Regarding Scientist X

Big Science, the war effort, and communist activity at Berkeley Radiation Lab (1929-1949)

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Sixty years ago, with Pearl Harbor bombs resounding faintly in their ears, physicists at the Lawrence Berkeley Lab were asked to give up their research in order to assist the American war effort. Their mission was to produce fissionable uranium for the super-secret atomic bomb project at Los Alamos. It was during this time that the left-wing backgrounds of some Berkeley physicists became a problem of national security. After the war, the careers of many of these physicists were ruined by accusations of Communist sympathies.

Why were these left-leaning physicists hounded and fired? Perhaps their persecution was a part of a larger post-war trend, in which all areas of American culture—from Hollywood to academia—were swept by a wave of "Communist hysteria" that chased people with leftist tendencies out of their jobs. But physics—and especially physics research at Berkeley—was particularly polemical, fraught with political overtones even before the war started.

Histories of science usually portray the war as the real beginning of the politicization of physics research, with unprecedented cooperation between the American military and university scientists, and the inauguration of "big-machine physics" under government sponsorship. But historical trends do not usually emerge spontaneously. In fact, many of the political-scientific events which played out during and after the war in the Berkeley physics community had their seeds in the early development of the Berkeley Radiation Lab, as it was then known, and in the general political climate of the University of California in the 1930's. Some physics professors were Communist sympathizers, and some were staunchly right-wing; the clash between the two types of intellectuals had tragic consequences for the post-war physics community. There were martyrs and spies on both sides of the political spectrum—all shadowed over by the mushroom cloud of the atomic bomb. No one was innocent.

The grand institution on the hill known today as the Ernest Orlando Lawrence Berkeley National Laboratory (LBL) began in a much humbler incarnation: as a very large magnet in a rather small shed. The magnet and shed were the brainchild of Ernest O. Lawrence, a young, brash Berkeley physicist who had arrived from Yale in 1928. Only in his late twenties, Lawrence already exhibited the qualities which were to make him world-famous: driving enthusiasm, erratic brilliance, the showmanship of a circus ringleader, and an almost magical ability to excite wealthy non-scientists into giving him money for his research projects.

> "Communist hysteria" forced many promising Berkeley physicists—along with academics all over the country—out of their careers.

Lawrence's magnet was the driving force behind his 27-inch cyclotron, a contraption he and his star graduate student M. Stanley Livingston had initially devised in smaller forms in the physics labs of LeConte Hall. They had been working to solve one of the knotty problems in physics research at the time: the penetration of the atom's nucleus. In the wake of Rutherford's experiments in England, physicists around the world were using linear accelerators to bombard the nucleus with ion beams, attempting to break through the Coulomb barrier which held the nucleus intact. The problem demanded a new feat of engineering: how could you build a machine that would accelerate ion beams fast enough to attain the tremendously high voltage necessary to break the Coulomb barrier—without melting down the laboratory? Physicists were furiously devising and building machines in the "race to a million volts."

Lawrence's breakthrough came in 1929, as he idly leafed through an obscure German science journal and came upon an article by a Norwegian engineer named Rolf Wideroe. Lawrence couldn't read German very well, but one picture caught his eye: the figure showed a device in which ions at relatively low voltage were accelerated by cylindrical electrodes of alternating charges. Theoretically, the ions could be accelerated faster and faster with every cylindrical electrode added to the linear path, until the beam became too diffuse and scattered into the cylinder walls. Lawrence realized that, rather

A big man with big ideas. Even as a young man Ernest Orlando Lawrence displayed the qualities that made him a scientific giant: driving enthusiasm, erratic brilliance, the showmanship of a circus ringleader, and an almost magical ability to excite wealthy non-scientists into giving him money for his research projects (LBNL Image Library).

than shooting ions in a linear accelerator, he could use a magnetic field to make the ions travel in a spiral between the two electrode poles, gaining kinetic energy with every pass. Thus the idea for the cyclotron was born.

