Part 9
The Russian Bomb
Before Hiroshima

Ioffe and Fiztekh

Like so many scientists before and after, Abram Fedorovitch Ioffe had a nearly insatiable need to know and understand, for which his Czarist education was no match. In 1900, the lectures at the St. Petersburg Technological Institute consisted of boring recitation of already discovered facts. There was little lab work, experimentation, or discussion. When he graduated, he traveled to Munich, talked his way into Wilhelm Roentgen's lab and was instantaneously in heaven. Roentgen had won the first Nobel Prize a year earlier and was known as the best experimental physicist in the world, and he considered Ioffe one of his finest students. In 1905, amidst revolution, Ioffe returned to Moscow with his new PhD.

For the next decade, he worked his way from laboratory technician to student, to professor, Magister of Philosophy, and Doctor of Physics. Known as the Red Professor, he founded what became The Ioffe Institute and fathered physics education in the USSR. By 1925, when he asked Igor Kurchatov to join him, his Institute of Physics and Technology was home of the best scientific minds in the USSR. It had the nickname, Fiztekh.

Despite the handicap of inadequate Czarist schools, two revolutions, a civil war, famine, and the philosophy that truth could be discovered by discussion rather than scientific experiment, physicists in the USSR were equal to those in the rest of the world. By the mid-1930s, due to men like Ioffe, Russia had elevated its teaching of physics to a world-class level.

The Beard

A 1963 Soviet postage stamp shows Igor Vasilyevich Kurchatov with his long, Orthodox-like beard, staring into the future. In the summer of 1941, he was clean-shaven, but when the Germans invaded, he vowed, like many present-day hockey players, not to shave until the enemy had been defeated. In fact, he never did shave and was known with affection thereafter as "The Beard."

Kurchatov was lean with dark hair, and penetrating eyes. He dressed simply, affected calmness, and seemed never to sleep. He had enormous focus, but was attentive, even-handed and, at times affectionate. His hands were those of an experimenter.

After earning a university degree in the Crimea, and another in Leningrad, he went to work in Ioffe's Fiztekh laboratory in Moscow, and by 1932, was its head. In the same year, he was building a cyclotron for Leningrad's Radium Institute and organizing the First All-Union Conference on the Atomic Nucleus. With Gregory Flerov, he had determined the basics for an atomic reactor, or as he called it, a uranium boiler. Nuclear physics was his life and passion. By 1941, Kurchatov had his own laboratory, which was among the leading research venues in the world, but in July, that all changed.

Barbarossa

On June 21, 1941, the time Stalin had been buying over the last two years ran out and the Wehrmacht crossed the Russian border on a two-thousand-mile front. He wept. "Lenin left us a state and we have turned it to shit," he said before leaving for his dacha. He expected to be overthrown and shot, but instead he was given even more power.

Operation Barbarossa put the Soviet nuclear program on hold. Kurchatov quickly shut down the cyclotron, which remained in Leningrad, and went to the Crimea to develop a defense against magnetic torpedoes. His colleagues, Yulii Khariton and Yakov Zeldovich, who were working on the critical mass of uranium before the invasion, began developing fuel for Katyusha rockets; Flerov was designing dive bombers in Leningrad. Other members of Fiztekh worked on radar, armor, and devices to locate enemy aircraft. Only Vitaly Khlopin's Radium Institute, relocated from Moscow to Kazan on the Volga, worked on uranium. The now-bearded Kurchatov continued other projects until he was recalled to Moscow in October, 1942.

Gregory Nichlayovich Flerov and Dogs That Did Not Bark

After high school, Gregory Nichlayovich Flerov went to work as a laborer greasing engines. In 1933, while at a Leningrad factory, he was picked out for a higher education, and entered the Polytechnic Institute, which was still vibrating from the discoveries of the previous year. Flerov quickly got caught up in its energy and in six years, was one of the top nuclear scientists in the USSR. While working in Kurchatov's lab, he measured secondary neutrons and discovered spontaneous fission, but his work came to a halt when Germany invaded. He volunteered and was sent to the Air Force Academy for training as an engineer, but he could not get physics out of his mind.

In December, 1941, while still with the Air Force, Flerov gave a seminar to Ioffe and others, detailing how an atomic bomb could be made, and saying that most likely America, and Germany, were both moving in that direction; his purpose was to persuade them to help restart nuclear weapons research. He later wrote Kurchatov a long letter giving the specifics of his talk, along with pages of calculations and a diagram of a bomb but, as was to be expected in the middle of a desperate war for existence, he got no response. Then one day, when he was browsing in a nearby University library, Flerov noticed that there were no longer any articles on nuclear research in the American journals. The western dogs were no longer barking, but it was not because they had lost interest, but rather, nuclear physics had become classified. He renewed his crusade, and in April, 1942 he finally wrote Stalin of his fears. At the same time, Russian soldiers found a German officer's notebook with atom bomb research details.

