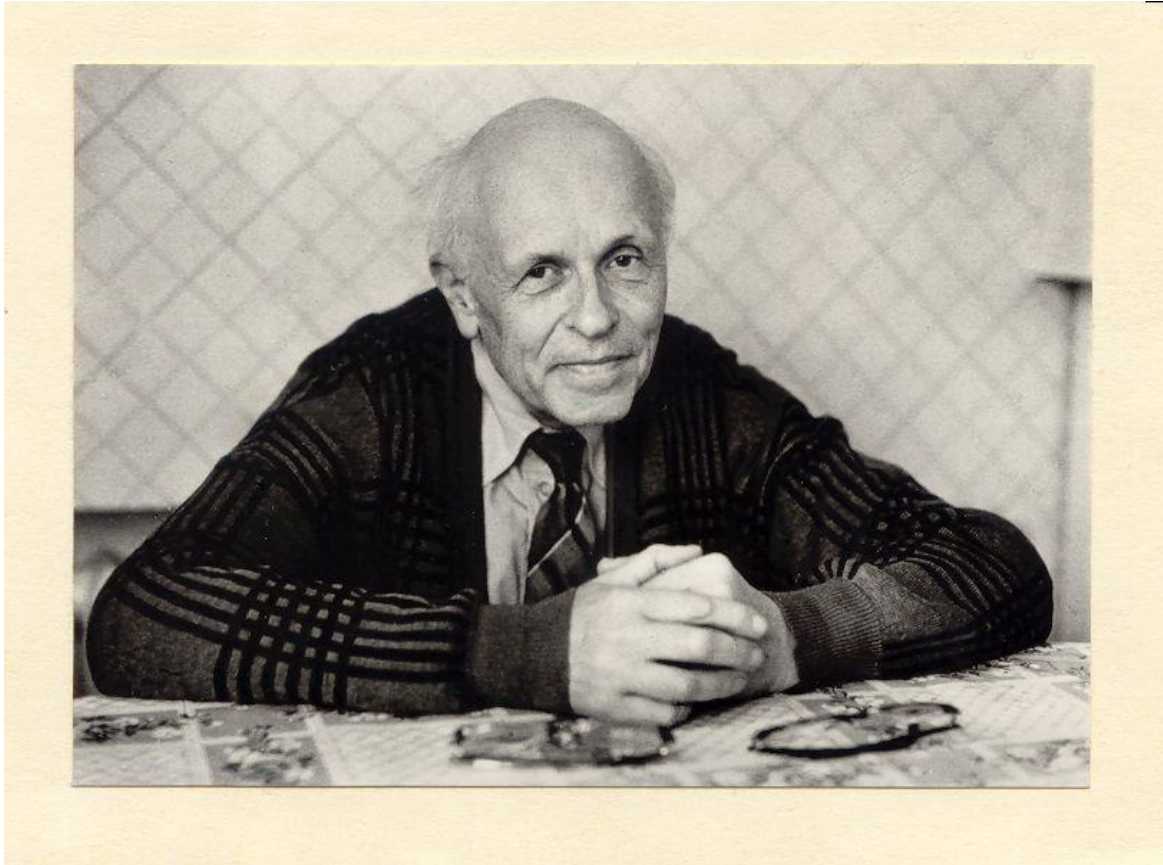


## **The genius of a design engineer: bomb, universe, human society. To the Andrei Sakharov Centenary**



*Andrei Dmitrievich Sakharov (21/05/2021 – 14/12/1989)*

### **Why Sakharov?**

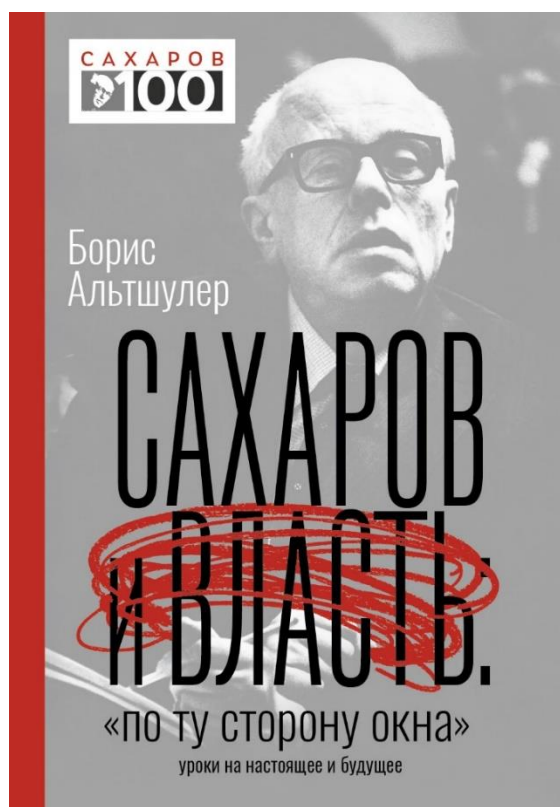
Andrei Sakharov died more than 30 years ago. Why is he important today? Here I'll try to show that his public, moral and scientific heritage (the first two being intimately connected) are essentially relevant today.