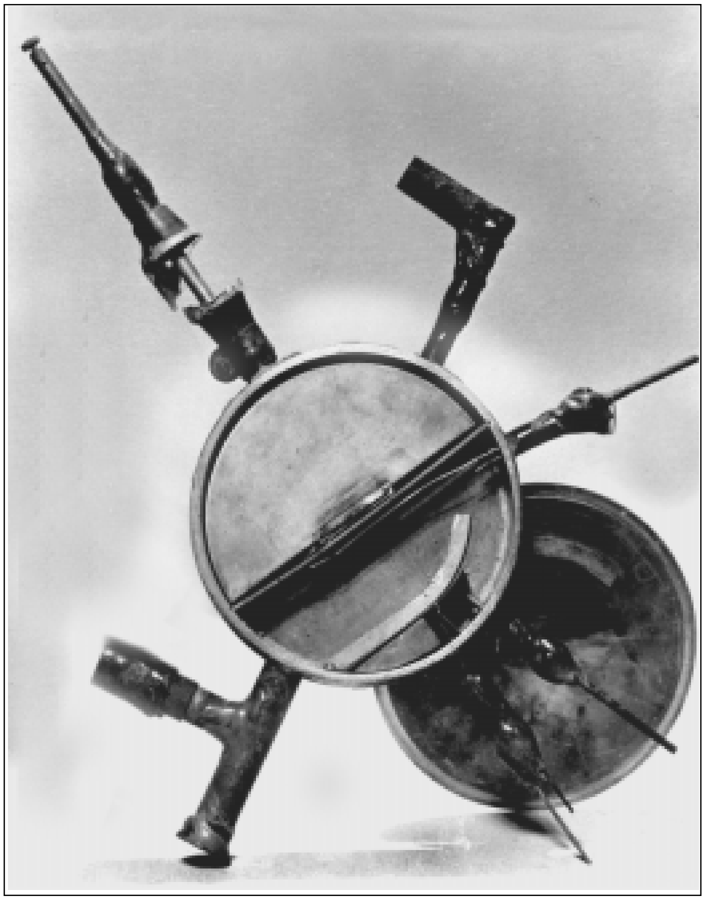
The Berkeley Radiation Lab (as LBL was known until 1970, when the word "radiation" became unfashionable), thus began as a temperamental machine in a small building near LeConte Hall. Lawrence and his team of dedicated graduate students began a series of experiments in consultation with eminent Berkeley theorist J. Robert Oppenheimer, perfecting successively larger and more powerful cyclotrons in order to make discoveries about the atom's nucleus. The then-unusual cooperation between theorist and experimentalist was crucial to the cyclotron's development, and helped to bring about the tremendous advances Lawrence made in the field of nuclear physics. (The fertile creativity of experimentalists in unrestrained dialogue with theorists was obviously a lesson which Oppenheimer took with him into the war—when he hit upon the idea for a bomb research complex at Los Alamos.)

In 1934, the cyclotron team succeeded in creating a radioactive isotope of carbon by bombarding it with deuterium ions. During the rest of the decade, the lab became famous for the string of artificial elements it created with the cyclotron (See this issue, pp. 32-37), in a series of discoveries which would eventually garner Nobel Prizes for many of the physicists working there. So even before the war a new kind of physics had already begun to take shape, in which experimentalists worked hand-in-hand with theorists, and discoveries made on "big machines" changed the way theorists imagined the atom.

> Many of the physicists on the Berkeley faculty had leftist sympathies, and some were literally "card-carrying members" of the Communist Party.

The exciting events surrounding Lawrence's cyclotron took place against the background of a turbulent time in UC Berkeley's political history. The campus's radical history really began in the 1930's, with an explosion of student activism. The reason was not hard to find: the economic trauma of the Great Depression won many students and faculty over to leftist causes. The phenomenal number of radical student groups at Berkeley in the 1930's was a sign of the times: the National Student League, the Young Communist League, the Social Problems Club, the Young Trotskyists, the Student League for Industrial Democracy, the Young People's Socialist Club, the Student Workers' Association, the Congress for Student Opinion, the Progressive Student Forum, the American Federation of Teachers, and so on.

