due to the state upheaval on 4 October 1964, after which Khrushchev’s place was occupied by L I Brezhnev. This raises the natural question: What will save the Russian Academy of Sciences today?

1966. Sakharov, together with other well-known scientists (P Kapitza, M Leontovich), artists, and writers (M Plisetskaya and others), altogether more than 20 people, addressed the XXIII Communist Party Congress with a letter against attempts to rehabilitate Stalin.

In September 1966, Sakharov sent a telegram to the Supreme Soviet of the Russian Soviet Federative Socialist Republic protesting against the inclusion of article 190-1 (the dissemination of certainly false information and defamation slandering the Soviet state and public system) in the Criminal Code of the USSR, as a pretext for persecuting Soviet citizens for their convictions.

On 5 December 1966, Sakharov participated in a demonstration near Pouchkine’s monument (an annual demonstration on Constitution Day for human rights and against anticonstitutional articles in the criminal code. The clear legal foundation for these demonstrations was created by a well-known mathematician Aleksandr Sergeevich Esenin-Volpin, son of the poet Sergey Esenin. We see how everything is intersected in our life).

In February 1967, Sakharov wrote a letter to the General Secretary of the Central Committee of the Communist Party of the Soviet Union in defense of Yury Galanskov, Aleksandr Ginzburg, Vera Lashkova, and Aleksandr Dobrovolsky. As a result, Andrei Dmitrievich was relieved of his duties in Sarov as the head of department. In summer of 1967, Sakharov takes part in the fate of a political prisoner, Yu Daniel.

In the same 1967, Sakharov wrote the above-mentioned letter to M A Suslov, and after a year he acquired a new status: having become known around the world, he was banned from all classified military-related research and returned to FIAN in Moscow.

In spring of 1969, K A Vikhireva, the first wife of A D Sakharov, the mother of his three children, died from cancer. I got acquainted with Andrei Dmitrievich in 1968. In March 1969, I was at Klavdiya Alekseevna’s funeral and remember that Andrei Dmitrievich wept bitter tears. He took his wife’s death very badly: “lived as in a bad dream, doing nothing in either science or public affairs.” But he always cared about his children. And his first wife well knew about all his ‘political’ actions mentioned above, which occurred long before his acquaintance with Y G Bonner, about two years after Klavdiya Alekseevna’s death. Sakharov and Bonner married on 7 April 1972. Talking about this union, it is impossible not to talk about its third participant, Russian poetry, verses, which were for them a way of existence. They happily found each other in this — even notes passed back and forth during Sakharov’s hunger strikes were coded with lines of Pouchkine’s verses [8].

Yes, Sakharov and Bonner, as other human rights activists and dissidents, became an insolvable problem for the totalitarian system. It is sufficient to write the words ‘a furious beast in a skirt’ (*zveryuga v yubke* in Russian) into an Internet search engine, and you will find at once the record of the historical meeting of the Political Bureau of the Central Committee of the CPSU on 29 August 1985. M S Gorbachev raised a question at this meeting as to what should be done to force Sakharov to abandon a half-year hungry strike, demanding permission for his wife to travel to the United States for medical treatment (during this hunger strike, Sakharov was subjected to painful force-feeding). Andrei Dmitrievich struggled to save his wife, i.e. he behaved like a real man. In discussing this question, the members of the Political Bureau called Sakharov’s wife ‘a furious beast in a skirt’, while Gorbachev added: “This is what is called Zionism.” But we should give him his due: he forced through the Political Bureau permission for Bonner’s medical treatment in the USA, and after about a year he returned Sakharov and Bonner to Moscow from exile in Gorky. The question arises: Why did Yelena Georgievna attract such attention at the highest political level in the USSR? The same question concerns Andrei Dmitrievich Sakharov. I have no answer, and I think that it is a question for future historians.

And it is quite amazing that all this is relevant today as well. This past has not passed at all. On the 90th birthday of Sakharov, Channel 1 of Central TV showed a ‘jubilee’ film in which all the mud and slander disseminated about Sakharov and Bonner a quarter of a century ago by the authorities was repeated word for word. Andrei Dmitrievich died 21 years ago, and Yelena Georgievna did not travel to Russia for almost 10 years because of heart disease. Why are their names still unheard of for ‘ever yesterday’s people’, who were inherited by the new Russia from the former USSR? All this is strange and disturbing.

