RNTs KI; the session was devoted to the 100th anniversary of the birth of Academician L A Artsimovich. The following talks were presented at the session:

(1) **Velikhov E P** (Russian Research Centre 'Kurchatov Institute', Moscow) "Academician L A Artsimovich — the founder of our field of science and industry";

(2) **Smirnov V P** (Russian Research Centre 'Kurchatov Institute', Moscow) "Retracing Artsimovich's path to the thermonuclear source of energy";

(3) **Boyarchuk A A** (Division of General Physics and Astronomy, RAS, Moscow) "L A Artsimovich and astronomy";

(4) **Martynenko Yu V** (Institute of Nuclear Fusion, Russian Research Centre 'Kurchatov Institute', Moscow) "Electromagnetic isotope separation method and its heritage";

(5) **Strelkov V S** (Institute of Nuclear Fusion, Russian Research Centre 'Kurchatov Institute', Moscow) "Our teacher: Lev Andreevich Artsimovich";

(6) **Mirnov S V** (Institute of Nuclear Fusion, Russian Research Centre 'Kurchatov Institute', Moscow) "L A Artsimovich through the eyes of a former postgraduate student".

A summary of the talk by Yu V Martynenko is published below.

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Nonaccidental coincidences (Lev Andreevich Artsimovich)

I M Khalatnikov

Physicists had begun thinking about the peaceful utilization of atomic energy some time before the work on creating the hydrogen bomb was completed. It was necessary to find a way to confine the gaseous deuterium and tritium at superhigh temperatures on the order of a hundred million degrees (the electron–ion plasma).

It appears that the first people to suggest how to confine the plasma in a limited volume were I E Tamm and A D Sakharov. They placed it in a specially configured magnetic field (magnetic traps). It was immediately clear that this was a difficult task and that creating industrial-scale thermonuclear reactors should take a very long time. Fifty years have elapsed since this project started and it is only now, and only by joining forces on an international scale, that we are discerning certain practical results at the end of the tunnel. However, the problem of studying the behavior of plasmas in a magnetic field proved to be both difficult and fascinatingly interesting for physicists. Lev Andreevich Artsimovich, one of I V Kurchatov's closest colleagues, also a graduate of the scientific school of the Leningrad Physical-Technical Institute, was chosen to head this peaceful atomic project.

I first heard about Lev Andreevich (hereafter referred to as L A) from the head of the First Main Directorate of the USSR Council of Ministers, B L Vannikov, who once complained to me that L A was moving forward too slowly in the matter of separation of lithium isotopes. Namely, the lithium-6 isotope, suggested by V L Ginzburg in his special reports of 1948–1949 as a 'fuel', was to play an important role in burning the hydrogen component of the 'sloika' (layered cake) — the first version of the hydrogen bomb suggested by A D Sakharov. This was in 1952, and the first tests were directed to take place in 1953. L A was ultimately able to keep to the schedule and the tests were conducted on time.

The Division of Plasma Physics at the Kurchatov Institute was expanded, and theoreticians of all generations were brought together — from M A Leontovich to the 'holy trinity' of youngsters: Roald Sagdeev, Evgenii Velikhov, and Sasha Vedenov. Andrei Budker played an important role of the trigger of ideas. I still remember a large gathering of physicists who filled the club hall of the Institute of Atomic Energy (IAE): the main sensation was Budker's idea of 'magnetic bottles' — bottlelike configurations of a magnetic field from which ions could escape only through a narrow bottleneck. Despite the general optimism, I V Kurchatov was less enthusiastic about its promise. His health was already deteriorating but he dreamt of witnessing the 'peaceful thermonuke' during his lifetime. Once, in summer 1957, he invited me to hear out some alternative ideas. This was an indication that I had earned what we now call a 'high rating' with him. When we left the administrative building of the IAE, Igor' Vasil'evich noticed my brand-new gray Moskvich car, the 2nd model ('le dernier cri'); his curiosity was aroused and he decided to ride with me. He needed to go to the Ministry on Ordynka Street, and I was going in the same direction. We drove away just like that: I V in my Moskvich in front and his huge ZIS limousine with bodyguards escorting us in the back.

My gray Moskvich deserves a brief digression. The more popular and prestigious car among ordinary citizens at the time was the Pobeda. One had to be on a waiting list for several years to buy it; I had the money for it but was not on the waiting list. Consequently, I had no choice and settled for the less prestigious Moskvich, the 2nd model. However, soon after that, I ran into a colleague (Tatjana Belova) from A I Shal'nikov's group at Moscow State University at the Institute for Physical Problems (IFP) and she asked if I wanted to swap my Moskvich for a new Volga-21, produced to mark the opening of the 1957 World Festival of Youth and Students in Moscow. She explained that the writer Nataliya Ilyina and her husband, the Moscow University philologist Professor A Reformatskii, were given permission to purchase a Volga-21 but did not have enough money. They would gladly buy my Moskvich in exchange for the permission to acquire a new Volga car. The deal was done and made both sides happy. In fact, my Moskvich was lucky – it entered history. Nataliya Ilyina returned to Moscow from emigration before WWII, namely from Harbin, China. There was a large Russian settlement in Harbin; it was founded in connection with the construction of the Chinese Eastern Railway (KVZhD). The railway line was later handed back to China, while nearly the entire Russian colony was moved to the USSR. This was how Alexander Vertinsky, N Ilyina, and other highly talented personalities found themselves in the Soviet Union. In reality, most of the repatriated Harbinites were soon arrested (in 1938) and sent into exile and remote labor camps. N Ilyina was lucky and retained her freedom: she was well integrated into the literary milieu. She was close to Anna Akhmatova's circle and when Akhmatova stayed in Moscow on the Ordynka str. with the Ardovs (who took care of her), Nataliya Ilyina would often organize trips for Anna Akhmatova out of Moscow, to the country, to enjoy the fresh air. These trips were made in my gray Moskvich, which thus

entered history twice: it knew both I V Kurchatov and Anna Akhmatova.