Surely it is amazing by itself that the creator of the most terrible weapon in the history of mankind became the Nobel Peace Prize Winner. Sakharov's fate is, one might say, an exciting detective story, a chain of incredible events, not accidental however, but dictated by the genius and fortitude of the protagonist. His special role became even more visible after "Sakharov" KGB and Politburo documents were recently declassified. They show that Sakharov was considered an expert by all ever changing leaders of the USSR, from Lavrenti Beria to Michael Gorbachev. In 1949-1967 he was an expert on nuclear armament, but in 1968-1989 he became an expert on nuclear disarmament, on the international security, and on saving the mankind

from the suicide of a thermonuclear war. His proposals were studied and some of them determined governmental politics. I'll come to this interesting topic in a minute.

And at the same time Sakharov never belonged to any State power structures, he always remained absolutely independent. My father Lev Altshuler, who worked together with Sakharov and, by the way, was a recipient of the Shock Compression Science Award of the American Physical Society (1991), had visited Sakharov in 1987, after his return from exile. Discussing perestroika and Sakharov's talks with Gorbachev, my father said: "Andrei Dmitrievich, you are on the top floor of the Power!" Sakharov immediately reacted: "*I'm not on the top floor. I'm next to the top floor - on the other side of the window*". This joke accurately reflects the uniqueness and irrationality of his status, which has become Sakharov's fate. Long before that, in the mid 1970<sup>th</sup>, commenting on my remark, Sakharov said: "*My name does not belong to me only, and I must take it into account*". He always knew his enormous personal responsibility for the deadly hydrogen bomb he created and for every word he said after that.

I used Sakharov's joke cited above in the title of my book written for Sakharov's centenary that was published in Moscow a few days ago.<sup>1</sup>



*“Sakharov and the Power: “On the other side of the window”. Lessons for the present and the future”*. According to the concept of the book, the outline of the

<sup>1</sup> Boris Altshuler, “Sakharov and the Power...” // “Omega-L”, Moscow, May 2021.

narrative is set by Andrei Dmitrievich Sakharov himself with short quotes from his books “Memoirs”<sup>2</sup> & “Moscow and Beyond”<sup>3</sup> which alternate with the reminiscences of contemporaries, reference documentary material and explanations. Here are some titles from the Content of the presently prepared English-language “mirror” of this book:

**Chapter 9.1958 -1963.** *The biological consequences of nuclear tests, the death of 10 thousand people over the next 5 thousand years: the global consequences of the "oddities of genius", the conflict with Khrushchev at a meeting in the Kremlin on July 10, 1961 (N.S. Khrushchev: "We helped the election of Kennedy. You can say that we elected him last year "). "Tsar-Bomb", three times Hero of Socialist Labor - again in the Kremlin.*

**Chapter 10.** *Cuban missile crises: “The Americans considered us as bandits in a certain sense”, “A guy named Arkhipov saved the world”. The reality of a big thermonuclear war: "Humanity was just lucky."*

**Chapter 15 1973.** *The first campaign of harassment, for unknown reason Sakharov was not exiled to "Naryn". The Jackson-Vanick Amendment, the Yom Kippur War, the Black September visit and the underlying reasons for Sakharov's focus on the Middle East; "Third World War on Christmas" and GlavPUR SA and the Navy.*

**Epilogue.** *The last day and possible causes of Sakharov's death, a nationwide funeral. Sakharov and our difficult Today in Russia: a monopoly in politics, law enforcement, economics and Sakharov's main lesson. Sakharov, looking ahead: forecast of the Internet, on the moral strength of new generations, on the role of individual in history.*