The turbulent politics of the decade, both on and off the Berkeley campus, inevitably influenced the development of Lawrence's Radiation Lab. Many of the physicists on the Berkeley faculty had leftist sympathies, and some were literally "card-carrying members" of the Communist Party. The most famous and influential of the leftist Berkeley physicists was J. Robert Oppenheimer. As Oppenheimer was to write on a 1942 security questionnaire with characteristic flippancy: "I am not a Communist, but I have been a member of just about every Communist Front organization on the West Coast." With his cultured urbanity and sharp theoretical mind, Oppenheimer was



First Successful Cyclotron. Lawrence wowed the scientific world with this machine, which accelerated a few hydrogen molecule ions to an energy of 80,000 volts. Lawrence's subsequent cyclotrons were the beginning of the era of "big machine" physics (LBNL Image Library).

something of a cult figure to his graduate students, who mimicked his tastes and mannerisms, including his penchant for left-wing politics. Many of Oppenheimer's students joined leftist and Communist groups because of his influence—a fact which would come back to haunt him in his later political trials.

Oppenheimer might not have belonged to the Communist party officially, but he was surrounded by close friends and family with strong Communist ties. His wife Kitty had previously been married to an American Communist, Joe Dallet, who died in Spain fighting against Franco. Dallet's wartime friend, Steve Nelson, often visited Kitty in Berkeley after her first husband's death, and was one of the top organizers of the Communist Popular Front in California. (Nelson's connections to the physics community would later rise to implicate him in the "Communist Cell" accused of spying on Berkeley bomb research.) Physicists, graduate students, and other intellectuals often gathered at professors' houses in the Berkeley hills for parties where radical political issues were hotly debated.

If we look back to the state of physics research in the 1930's, it is understandable why so many of the young Berkeley physicists had leftist or Communist sympathies. Eminent foreign scientists, fleeing Fascism in Germany and Italy, were turning up at Lawrence's Radiation Lab bearing tales of persecution and academic suppression. Closer to home, the Depression meant that there was little money around for graduate students, many of whom worked for nothing just to be in the vicinity of Lawrence's wonderful machines. The cyclotrons were finicky, tricky devices, often improved more by experimental, brute-force methods than by elegant calculation, and the work was a grueling, twenty-four-hour-a-day affair. There was a dearth of money in physics departments across the country to hire new professors, so many graduate students simply lingered on at Berkeley as researchers, hoping something would turn up. Oppenheimer helped to organize a branch of the Alameda County Teacher's Union at Berkeley, and encouraged his students to join.

Although Oppenheimer exerted a strong leftist influence in Ber keley physics, Lawrence, in contrast, could be found on the other side of the political spectrum. Lawrence did make a point of declaring that politics would have no place in his lab; but his chief of personnel, George Everson, whom he hired in the late 1930's, was avowedly anti-Communist and anti-New Deal. Everson had what was sometimes referred to as an "anti-Bohemian" bias in his lab hirings, which often meant the exclusion of students with East-Coast Jewish backgrounds.

There is a more explicit link to be made between Lawrence and right-wing politics. In 1932, Lawrence's friend and university president Robert G. Sproul sponsored Lawrence for membership in the prestigious San Francisco Bohemian Club. "Bohemian" was a rather ironic term, given that the group was what Gray Brechin describes in his book *Imperial San Francisco* as an "exclusive brotherhood composed of some of the nation's most powerful and conservative industrialists, bankers, and weapons makers." It was in this club that Lawrence befriended two powerful UC Regents: the banker William H. Crocker and the Republican lawyer and power-broker, John Francis Neylan. Both men proved valuable in helping Lawrence raise money for his cyclotrons. Before his death Crocker gave Lawrence $75,000 out of his own pocket to build a new Radiation Lab on the hill, and Neylan became the lab's representative and major promoter on the board of UC Regents. (Neylan would gain notoriety in 1949 as the driving force behind the firing of 31 Berkeley professors who refused to sign an anti-Communist loyalty oath).