Back to Lev Andreevich, though. After I had visited A P Aleksandrov (in 1963) and received his support for founding the Institute for Theoretical Physics (ITF), he charged L A with the ensuing activities in the USSR Academy of Sciences needed to create a 'gypsy camp' of theoreticians. L A was a very influential figure in the Academy – he occupied the lofty position of the Academician-Secretary of the Division of General Physics and Astronomy. Correspondingly, the creation of a new institute within the Division was part of his responsibilities, and thus we were in close contact at the time. Lev Andreevich was a benevolent person: his entire appearance advertised solid aristocratic upbringing. We had met before at family reunions at the country house of Petr Leonidovich Kapitza in Nikolina Gora.

By 1971, ITF was safely standing on its own feet and we were conducting the Second Soviet–American Symposium in Leningrad, where the local authorities closely watched over us. The Soviet participants in the symposium were contacting the foreigners far too freely and without restraint. I had to discuss the summary of the symposium with Lev Andreevich in a rather unpleasant context: he phoned me and began to reprimand me nervously for the 'wild' behavior of our physicists in Leningrad, where one of them ended up in either the hospital or the drunk tank. In complete deviation from the academic style of discussion, L A demanded that I provide a written so-called 'explanation'. We had never had anything like this complication before, and it seemed that the Leningrad authorities had placed us under a microscope and had written a heavy-handed shadowing report. I will not go into the details of how the crude reply was composed or of the suffering of our colleague who had worked so hard during the symposium that he ended up in the hospital. I had never deigned to send explanations to bosses and did not wish to create a precedent. As luck would have it, Arkadii Migdal lived in the same house, in an apartment on the same floor as Lev Andreevich, and they were friends. I decided not to mail the explanation but to pass it on by hand through A B Migdal. It appears that, having received the explanation on the stairs, L A felt a certain uncomfortableness and tore it up immediately. That was the end of the sensitive story with the explanations. We were able not to slip to the level of the explanations informing others on the behavior of respected young scientists. It cannot be ruled out, though, that L A recalled that when his sharp 'politically incorrect' remarks made in 1950 about the Korean War were reported to Lavrentiy Beria, the story ending with a 'hello' passed on to L A through I V Kurchatov, warning L A to be more prudent in his remarks.

And something about the Korean War, by the way. When it ended at the same time as Stalin's death, every organization was ordered to send gifts to North Korea, which by that time had almost been wiped off the face of the Earth. The Academy of Sciences had a list of possible gifts drafted and sent it for a second opinion to the Institute for Physical Problems. The list reached me and Abrikosov. I still remember that the first two items on this 'list of gifts' were a pedestal of a candelabrum from Nakhichevan and a list of courses served at the table of Patriarch Job. It is possible that this list continues to be 'relevant' in some way to North Koreans.

L A could not stomach moral corruption. One example comes to mind. A good theoretician, Boris Davydov, worked for many years at IAE. He was a modest man but the circumstances of his family life were far from trivial. It so happened that he married the former wife of the accompanist of the famous singer Alexander Vertinsky. Vertinsky, together with his accompanist Brokhes, often gave concerts at foreign embassies in Moscow. Big Brother did not rule out the possibility that Brokhes' wife may have visited these embassies, too (this was absolutely off-limits for ordinary citizens). Only Davydov's closest friends knew about the marriage, but one of them did alert 'those who needed to know'. The end was disastrous: Davydov lost access to classified work and was fired from the Kurchatov Institute. Many of us had a good idea who the fink was.

Once there was a sort of party at L A's division at IAE on the occasion of an 'event' (this could be a revolution-related festivity or an informal gathering to summarize a successfully completed job). The party was in full swing when the door opened and a person from Davydov's circle of 'friends' entered. L A looked the new arrival straight in the eye, then addressed the rest of the company in a well-modulated voice: ''What is this fink doing here?''. The man burst into tears, covered his face with both hands, and hastily retreated. Very soon he found employment in another organization where colleagues did not know that much about him.

By tradition, everyone present at Petr Leonidovich Kapitza's birthday parties in his country house in Nikolina Gora (where the cream of the Moscow intelligentsia would get together) delivered a toast, one after the other. This wave of toasts was conducted by the well-known sculptor Nokogosyan, who spoke with a recognizable Armenian accent. I still remember his loud invitation: ''Ai, Artsimovich, we wish to hear you!'' L A would obediently rise from his seat and deliver a brilliant toast — as he always did.

Lev Andreevich died early. I will never forget his smiling face, on which you would invariably read that he was very happy in his personal life.

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Avenues for the innovative development of energetics in the world and in Russia

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1. Introduction

In this paper, we consider the expected avenues of scientific and technological progress (STP) in energetics, as well as the possible effects of innovative development of energy production in the coming decades, with an outlook to 2050. Accelerated social development and economic globalization urgently require the study of the potential, possibilities, and strategic priorities of the innovative development of anthropogenic energy production — a set of means of energy conversion (covering all populated areas of our planet) into forms useful for human activity. Nowadays, the anthropogenic energy production that exceeds the cumulative energy of people living on Earth by 15 times and their power by 60 times, is already discernible in the Earth's biosphere, reaching 5% of the energy released in photosynthesis processes supporting life on Earth, but yet indiscernible at the level of space, making up less than