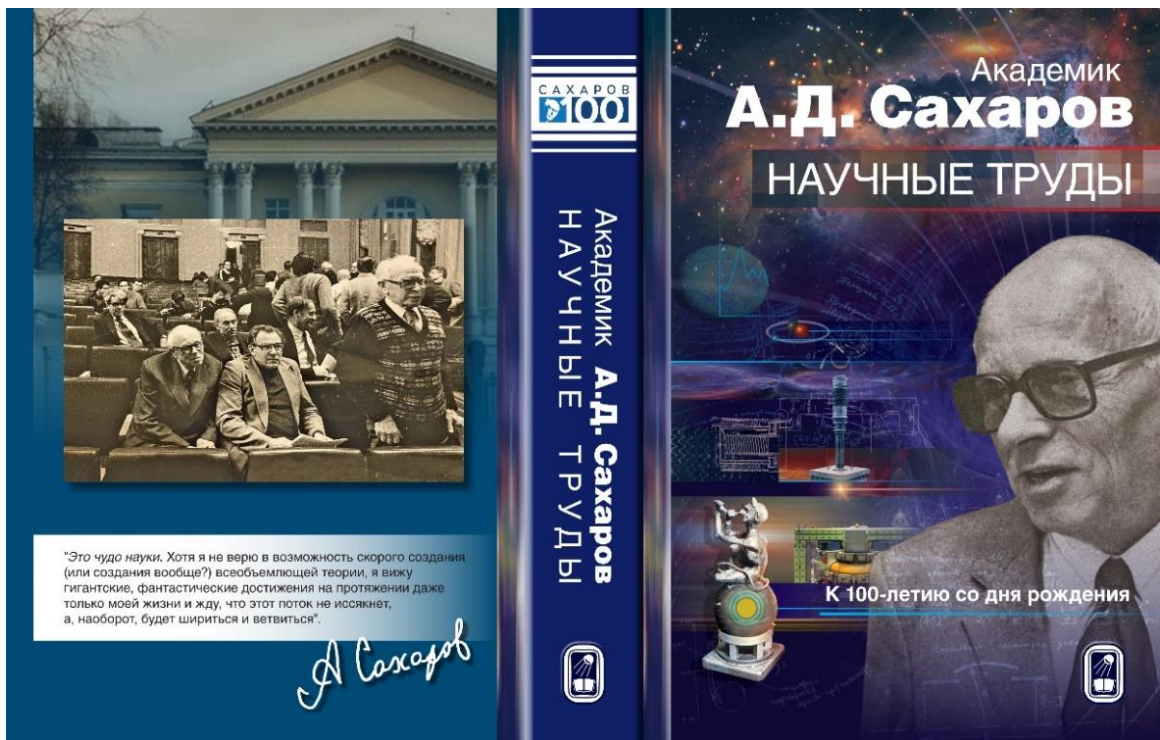
I must add that for Sakharov’s Centenary, we in the Theoretical Physics Department of the Lebedev Institute, compiled the new edition of his scientific works with new commentaries from top experts, which also came out a few days ago.<sup>4</sup>

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<sup>2</sup>Andrei Sakharov, “Memoirs” / Translated from Russian by Richard Lourie // Alfred A. Knopf, New York, 1990.

<sup>3</sup>Andrei Sakharov, “Moscow and Beyond” / Translated from Russian by Antonina Bouis // Alfred A. Knopf, New York, 1991.

<sup>4</sup>“Academician A.D. Sakharov. Scientific works. To his 100 years” / Compiled by Boris Altshuler, Igor Dremin, Vladimir Fortov, Leonid Gurvits, Vladimir Ritus, Anatoly Shabad, Michael Vasiliev // Theordep Lebedev Physical Institute – FIZMATLIT Publ., Moscow, May 2021.



This is in a sense the continuation of the two similar collections:

- Academician Andrei Sakharov, "Collected Scientific Works" / Marcel Dekker Inc., New York & Basel, compiled in 1981 to Sakharov's 60 years by Dmitry and Grigory Chudnovsky and Dirk ter Haar;
- And one compiled in Theordep of FIAN in 1995.

My article "Sakharov's scientific works in modern perspective" has been published in the May 2021 issue of *Uspekhi Fizicheskikh Nauk*.

I'll comment on Sakharov's scientific heritage below.

### **Now about Sakharov's public and moral heritage.**

In early 1968 Sakharov wrote his famous article "Reflections on progress, peaceful coexistence and intellectual freedom". In May of that year he gave it to friends for distribution in Samizdat, with his understanding that it would tunnel quantum-mechanically to the West. Declassified documents say that at the end of May 1968 this article "*confiscated by the KGB from dissidents' apartments during secret searches*" was submitted by the Chief of KGB Yuri Andropov to the Politburo. Soviet leader Leonid Brezhnev read it and ordered other Soviet top personalities to read it.