3. Sakharov’s scientific ideas today

I wrote a long article, bearing the title of this section, for the recently published jubilee *Sakharov’s Collection–2011* [9]. In essence, this is the major theme of the current scientific session of the Physical Sciences Division of the RAS devoted to the 90th anniversary of the birth of A D Sakharov. Therefore, I will only briefly present this topic here, trying to avoid overlapping with other reports.

Peaceful use of nuclear fusion: tokamaks. In the report “The theory of a magnetic thermonuclear reactor” (MTR) prepared by A D Sakharov and I E Tamm in 1951, they

proposed for the first time an idea for the magnetic insulation of deuterium–tritium plasma heated up to a few million degrees (‘a magnetic trap’, which was later called a tokamak). These Sakharov’s and Tamm’s works are acknowledged as pioneering. Further investigations were continued under the supervision of L A Artsimovich, and theoretical studies were headed by M A Leontovich. In 1956, the results of Soviet research on the possibility of confining hot plasma in a limited spatial volume by means of a magnetic field were unclassified by the order of N S Khrushchev and reported by I V Kurchatov in Harwell (Great Britain), and then published in the *Proceedings of the First Geneva Conference on the Peaceful Use of Nuclear Power*. It is this publication that became a revelation for researchers all over the world. Hans A Bethe wrote about this in 1976: “At present, the prospects appear to be better than ever before; a few years ago, Russian experimentalists invented a setup called the ‘tokamak’.... This setup was comparatively successfully reproduced in the USA” [10].

The realization of the idea of controlled nuclear fusion promises the production of infinite energy. These prospects are so attractive that tokamaks have been under development for already 60 years, with the efforts in their studies increasing. However, a positive energy balance has not been achieved so far. Many ideas were proposed to overcome the encountered problems. Altogether, more than 200 tokamaks have been developed, 35 of them operating today (see <http://www.tokamak.infor>). The history’s largest tokamak [the International Thermonuclear Experimental Reactor (ITER) project] will be constructed at the CEA Cadarache Research Center in the southern France, 60 km from Marseille. The concept of this project was advanced for more than 15 years, and it was finally accepted in July 2010. This is a great and very expensive project, involving about 30 countries, including Russia and the USA.

It should be noted that a number of researchers (for example, Bruno Coppi [Massachusetts Institute of Technology (MIT)], who is also known to have actively helped Sakharov in his difficult years) doubt the efficiency of the ITER project and justifiability of the huge investment in it. Bruno Coppi argues, and reported it at the Third International Sakharov Conference on Physics in 2002, that ‘Ignitor’ type tokamaks being developed at MIT, in Italy, and at the National Research Centre ‘Kurchatov Institute’ in Moscow are much more promising and also less expensive.

Surprisingly, despite all the difficulties and high cost of these experimental projects, the enthusiasm of researchers and State leaders has not diminished. The stakes are too high, especially taking into account the rising cost of oil and natural gas. Thus, we see that problems in the field of controlled nuclear fusion formulated by Sakharov 60 years ago remain more than urgent today.

Explanation of the baryon asymmetry of the Universe. This classic article [11], published in 1967, occupies only three journal pages. The essence of the problem is that it was assumed for a long time that the theory of elementary particles is charge-symmetric and, therefore, it was unclear why galaxies and stars consisting of baryons (protons, neutrons, etc.) are observed in the Universe, whereas antigalaxies and antistars consisting of antibaryons (antiprotons, antineutrons) are not observed (see also Refs [12, 13]).

Sakharov formulated three following conditions for the appearance of the baryon asymmetry at the early instants of the hot Universe expansion.

(1) Violation of the combined parity (*CP*-parity) in scattering processes of elementary particles, which was discovered shortly before this by S Okubo (the numerical values of the scattering characteristics of some particles differ by 0.6% from the characteristics of spatially (*P*) reflected scattering of their antiparticles). Sakharov wrote his own verse on a copy of his article, which he gave to E L Feinberg [7]:

*Based on S Okubo effect
At a high temperature,
A fur coat made for the Universe,
Fitting its crooked figure.*

(2) Symmetry violation during time reversal, i.e. under the dynamic conditions of a strong nonstationarity, which takes place due to the rapid expansion of the Universe immediately after the Big Bang.