The connection between Lawrence and the California industrialists underlines the extent to which so-called "big-machine physics" was itself a kind of big business. The connection was accentuated by Lawrence's theatrical methods of presenting his results to the public and to possible investors—as when, in 1930, he unveiled his 4.5-inch cyclotron prototype to the Academy of Sciences, dramatically flipping the switch onstage and provoking a ripple of exclamations in the audience when the machine, using only 1,000 volts, produced an 80,000 electron-volt beam. In the later thirties, Lawrence delighted in demonstrating the cyclotron's use in biomedical research with a live, on-stage demonstration of radioactive tracers in the human bloodstream. He would call up volunteers from the audience and feed them "hot" radiosodium, freshly airmailed from the cyclotron; then he would trace the progress of the chemical in their blood with a clicking Geiger counter.

Once Communist Russia became an enemy of the country, the expression of a political opinion—even if it was to support something as seemingly innocuous as a teachers' labor union—became a security risk.

Lawrence's showmanship was a necessary part of his science: the important new thing about his cyclotron physics was that it needed huge sums of money to build bigger machines. Unlike more theoretical work, which had only to support the salaries of the professors, big-machine physics needed more money than a university alone could provide. This required the involvement of sources of funding like wealthy philanthropists, who, more often than not, were successful businessmen with conservative political interests. So—again, before the war started—big-machine physics was already aligned with a conservative political element which would not look favorably on leftist professors.

Lawrence reached the height of his profession with a Nobel Prize in 1939, gaining with it a million-dollar grant from the Rockefeller Foundation to build a newer, bigger, fifth-generation 184-inch cyclotron. Much of Lawrence's success derived from his canny ability to "spin" his physics research for the eyes of the public, the press, and non-scientist philanthropists. In the public imagination of the 1930's, the future was powered by miraculous machines, and Lawrence's Jules Verne-like cyclotrons, with their intrepid explorations of the atom's *terra incognita*, played the role perfectly. But the connection between scientist and entrepreneur took on a more ominous cast when the machines were used to produce weapons. With the onset of war, the magical onstage performances disappeared, and the miracle of nuclear research retreated behind closed doors.

In 1939, Albert Einstein and Leo Szilard wrote a letter to President Roosevelt warning him that the Germans might be researching the use of fission to create an atomic bomb. Roosevelt responded with the creation of a secret "Uranium Committee," but the research didn't really become an urgent need until the attack at Pearl Harbor in December 1941. In the meantime, work continued at the Berkeley cyclotron in the creation and identification of the mysterious radioactive heavy elements. On February 23, 1941, chemist Glenn Seaborg and his colleagues produced a tiny amount of a new element which, calculation suggested, would sustain an atomic chain reaction in much smaller amounts than uranium. They named the element after the next planet in the series of astronomically-named elements: plutonium.

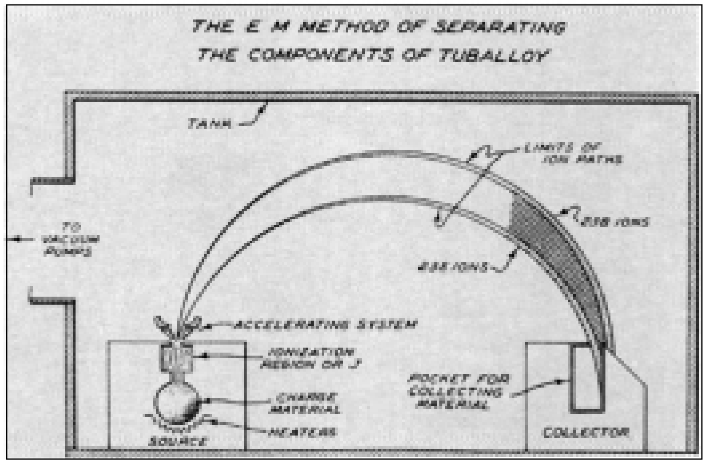
These two elements were to become the explosive centers of the two bombs produced at Los Alamos, nicknamed "Fat Man" and "Little Boy." Lawrence agreed to allow his beloved new cyclotron, then in construction on a hilltop overlooking campus, to be diverted into the war effort. The machine was retooled for one primary purpose: the separation of the rare, fissionable isotope U-235 out of

Science, Academia, and the Military. Manhattan Project director General Leslie R. Groves (left), and legendary U.C. President Robert Sproul admire Lawrence's Medal of Merit for wartime achievement, in 1946 (LBNL Image Library).