On July 1, 1968, 10 days before “Reflections” were published in the West, U.S. president Lyndon Johnson stated that the USSR – in contradiction to its previous negative position – agreed to negotiate the mutual moratorium on the development of anti-missile systems. This was one of the proposals of Sakharov’s “Reflections”. In 1967, Soviet leadership rejected such American proposal. This U.S.S.R-U.S.A agreement was signed in May 1972 in Moscow by Leonid Brezhnev and Richard Nixon.

The main thesis of Sakharov’s “Reflections” was that thermonuclear charges stored in the U.S.A and U.S.S.R were sufficient to eliminate mankind several times: “*For humanity, moving away from the edge of the abyss means overcoming disunity*”. And this was heard by Leonid Brezhnev. Soviet ambassador to the U.S. Anatoly Dobrynin, who served 24 years and saw six U.S. presidents, writes in his memoirs<sup>5</sup> that in the beginning of 1969 he got an Order from Moscow to begin secret negotiations with Henry Kissinger on “Détente”. The Helsinki Act of 1 August 1975 – an apogee of the politics of Détente, with its famous human rights obligations “Third Basket”, signed by the leaders of 35 states, was initiated by Leonid Brezhnev.

Two natural questions arise. (1) Why was there such a strange attention of Soviet “Leader-Gods” to the article of an academician? And (2) Why didn’t all these wonderful things (détente, human rights, etc.) work in real Soviet politics?

The answer to the first question is found in all 20 years of Sakharov’s work on the bomb. Leonid Brezhnev, who in Nikita Khrushchev’s epoch was the Party leader responsible for the armaments, saw Sakharov a number of times and adored him. Sakharov’s special status permitted him to use the governmental special line to call to Khrushchev, Brezhnev, and Andropov at any time. And one of the accusations against Khrushchev after his dismissal in October 1964 was that “*For two weeks he did not show Sakharov’s letter on the situation in the Soviet biological science to the members of the Politburo*”.

As to the answer to the second question, I’ll quote Sakharov’s answer to my rather naïve bewilderment back in 1973 - why didn’t Brezhnev do something evident (I

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<sup>5</sup> Dobrynin A.F. “Very confidential. Ambassador to Washington under six US presidents (1962-1986)” // Ed. “Author”, Moscow, 1996. - <https://biography.wikireading.ru/149770>

don't remember now what I had asked about)? Sakharov reacted in the language of physics: "The higher the position the less is the number of degrees of freedom. Brezhnev can do very little". The arrest in 1977 of the members of the Helsinki Groups (Yuri Orlov, Alexander Ginzburg, Anatoly (Natan) Sharansky and others) demonstrated to the whole world that the signature of Leonid Brezhnev under the Helsinki Act cost nothing.

Also, during these years U.S.S.R began deploying medium-range Pioneer thermonuclear missiles (SS-20, 1374 war-heads in 1983) with a mobile launch and a range of up to 5,500 km, each capable of destroying Paris, London, Rome, Berlin. Brezhnev was unable to stop this gigantic military-industrial flywheel.

It was evident that without the inner liberal human-rights reforms in the U.S.S.R the real nuclear disarmament was impossible. And now we come to, perhaps, the main feature of Sakharov's heritage that was reflected in the title of his Nobel Lecture "Peace, Progress and Human Rights". Observation of human rights is a necessary condition of international security. This idea is absolutely untrivial. How would saving one prisoner of conscience guarantee the saving of mankind? The physical analogy is a hologram when a small fragment of a system contains information about the whole system. When the judges in ancient Israel were hearing cases of murder they pronounced: "*He who saves a person saves the Whole World. Whoever kills a person kills the Whole World*":

מי שמציל אדם מציל את כל העולם. מי שהורג אדם הורג את כל העולם

(Mishnah "Sanhedrin" 37A)

H'ameabed nefesh ahah meabed Olam Male. H'amazil nefesh ahah mazil Olam Male

They meant that all people came from Adam, hence killing somebody is an attack on the very principle of life.

But who followed this and when? The historic achievement of the Soviet human rights movement of 1970<sup>th</sup> is that it managed to turn the attention of the world's Big Politics to the suffering of individuals. The role of Sakharov was crucial in this. It was not by chance that in his Nobel Lecture (1975) he listed 127 names of Soviet prisoners of conscience and apologized to those he missed. And surely the pain for every suffering individual was in his heart. This is his most important moral heritage.