(3) Baryon number violation. Sakharov considered in his paper the simplest mechanism of such a violation—proton instability. According to Sakharov’s estimates, for the observed baryon asymmetry of the Universe to appear at the initial stage of its existence, it is sufficient to assume the proton is unstable, with a lifetime of about 10^{50} years. This ‘crazy’ idea suggested by Sakharov in 1967 was established in theoretical physics in 1979, although today other mechanisms of baryon number violation, differing from proton instability, are being considered.

In recent years, models of baryogenesis at the reheating stage—the decay of the vacuum-like state in inflation models (the inflating Universe)—are being widely discussed. It is at this stage that Sakharov’s three conditions for the appearance of the observed baryon asymmetry of the Universe ‘operate’. At the same stage, the initial quantum inhomogeneities of vacuum produce the primordial density fluctuations of matter from which galaxies and stars were later formed. (See below comments on the relevant paper by Sakharov).

“*The initial stage of an expanding Universe and the appearance of nonuniform distribution of matter*” [14]. This was Sakharov’s first paper following his return to ‘major science’ after a 15-year ‘bomb’ interruption and performed in 1963–1964. How were spatially inhomogeneous accumulations of matter such as galaxies and galaxy clusters produced, while everything was absolutely uniform at the early evolution stage of the Universe? Sakharov writes in his *Recollections* ([7], Part 1, Ch. 18): “The theory of gravitational instability shows how initially small density inhomogeneities increase. However, to find these inhomogeneities, additional physical considerations or hypotheses are needed. This is one of the major problems of large cosmology. In my paper published in 1965, I tried to study this question.”

I will cite comments on this paper published in Sakharov’s collection *Scientific Works* ([3], pp. 214, 215):

“*This work is quite typical for the scientific style of A D Sakharov. As with his subsequent work, it is significantly ahead (in time) of the development of science in this field. In fact, this paper laid the foundation of a new avenue of inquiry in cosmology—the theory of the origin of the initial perturbation spectrum for the formation of galaxies and their clusters*” (V F Mukhanov).

“*This work by A D Sakharov is remarkable in that he put forward for the first time the assumption about the origin of pregalactic inhomogeneities from quantum fluctuations.... At present, most cosmologists are sure that pregalactic inhomogeneities were produced namely from quantum zero-point oscillations, not of cold baryonic matter, but, for example,*

scalar fields, which are substantial components of modern models of the Grand Unified Theory.... These fields determine the inflation stage” (G V Chibisov).

Paper [14] was written just before the discovery of relic radiation in 1965, which proved the validity of the hot Universe model. Much later, while in exile, Sakharov wrote about this paper: “I proceeded then, following Zel’dovich and many other authors of that time, from the so-called cold Universe model, according to which the initial temperature of superdense matter was assumed to be zero.... The use of the cold model considerably depreciated my first cosmological work” ([7], Part 1, Ch. 18).

However, the situation drastically changed after the discovery of the anisotropy of relic radiation with the help of extraterrestrial radio telescopes in 1992. The difference between the ‘relic temperatures’ at different points in the expanse of heaven is extremely small, within 0.01% of the mean temperature of 2.725 K of relic radiation. But this became a powerful tool for studying the early evolution stages of the Universe, because the observed small fluctuations of relic radiation are the ‘prints’ of primordial density fluctuations of the matter and cosmological gravitational waves.

And it is remarkable that baryon acoustic oscillations of relic radiation discovered by astrophysicists in 2001 are similar to the matter oscillations described theoretically by Sakharov in his paper in 1965 (see, for example, book [15]). These inhomogeneities of the relic background were rightly called ‘Sakharov oscillations’. It is sufficient to search for this term on the Internet in order to see how Sakharov’s ideas are actively being used in modern science.