the more plentiful U-238. Lawrence dubbed his converted cyclotron a "calutron," in honor of the University of California. The calutron's method of uranium separation was known as "electromagnetic separation." Uranium-hexafluoride gas was ionized in an electric field, producing a beam of gas-ions. The ions were projected into a vacuum tank, where a 37-inch magnet bent their course in a loose semi-circle, and the U-235 ions, with their lesser mass and momentum, separated out in a tight arc. Two containers on the other end of the field caught the heavy and light streams of ions. In 1943 Lawrence also helped oversee the construction of an enormous U-235 production plant at Oak Ridge, Tennessee, using the calutron technology.

Security at the Radiation Lab was tight. Many of the technicians working on the calutron did not know the reason for their work, and were mystified by the obsession with collecting the minute amounts of slimy green "gunk" the machine produced. The army monitored all of the scientists working at the lab, especially those with the dangerous knowledge that the lab was working to produce a bomb. Martin Kamen, famous for the discovery of carbon-14, recalls in his memoir *Radiant Science, Dark Politics,* that an Army security van regularly stationed itself on his street—threatening local housewives and other guilt-ridden neighbors who mistakenly thought they were the target of its surveillance.

We can do it! Wartime workers operate calutrons (of Lawrence's design) at the Oak Ridge Facility in Tennessee. The machines ran 24 hours a day to produce pure U-235 for use in atomic bombs (LBNL Image Gallery).

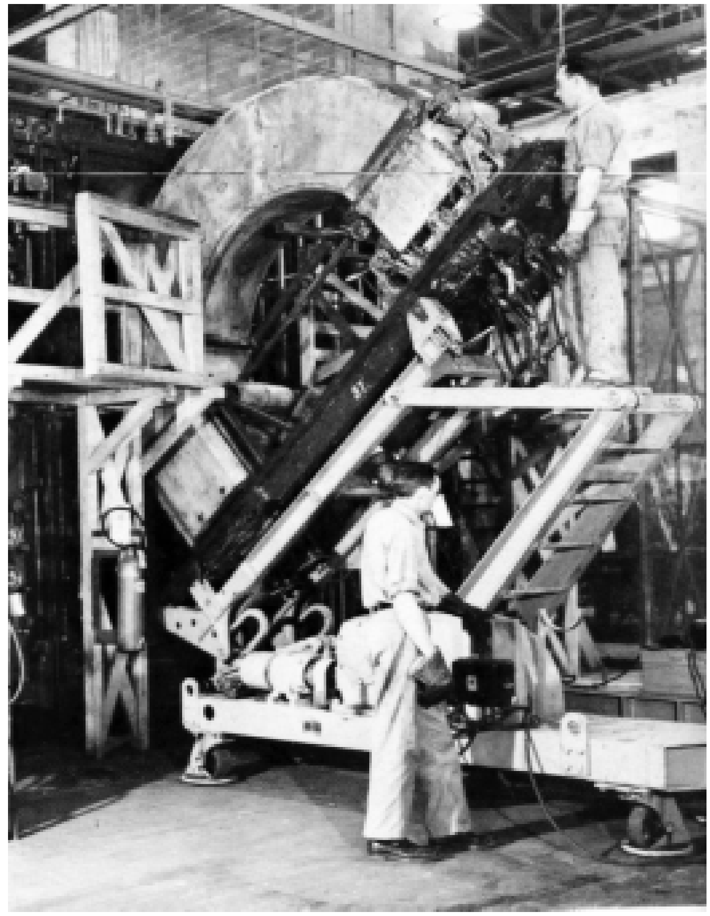


Collecting Uranium. Schematic diagram of uranium isotope separation in the calutron. Naturally-occurring uranium is accelerated through a magnetic field. The lighter, and much more rare, isotope, U-235 completes a tighter spiral than the heavier U-238. Lawrence's team used this method to collect U-235 for use in the first atomic bombs (LBNL Image Library).