And like in Soviet politics where “Brezhnev could do very little”, the same was true about Brezhnev’s (and perhaps Andropov’s, as indicated by some declassified documents) inclination to protect Sakharov. There were other super-influential “towers of Kremlin” (which is quite typical for any autocratic totalitarian system) which hated Sakharov, and this explains many dramatic sufferings of Sakharov and of his loved ones who became hostages of his social activity.

At this point I must express my gratitude to Western colleagues whose support at those times was really salutary. It goes to the American Committee of Concerned Scientists, the SOS (Sakharov, Orlov, Sharansky) Committee, APS Committee on International Freedom of Scientists, French scientists, etc. I personally was saved by the attention of John Archibald Wheeler, Joel Lebowitz, David Finkelstein and many others. Thank you! And I take a chance to say my gratitude to my friends – schoolmates at the Physical Department of the Moscow University, in 1956-1962, who I addressed first at the critical situation of March 1982 and who at that time, already for many years, lived in Israel and in the U.S.A: Pavel (Jan) Wasilewsky (Boston), Lev Levitin (Boston University), Dima (Dan) Roginsky (Hebrew University), Szimon Suckewer (Princeton). They approached prominent colleagues and the result was an avalanche of appeals “in support” to the Soviet tops. And this, I repeat, was salutary. We still do not fully understand the mechanisms of the influence of this support on the Soviet ruling elite, but we know that it worked. It looked like a miracle, but this was an observable fact confirmed by the repeated experiments.

### **Now in short about Sakharov’s scientific heritage.**

Fundamental physics has been an object of admiration for Andrei Dmitrievich throughout his life. “*I felt like a messenger of the Gods,*” - Sakharov said about his first report on quantum field theory at the FIAN Theoretical Physics Department in 1945. “*Do you know what my favorite subject is?*” he asked his wife Elena Bonner when they (at the beginning of 1970s) walked in the evening under the starry sky. And he himself answered: “*relic radiation*” (that is cosmological background radiation). In the words of Sakharov himself, his work on fundamental physics was carried out “on the sidelines” of the defense projects and public tasks that occupied his entire time. However, some of this work started scientific directions that are

relevant today, 50-70 years after they were researched by Sakharov. Let's briefly go through some of these works.

Firstly, this is the controlled thermonuclear fusion for electricity generation, Sakharov's 1950 idea of the magnetic confinement of hot plasma, which he finalized together with Igor Evgenievich Tamm.



*Niels Bohr and Igor Tamm, FIAN, Moscow, 1961*

The best results were shown by the European JET reactor (where the plasma temperature was up to 300 million degrees, 15 times higher than the temperature in the center of the Sun) and the experimental reactor of the Princeton Laboratory of Plasma Physics TFTR (Tokamak Fusion Test Reactor) installed in 1982, with the world record of 510 million degrees for plasma temperature. Unfortunately, the TFTR project was closed in 1997 during the presidency of Bill Clinton. These temperatures are significantly higher than those required to ignite thermonuclear reactions. However, the operability of a thermonuclear reactor is determined by the value of the key parameter  $Q$  - the ratio of the obtained energy of thermonuclear fusion to the energy spent on heating and confinement the plasma ( $Q$  is called Fusion energy gain factor). Formally, for self-sustaining plasma combustion (ignition), one needs  $Q > 1$ . In reality, taking losses into account, the plasma will burn without external heating at  $Q > 5$ . In a commercially viable reactor it is necessary to have  $Q > 20$ .



The most promising today is a giant tokamak that is being built in the south of France as a part of the international project ITER. Today its cost is estimated at 19 billion euros, and the first plasma is planned to be obtained in 2025. Expected  $Q = 10$  is good but still not enough for commercial use. The possibility of creating a commercial successor to ITER in Europe, an even more expensive DEMO tokamak, is being discussed.

The sad specificity of such gigantic and expensive projects is their analogy with gravitational instability: the larger the mass, the more it absorbs the surrounding matter, becoming even larger. The more expensive the project, the more funds it tends to absorb regardless of the expected success of the project. Experts note that the allocation of huge funds to the ITER project objectively led to the closure of a number of other less costly, but potentially also effective projects. I would like to note also the reports of the US National Academy of Sciences (2019)<sup>6</sup> and of the American Physical Society (2020)<sup>7</sup>, which emphasize the need, without abandoning ITER, to also support alternative to ITER directions of hot plasma research, such as for example, compact experimental installations for thermonuclear fusion (Fusion Pilot Plants) with super-strong magnetic fields.