4. Sakharov’s public legacy today

Sakharov’s method in science and public activity was in fact the same: he always remained a man of exact sciences, a physicist, a constructor, and a designer. I talked about this in detail in my report at the IV International Sakharov Conference on Physics in 2009 [16]. Here, I will talk about the possible application of his ‘method’ to solving some modern social problems.

Through his public activity, Andrei Dmitrievich Sakharov gave an example of the powerful influence of civil society on the authorities. Today, Russia is ready to take in this experience. There are two reasons for this:

(i) The ‘unwhipped’ post-Soviet generation, free of the ineradicable Soviet fixation of passively waiting for decisions from higher comrades;

(ii) the development of social networks on the Internet, which is called Internet democracy.

In 1968, Sakharov wrote in his futurological article “Future science”: “Progress in cybernetics will result in deep displacements in ideology and philosophy... will introduce great and unexpected corrections to the prediction of the domestic, social and political structure of future society.”

In his interview for the *Book Review* newspaper in spring of 1989, he said about the youth: “I believe that moral strength is always preserved in people. I especially believe that youth, which in each generation begins to live as if anew, is capable of taking a high moral position. I do not mean the revival but rather the necessity of the development of moral strength, which is inherent in each generation and can proliferate again and again.”

Today, we see this with our own eyes. In recent years, wide volunteer initiatives have appeared to help children inmates of boarding schools (it is namely this ‘moral strength

proliferating again and again’); the actions and hunger strikes of the All-Russia movement Accessible Preschool Education for Russian Children against queues for kindergartens; mass movements of car drivers; ecological movements, the best known being To the Defense of the Khimki Forest, etc. are occurring all over our country. The activists of these movements are mainly young people, young parents 30–35 years old, i.e. grown up after the collapse of the Soviet Union. They are united primarily by the Internet. At the same time, it is obvious that we are only at the beginning, and all these initiatives require support, including technological support, for the more efficient use of social networks, and the entanglement of wider population layers interested in the solution to various essential problems for people.

One well-known example of internet lobbying, which was amazing in its effectiveness, is a letter (January 2011) by Sergey Volkov, a teacher at school No. 57 in Moscow, against new educational standards, which was supported by thousands of bloggers and evoked a positive response from V V Putin and A A Fursenko.

And questions arise: Where is the Russian scientific community? Why is there nothing similar to Sergey Volkov’s letter in our scientific media? Whereas the problems are acute and well-known to all:

(i) While the leading scientific institutes of our country suffer a miserable existence, huge portions of the budget are being spent to construct a scientific paradise in one separately picked town of Skolkovo: 5.75 billions rubles (appr. \$ 190 mln) having been already spent just to build the 5-km highway from Skolkovo to the Moscow belt highway (and after six months this highway became worthless).

(ii) So-called ‘efficient managers’, who are infinitely far from science, were appointed the directors of a number of the largest institutes in our country (NRC ‘Kurchatov Institute’, SSC ‘Alikhanov Institute of Theoretical and Experimental Physics’, Konstantinov Petersburg Nuclear Physics Institute, RAS), and this was done by ignoring completely the opinion of the researchers from these institutes.

(iii) There also exist many problems in the organization of the work of the Russian Academy of Sciences itself.

Clearly, it is possible to get out of the quagmire in this and all other spheres only with the help of an ‘external force’, an ‘external fulcrum’, such as well-organized and sufficiently ‘high-pressure’ scientific and civil societies.²

Now I will tell about children and the defense of their rights — the everyday occupation in which I and my friends and colleagues have been involved for the last 15 years. Obviously, children are the future of our country, and we have serious problems with this future (in direct and