Perhaps the most restrictive element of army security, bemoaned by every scientist working on the bomb project, was General Leslie Groves's notorious idea of "compartmentalization." Under this policy, scientists were only allowed to know about the specific projects they worked on, in order to minimize security leaks. Only a few very highly-placed officials and scientists had a view of the whole picture. Oppenheimer—surely influenced by his experience at the Berkeley cyclotron—finally convinced Groves that compartmentalized research was an obstacle to scientific productivity and creativity. Groves responded with an order to consolidate the bomb research at Los Alamos, where scientists could freely communicate with each other, in virtual quarantine from the outside world.

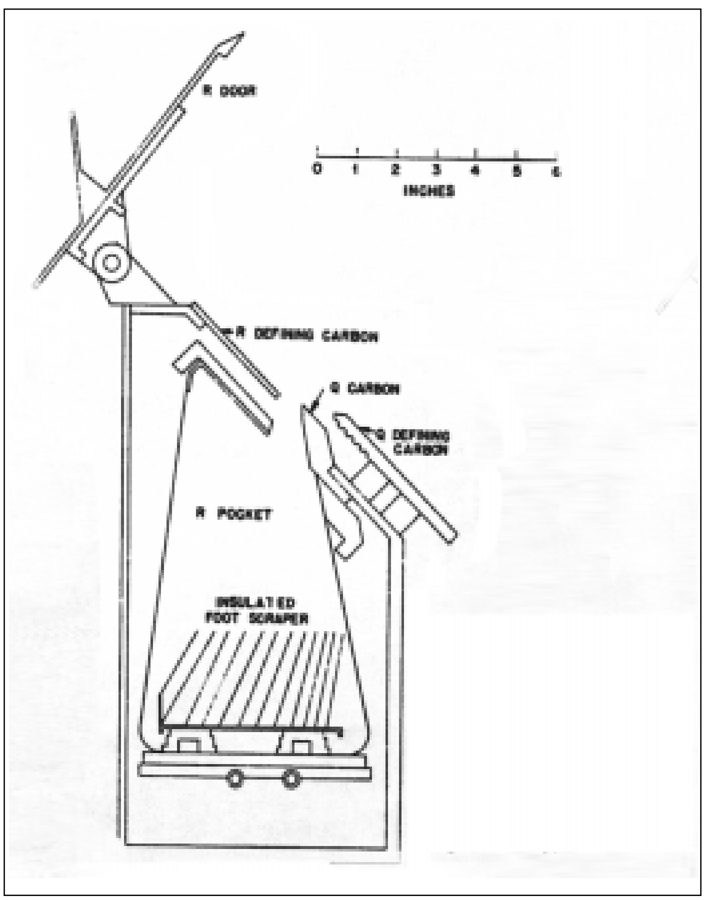
When Oppenheimer was selected by General Groves to direct research at Los Alamos, most scientists had little concern for his radical past. The general consensus among scientists was that they were fighting a war against Germany and Japan. But the American Army took a different view. As General Groves later recalled, "There was never from about two weeks from the time I took charge of the Project any illusion on my part but that Russia was our enemy, and the Project was conducted on that basis." So any scientist with a history of leftist or Communist sympathies was now under suspicion for espionage connected with Communist Russia. The fact that Groves selected Oppenheimer to direct Los Alamos was obviously a wise choice from a military perspective, given the result of the appointment—but Groves was later forced to defend his choice when post-war anti-Communist sentiment turned on Oppenheimer.

Other Berkeley scientists with leftist leanings fell victim to the war-time security net. A group of Oppenheimer's former students, led by Giovanni Rossi Lomanitz, had successfully introduced a union into the Radiation Lab, as a branch of the Federation of Architects, Engineers, Chemists, and Technicians. Lieutenant Colonel John Lansdale, army intelligence chief for all fission work and hardened anti-Communist, convinced Lawrence that the union members were a security risk, and Lawrence quietly began firing them. It quickly became known in the Lab that union membership was a surefire ticket to expulsion. Once Communist Russia became an enemy of the country, the expression of a political opinion—even if it was to support something as seemingly innocuous as a teachers' labor union—became a security risk.



The "C" shaped alpha calutron tank, together with its emitters and collectors on the lower-edge door, was removed in a special "drydock" from the magnet for recovery of uranium-235 (LBNL Image Library).