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### **"Sakharov oscillations".**

The first work of Sakharov on cosmology (published in 1965) was devoted to the emergence of inhomogeneities in the Universe: stars, galaxies, clusters and superclusters of galaxies. Gravitational instability mentioned above in connection with “financial weight” of the ITER project, explains the origin of the observed inhomogeneities from small initial fluctuations of matter. Sakharov was the first to suggest that these initial fluctuations had quantum nature. He also showed that under strong nonequilibrium conditions due to expansion of the Universe and change in the equation of state of superdense baryonic matter the amplitude of final fluctuations of matter must depend periodically (with varying maximum values of the peaks) on the wavenumber of fluctuations. After the discovery in 1965 of the

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<sup>6</sup> National Academy of Sciences, Engineering and Medicine, “Final Report of the Committee on a Strategic Plan for U.S. Burning Plasma Research”, The National Academies Press (2019).

<sup>7</sup> American Physical Society Division of Plasma Physics Community Planning Process, “A community plan for fusion energy and discovery plasma sciences.”, *Tech. Rep.* American Physical Society (2020).

background radiation, similar calculations with the same nontrivial result were carried out in the model of a hot Universe by Zel'dovich and Sunyaev and Peebles, both articles were published in 1970. Ya. B. Zel'dovich then proposed to call these baryon acoustic oscillations (BAO) "Sakharov oscillations".

Sakharov himself did not attach much importance to this work of 1965, since the calculations were carried out by him for an incorrect "cold model" of the Universe. The necessity of "hot model" was revealed in 1965 by the discovery of the background radiation, but that discovery took place after publication of Sakharov's work.

However, about 10 years after Sakharov's death, when the accuracy of measuring the temperature of the background radiation emanating from different points of the sky has reached a millionth of a degree, something similar to the BAO predicted by Sakharov was discovered in the fine temperature spectrum of the background radiation. In the article in *Uspekhi Fizicheskikh Nauk*, written in 2011 for the 90th birthday of A.D. Sakharov, Leonid Grishchuk explained the universality of Sakharov's result. For the appearance of BAO, it is necessary that the initial fluctuations were standing acoustic waves. In the visualization proposed by Grishchuk, these quantum vacuum fluctuations (as Sakharov had suggested) are analogous to the quantum creation of a particle-antiparticle pair from vacuum, the total moment is equal to zero in this case, that is, the wave function of the system corresponds to a standing wave.

For the inflationary model of the Big Bang, the calculation of the evolution of primary quantum fluctuations was first performed in 1981 by Mukhanov and Chibisov (FIAN). Of course, the interpretation of astrophysical observations is a delicate and not always straightforward matter. But today it is enough to type in the search engine "Sakharov oscillations" to see how relevant to the current studies is Sakharov's work published in 1965.

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### **Baryon asymmetry of the Universe.**

In a 1967 paper devoted to the explanation of the baryon asymmetry of the Universe (BAU), Sakharov formulated three famous conditions for the dynamic emergence of

the BAU from the initially matter-antimatter symmetric state of the hot Universe:

- 1) Violation of the C and CP symmetries (found experimentally in 1964).
- 2) Strong departure from equilibrium - the processes proceeding with the violation of the baryon charge should not be accompanied by reversed processes restoring the baryon symmetry.
- 3) Protons must be unstable, albeit with a huge half-life.

The third condition was so unusual that this work of Sakharov was not taken seriously for a long time, including by Ya. B. Zel'dovich. Later, after the appearance in the 1970s of the Great Unification Theory (GUT), in which the instability of the proton is introduced in a natural way, and especially after the appearance of inflationary models of the Universe in the 1980s, Yakov Borisovich revised his negative attitude. In the new collection of Sakharov's scientific works that we now compiled in FIAN, commenting on this work of Sakharov, Andrei Linde recalled the witty experimental confirmation of the proton instability noted by Zel'dovich many years ago.

Andrei Linde: *"In one of his speeches, Ya.B. Zel'dovich asked the audience a question about whether there is now any experimental evidence of violation of the law of conservation of baryon charge? The naive answer is negative: the search for proton decay has not yielded any results. But Zel'dovich gave a different answer, which I give in a slightly modified form, emphasizing its paradoxicality: the fact that parallel lines do not intersect serves as experimental evidence in favor of non-conservation of the baryon charge."* (See book of footnote 4, page 330).

I'll explain. Parallel lines do not intersect in the flat model of the Universe, which unambiguously follows from the theory of initial inflation. But this inflation inevitably evens out any inhomogeneities and asymmetries. In the theory of inflation, the observable Universe arose from a strictly charge-symmetric initial vacuum state. This means that the baryon asymmetry of our Universe could arise only dynamically - "according to Sakharov."