² The role of such an authoritative publicly active platform could be played by the Russian Association for the Promotion of Science, founded on 28 July 2011 on the initiative of Academician E P Velikhov, the Secretary of the Public Chamber of the Russian Federation. The aims and tasks of the association are discussed in Velikhov’s interview presented on the site, Tribune of the Public Chamber (<http://top.oprf.ru/interviews/3894.html>). The aim is beautiful, but what will happen in practice is not clear now. Maybe this will come to good if foreign scientists working in Russia, some of whom at a meeting with the President of the Russian Federation on 23 May 2011 straightforwardly related stories about Russian bureaucrats preventing the development of native science (<http://kremlin.ru/news/11309>), join the active core of the association. But we should not rely only on foreigners, even if they are former Russians. Now the question arises: Where are our scientific analogues of Sergey Volkov, the teacher at school No. 57 in Moscow. (*Author’s footnote*)

figurative senses). The number of children in Russia is decreasing, thus approaching our country to a ‘demographically irreversible’ point. In 1998, 22 million pupils were educated in eleven grades in all Russian schools; in the 2010–2011 academic year, this number was 12.8 million, i.e. 9.2 million less in 12 years. The total number of children in Russia in 2003 was 31.18 million (21% of the country’s population), while in 2010, this number was 25.981 million (18% of the population). At the same time, the number of preschoolers increased by 1.5 million in the same 7 years. Specialists explain this growth by the introduction of financial incentives to mothers in 2007, but mainly by the fact that the last demographically intact generation born in the 1980s reached child-bearing age in the 2000s. Farther, the inevitable failure and accelerated aging of the population will follow.

One of the major lessons from Andrei D Sakharov is that people should not be sacrificed for achieving ‘great goals’, the fulfillment of desirable reforms, etc. This lesson was neglected by the architects and leaders of the ‘market’ reforms in the 1990s (in reality, pseudomarket reforms that annihilated any competition and gave away our country to the power of uncontrollable monopolies). As a result, millions of families with children, budgetary employees, and pensioners were set on the edge of survival, and beyond it. People ceased having children in the 1990s, and they do not do so today because the cost of the necessities of life (food and housing) is so high that they cannot feed their children, and the children have no place to live. Russian poverty has a ‘child’s face’. I say this with the full knowledge of the facts, being engaged in these problems with my colleagues in the Public Chamber of the Russian Federation and in the Expert Group No. 9 (“The reduction of social inequality and overcoming poverty”) to develop the so-called Strategy 2020 (the concept of the social and economic development of our country up to 2020).

There also exist other acute problems concerning childhood. For example, the mass separation of children from parents (more than 100 thousand new orphans appear each year, about 300 orphans per day, and this has gone on for many years), or the fact that 300 thousand children (in 2009) are living permanently in children’s institutions, only 30% of them being orphans, while others were abandoned by their parents and leaved in care of the State because of a disability of the child or unfavorable conditions in the family, in particular, due to the absence of money for feeding the child.

The methods of solving all these social and economic problems of childhood and the family, including legislative measures, are well known: they have been proposed many times by specialists, and have even been considered at the highest political level. Nevertheless, all remain ‘as always’ because the corporative interests of departments and monopolies, which are not interested in these reforms, always win, whereas the pressure from society is negligibly small.

Sakharov could produce pressure leading to the desirable effect, whether it was the pressure required to compress the hydrogen isotope nuclei in the hydrogen bomb or the public pressure which the leaders of the great superpowers were forced to take into account.

Andrei Dmitrievich Sakharov passed away in another country during another epoch. The history does not have the conjunctive, but I am sure that if Sakharov was alive, the history of Russia would be quite different.

5. Conclusions

I was closely acquainted with Andrei Dmitrievich for more than 20 years, and the same period of time has elapsed since his death. Many recollections have been written, but I was pleased most of all when the First September Publishing House suggested recently that I write an article commemorating the 90th birthday of Sakharov for teachers and school kids [17]. There are strong grounds to believe that interest in Sakharov will only increase in the course of time with the appearance of new generations in our world.

In conclusion, I will speak again about science, to which Andrei D Sakharov was infinitely devoted. In August 1989, four months before his death, he completed his recollections with these words:

“Of course, the end of the work on the book creates the feeling of a borderline, a summing-up. ‘Why, however, is an obscure sorrow secretly troubling me? (Alexandre S Pouchkine). And at the same time, I am feeling a powerful life flow, which has begun before us and will continue after us.... This is the miracle of science. Although I do not believe in the possibility of the creation of the ‘theory of everything’ in the near future (or at all?), I have seen gigantic, fantastic achievements during my life alone and I expect that this flow will be not exhausted, but, on the contrary, will widen and branch out...” [18].

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