Starting in 1940, the Soviet Union had been diligent in creating a nuclear espionage network, ENORMOZ, and in October, 1941 they had in their hands documents revealing Britain's plan to construct an atomic bomb factory. The reports arrived as the Germans were at the gates of Moscow and the city was being evacuated. The next spring, Lavrentiy Beria, head of the NKVD, informed Stalin of England's plans. This information, along with Flerov's letter and the German's notebook, finally convinced him to continue nuclear research; this time the bomb was the clearly stated goal. By July, 1942, the final proposal to start work on the Russian bomb was approved and by August, Flerov was back working on neutron multiplication, this time at the Radium Institute.

ENORMOZ

Since the start of ENORMOZ, Soviet agents had been sending nuclear information home and by 1943, the NKVD had received a large pile of documents regarding nuclear research, the problem was, no one there could read them. In February and March, 1943, a month after the German surrender at Stalingrad, Kurchatov sat in Vyacheslav Molotov's high-ceilinged study meticulously going over more than 2,000 pages[1] of purloined British and American reports. Soon after, he was made head of the Soviet atomic bomb project.

In Molotov's study, Kurchatov learned that the Brits thought they could build an atomic bomb within two years and had let a contract for the construction of a bomb factory. He also read critical details of the extraction and fissibility of plutonium, and isotope separation or uranium by gaseous diffusion. The documents were so sensitive that few other physicists were privy to their content and Kurchatov could not divulge the source of his knowledge. He amazed his colleagues with his almost superhuman ability to solve complex problems in his head and he always seemed to know the results of the various experiments before they were completed.

[1] Among the 2,000 pages were the MAUD report, the Frisch–Peierls memorandum and a list of possible recruits headed for America and the Manhattan project.

Klaus Fuchs

Klaus Fuchs hated the Nazis. His father was a Quaker and socialist and he was a communist. As soon as Hitler took power, Klaus, by then a dedicated follower of the party line, and under a death threat, removed the hammer and sickle pin from his collar and, with his worldly possessions in a canvas bag, fled to England.

As a communist refugee from Germany, he quickly became known to the British government, but far from a drawback, his antifascism was an asset. He quickly found a home as a graduate student at the University of Bristol and got his PhD in physics. Klaus was quiet and unassuming; brilliant, with sad eyes.

After two productive Carnegie Fellowship years in Max Born's lab, the war began and Fuchs was classified as an enemy alien. The fall of France sent a panic throughout Britain and as a German, he was interned on the Isle of Man. Despite Born's help (he wrote that Fuchs was "among two or three of the most gifted theoretical physicists of the young generation.") he remained in camp there and in Canada, where he gave physics lectures to his fellow prisoners. In 1940, the English government realized that a good number of internees were anti-Nazi and could be useful in the war effort, and by December, Fuchs was back in England. By May, 1941, he was working for Rudolf Peierls in Birmingham on the Tube Alloys project, the British atom bomb program, and that summer, he helped compile the MAUD Committee report.

On July 28, one month after the German invasion, the USSR and Britain signed the Molotov-Cripps pact assuring scientific cooperation; Russia was now a British ally. A bust of Lenin was unveiled in central London; the BBC played the Internationale; there was a "Tanks for Russia Week," and an Aid to Russia Fund. British and Soviet intelligence agencies cooperated. Klaus Fuchs took this agreement to heart and at the end of 1941, even though he had signed the Official Secrets Act, he was working as a Soviet spy. In Klaus Fuchs's mind, he was doing his duty as a patriotic British citizen by sharing his work with the USSR; his communism was not then a disqualification for his access to secrets.

Fuchs's summer work on the size of the uranium core, the heart of an atom bomb, became part of the official MAUD Committee report, which was produced in September, 1941. Due to another Russian spy, John Cairncross, the report was in Soviet hands a few days later. Fuchs's first contributions to the huge pile of papers on the desk in Molotov's study, also included details on the process of gaseous diffusion and the status of the German atom bomb project. His name was well known to the NKVD.