However, until now it has not been possible to propose a convincing theoretical

scenario in which all three of the above conditions of Sakharov would be fulfilled. Moreover, today we can say with confidence that such a scenario is impossible within the framework of the Standard Model of elementary particles. Theorists are considering different versions of the Standard Model generalization, which make it possible to explain the baryon asymmetry of the Universe.

### **Induced gravity.**

Finishing with this short review of Sakharov's scientific legacy, I will also name his famous 1967 work on induced gravity. - It turns out, as Sakharov showed, that the Einstein-Hilbert action of general relativity can be obtained as a response of the vacuum of quantum fields to the curvature of space-time (Sakharov calls this "elasticity of vacuum"). The number of references to this article by Sakharov is enormous, including in today's latest works.

### **Other topics that worried Sakharov:**

Quantum cosmology, the anthropic principle, is also the cutting edge of modern science. And, of course, there is his favorite "multi-sheet" (that is, oscillating, pulsating) model of the Universe, which received unexpected attention in the 21st century. In connection with the idea of an oscillating universe, I will share an episode from my life experience. Half a century ago, when I was working in some secret (the so-called Mailbox) institution, I was asked to talk about cosmology. I started speaking about the Big Bang, about the expansion of the Universe, reaching its maximum size - then contraction and the inevitable Big Crunch, in which everything will burn out. The head of my laboratory, Andrei Mikhailovich Vasiliev, asked how soon this disaster would happen. I named some billions of years, to which he uttered the immortal phrase: "I hope that during this time our views will change and we will be saved."

### **In conclusion some statements about Sakharov:**

#### **Edward Teller ("Facets of a Life"<sup>8</sup> p. 636):**

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<sup>8</sup> "Andrei Sakharov. Facets of a Life. Reminiscences of colleagues" / Editorial Board: B.L. Altshuler, B.M. Bolotovskiy, I.M. Dremin, V.Ya. Fainberg, L.V. Keldysh (chairman) // Editions Frontieres - P.N. Lebedev Physics Institute, Gif-sur-Yvette Cedex - France, 1991.

*“My brief personal contact with Sakharov convinced me of something I had earlier suspected: Sakharov was an optimist. I also consider myself an optimist. I consider optimism a necessary virtue. A pessimist is a person who is always right but gets no enjoyment from it. An optimist is a person who believes that the future is uncertain and does his best to bring about an improvement.*

*I particularly admire Sakharov, because in his case it took great strength of character to retain his optimism. I deeply hope that all of us who are grateful for his many contributions will let our memories of him encourage us in efforts to solve the very real problems that continue to separate the East and West.”*

**John Archibald Wheeler (in “Facets of a Life”, p. 647, and in “Sakharov Remembered”<sup>9</sup>, p. 79):**

*“Give us a new and deeper way to understand what we thought we already understood: that was Sakharov’s great gift... Never have I met anyone so senior who communicated more strongly the aura of a humble searcher for truth, one wanting to learn about the great mysteries – learn from nature, learn from the scientific literature, learn from discussion”.*

**Raisa Orlova and Lev Kopelev (in Collection “On Sakharov” dedicated to Sakharov’s 60 years<sup>10</sup>, pp. 78-79):**

*“With the first fairy-tales told to him by his grandmother, with the sounds of the piano played by his father, with poems and books Andrei took in that spiritual culture from which grew his notions of good and evil, of beauty and justice.*

*We have often heard him recite Pushkin by heart, almost to himself: “When for mortal man the noisy day is hushed...” He once said: “One would like to follow Pushkin’s example... Genius can’t be imitated. But one can follow something else, perhaps higher...”*

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<sup>9</sup> “Sakharov Remembered. A Tribute by Friends and Colleagues ”/ Edited by S.D. Drell, S.P. Kapitza // American Institute of Physics, New York, 1991.

<sup>10</sup> “On Sakharov” / To Sakharov’s 60 years. Compiled by Alexander Babenyshev, Raisa Lert, and Evgeniya Pechuro; translated from Russian by Guy Daniels // Alfred A. Knopf, New York, 1982.

*We were talking about how delighted Pasternak had been by Camus's Nobel speech, and Andrei Dmitrievich remarked: "That's like Pushkin. That's Pushkin's code of honor."*

*He and his brother Yuri would recite Shiller's "The Glove" with youthful excitement, interrupting each other. And they remembered a game they played in childhood: One would "mumble" a rhythm, and the other had to guess what poem of Pushkin's the first was thinking of. <...>*

*One hundred years ago, in his speech on Pushkin, Dostoyevsky said: "To be a real Russian means to be universally human". Today that is being confirmed again by Andrei Sakharov."*

**I also refer to the book by Gennady Gorelik with Antonina W. Bouis, "The World of Andrei Sakharov. A Russian Physicist's Path to Freedom" / Oxford University Press, 2005, telling about the "incredible transformation" when "a theoretical physicist and acknowledged father of the Soviet hydrogen bomb became a human rights activist and the first Russian to win the Nobel Peace Prize".**

And another quote: "*The most amazing thing about Sakharov is that he is not angry*", American physicist Jerome Wiesner told me when we went out with him after an evening spent at the Sakharovs'. "*He's not angry*" - surprisingly accurately and succinctly in the American way of saying.

No less accurate Sakharov's attitude to people was defined by his friend, human rights activist, mathematician Tatyana Velikanova - just two words: "*The presumption of decency.*" Respectful attitude, hope to see human in any person, including leaders of states. And never, in any of Sakharov's statements and documents, even the most critical ones, will we see what is called "personalization", personal accusations. A wise man he was!

And one more reason why Sakharov's word was so convincing. His speeches are not the speech of a prophet proclaiming the truth in the ultimate instance, but always an invitation to reflection.

**Sakharov ("Memoirs", pp. 579-580):**

*“My statements on general issues are often tentative, meant to provoke discussions, and subject to revision. I agree with Leszek Kolakowski when he writes:*

*“Inconsistency is simply a secret awareness of the contradictions of this world... a permanent feeling of possible personal error, or if not that, then of the possibility that one’s antagonist is right” [Leszek Kolakowski, *Toward a Marxist Humanism* (Grove, 1968), p. 24,]”*

**Sakharov, from interview during 38<sup>th</sup> Pugwash conference, Sochi, September 1988 (*The Youth of Estonia (Molodezh Estonii)*, October 1, 1988)<sup>11</sup>:**

*“- My fate was in a sense exceptional. It is not false modesty but the desire to be precise that prompts me to say that my fate proved to be greater than my personality. I only tried to keep up with it.*

*- But do you believe in destiny in general?*

*- I believe virtually nothing in this regard, except for some sort of general idea of the intrinsic meaning of the course of events. The course of events, not only in the life of a man, but also in the world at large. In fate as a destiny, I do not believe. I believe that the future is unpredictable and indeterminate; it is created by all of us, step by step, in our endless, complex interactions. But freedom of choice is our inherent right. This is why the role of the individual whom fate has singled out at some crucial moment in history is so important.”*

**In the end of his second book of memoirs “Moscow and Beyond” Sakharov sums up certain crucial issues of his life including science:**

*“This is a miracle of science. And although I do not believe in the possibility of a rapid creation (or creation at all?) of an all-encompassing theory, nevertheless I see gigantic, fantastic achievements in the course of even only my own life and expect that this flow will not dry up, but, quite the reverse, will expand and branch out...”*

Boris Altshuler,  
May 2021

*Altshuler Boris - physicist and human rights activist.  
Born on August 16, 1939 in Moscow, where he lived all his life, except for school years (1947-1956) in the nuclear center "Arzamas-16" (the town of Sarov), where*

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<sup>11</sup> Engl. Transl.: “Sakharov Remembered”, p. 248.

*his father Lev Altshuler worked together with Sakharov. Boris Altshuler himself knew Sakharov for over 20 years: 1968-1989. In 1982-1987, he was forced to work as a janitor, A.D. Sakharov, after returning from exile in December 1986, insisted on his admission to work in the Department of Theoretical Physics of the P.N. Lebedev Physics Institute of Academy of Sciences (FIAN), where B.A. is still working (2021). He participated in the compilation of a number of books about Sakharov, and wrote a lot about him. Boris Altshuler is a participant in the human rights movement in the USSR and in the Russian Federation, a member of the Moscow Helsinki Group (since 1995), Chairman of the Board of the NGO "The Right of the Child" (since 1998).*

*2009, Award "Person of the Year - 5769 for many years of human rights work, humanitarian actions in favor of children" by the Federation of Jewish Communities of Russia (FEOR). Presentation at the Grand Kremlin Palace - [http://right-child.ru/2009\\_boris\\_altshuler.html](http://right-child.ru/2009_boris_altshuler.html)*

*2013 – Andrei Sakharov Prize of the American Physical Society "For many years of struggle in defense of democracy in Russia and for activities to protect children's rights".*

*2019 - Award "Parental Thank You!" by the All-Russian Organization of Parents of Disabled Children (VORDI).*