Laboratory No. 2

One year after Flerov's letter, Kurchatov's new Laboratory No. 2 was set up just outside Moscow; it was under the overall control of Mikhail Pervukhin so Kurchatov could concentrate on his research. Although Pervukhin was an electrical engineer, he knew little about nuclear physics or atom bombs so Kurchatov wrote a primer on "The Proton, the Electron, and the Neutron" and the "Uranium Problem," bringing him up to speed as of June, 1941. In the beginning, work at Laboratory No. 2 went slowly, as Stalin's focus was still on winning the war.

As project leader, Kurchatov assigned different parts of the problem: producing and extracting plutonium, separating uranium isotopes, and creating the bomb, to his closest colleagues, but kept the building of a nuclear pile for himself. Even though Fermi's graphite-moderated reactor, had gone critical the winter before, it was not mentioned in any of the papers Kurchatov had read in Molotov's study and he did not have a clear picture of the best way to build one. Even so, he realized that the choice of a moderator was critical and in his list, he included both graphite and heavy water. In July, graphite was chosen because it was easier to obtain in the USSR, but there was no mention of the purity problem at that time; the real problem was uranium.

The graphite pile Kurchatov settled on needed one hundred tons of uranium, but by the end of 1943, he only had one ton. Although graphite was more readily available they discovered boron contamination and that problem needed to be solved. It would not be until after the war that Kurchatov began to get the quantities of both uranium and pure graphite he needed.

Pure plutonium was needed for a bomb and Kurchatov tasked his brother, Boris, with devising ways to chemically separate it from the mixed fission by-products produced in the reactor, but Boris needed small amounts of plutonium for his experiments, but he could not get it from the reactor. A cyclotron could provide small quantities, so Leonid Nemenov was directed to build one. Pieces of the Radium Institute cyclotron were still trapped in Leningrad, only a few miles from the front line and he set out to retrieve them. There was only a precarious rail line, frequently under German artillery fire, from Leningrad to Moscow, but the parts arrived safely and by September, 1944 it was producing tiny amounts of plutonium.

Even though the separation of isotopes was not a part of the critical path to the plutonium bomb, it was pursued vigorously. Gaseous and thermal diffusion, electromagnetic separation, and centrifuges, were all researched vigorously, but none made much progress until after the first Soviet bomb was tested. Eventually, they chose gaseous diffusion and huge plants were constructed at Neviansk, north of Sverdlovsk. Known as Sverdlovsk-44, it was a smaller version of the American Oak Ridge plant[2].

In 1944, Kurchatov learned of the west's great progress towards a bomb and sent a letter to Beria complaining that a scarcity of raw materials, slow progress on separation, and a lack of coordination were hampering his progress. It was obvious that the Soviet leadership was not giving his projects the high priority their competitors enjoyed, but Kurchatov had an asset in the west, Klaus Fuchs.

In December, 1943, as part of the renewed spirit of cooperation between Britain and America, Fuchs moved to New York and started work for the Manhattan Project. In the spring of 1944, he met frequently with his Soviet contact, Harry Gold, handing over information on gaseous diffusion, electromagnetic separation, Manhattan Project security, and pages of mathematical formulae. Within hours, the information was in the Soviet embassy and on its way to Laboratory No. 2. Kurchatov was even able to ask questions of Fuchs through Gold and get answer within a week or two; it was as if Fuchs were part of Kurchatov's team. In the summer, after a total of seven meetings, Fuchs disappeared; a month later he was checked into Los Alamos and in September, Kurchatov received another 3,000 pages from Soviet agents; it seems certain that much of the information came from Fuchs.

Although Fuchs was not outgoing, he fit in with the eccentric society of scientists and their families. He danced well, babysat when asked and kept his mouth shut. For some reason, British scientists had fewer security restrictions than Americans and Fuchs had a wide view of what was going on in Los Alamos. His first job was to calculate the yield and efficiency of the bomb, but he also worked on the theory of implosion. In February, 1945, while visiting his sister in Massachusetts, Fuchs gave Gold detailed instructions on how to make a bomb, including a diagram, and in June he handed over a package containing a detailed drawing of the plutonium bomb which included its various parts, materials, and dimensions. Soon they were in Kurchatov's hands and he was delighted. He based most of his decisions on the successes and failures of the Manhattan Project and in the end, both the infrastructure and the bomb itself were Soviet copies. Fuchs continued to provide information to Kurchatov after he returned to Britain from Los Alamos.

As if Fuchs's flow of information were not enough of a windfall, in August, 1945 the United States government published *Atomic Energy for Military Purposes*. Known as the Smyth Report, it gave many details of the Manhattan project which Fuchs did not know. In early 1946, thirty-thousand translated copies were in the hands of Soviet scientists.

[2] Problems prevented the production of bomb-grade U^{235} until 1951.