The end of the war did not ease the need felt for security in nuclear physics research. Russian aggression resulted in the blockading of Berlin, and Churchill spoke of an ominous "iron curtain" descending over Eastern Europe. When the shocking news came in 1949 that Russia had successfully detonated an atomic bomb, America began public trials in search of the scapegoats who had leaked the secret to the Communists. With its "red" reputation, Berkeley became a target of espionage investigations. In 1949 the California House Un-American Activities Committee convened a panel to investigate the "Communist Cell" which had supposedly operated as a spy ring in Berkeley during the war. (The chairman of the committee was none other than Richard M. Nixon, who got his start in politics pursuing California Communists.)



U-235 Receiver. Tiny amounts of "slimy green gunk"—uranium 235—accumulated in this collector placed at the U-235 beam's end in the calutron (LBNL Image Library).

along with academics all over the country--out of their careers. A typical example was Lomanitz. Called before the HUAC committee, Lomanitz was eventually cleared of the espionage charges, but the Communist taint stuck with him, and he was asked to resign from the post-war position he held at Fisk University in Tennessee. Lomanitz's subsequent occupations included roof tarring, tree trimming, loading barley bags, and bottling hair oil. While holding these jobs the ex-physicist was constantly hounded by the FBI, who questioned all of his coworkers and made it hard for him to stay employed.

History's Loser. Oppenheimer (left), with physicist Enrico Fermi (center), and Ernest O. Lawrence. Post-war red purges essentially erased Oppenheimer's scientific legacy. His leftist leanings and connections to workers unions and other organizations were easy fodder for anti-communists' accusations (LBNL Image Library).

Yet the HUAC investigation was not completely fruitless. There *was*, it turned out, a real spy working in the Berkeley cyclotron during the war. The committee referred to him by the dramatic name, "Scientist X." According to the published reports of the HUAC hearings, in March 1943 Scientist X contacted Steve Nelson, a local organizer of the Communist Popular Front organization, and late one night went to Nelson's home bearing a complicated formula. FBI men lurking in the bushes watched as Nelson copied the formula so that it could be returned to the Radiation Lab in the morning. Days later, Nelson contacted the Soviet Vice Consul in San Francisco, and arranged to meet with him in a park on the grounds of St. Francis Hospital. There Nelson transferred a package to the Vice Consul, and within a few days Nelson had a visit from a Russian diplomat at the Washington Embassy, who paid him "ten bills of unknown denomination." The identity of Scientist X was later revealed to be another of Oppenheimer's former students, Joseph Weinberg.

If all of Weinberg's activities were carried out in full view of FBI binoculars, one wonders why he was never arrested, nor his activities halted during the war. Scientific historian Nuel Pharr Davis speculates that army security was using Weinberg to manipulate the flow of information to the Russians. The fact of the matter was, the electromagnetic separation method was only one of several competing methods of U-235 production used in the early war years, and its effectiveness compared to other methods was highly questionable. The calutron produced only very tiny amounts of U-235, and its beams were difficult to focus. Most historians agree that it was only Lawrence's bullish enthusiasm that convinced the army to go with his method. In 1954, General Groves testified that the process of electromagnetic separation was relatively unimportant in the American production of uranium. This war secret, it seems, was more useful to the military in misdirecting the Russians than in actually creating the bomb.

A final twist on the subject of atomic espionage at Berkeley comes out of very recent revelations. In their 1999 book *Venona: Decoding Soviet Espionage in America*, John Earl Hynes and Harvey Klehr describe their findings in the shadowy CIA files known as the "Venona Project." Only declassified in 1995, these files consist of more than 3,000 coded cables sent from KGB operatives in America to Communist headquarters in Moscow. The Venona project decoded the cables between 1943 and 1946, and much of the top-secret material was subsequently used to pursue American Communist spies. Hynes and Klehr make a surprising assertion: that the Communist party in America was not merely ideological, but also active in espionage for the Soviet Union. Among other groups, the Federation of Architects, Engineers, Chemists, and Technicians (FAECT) was a cover for Soviet agents—spearheaded by Steve Nelson—hoping to gain access to bomb secrets. So the firing of members of the union at the Berkeley lab was actually more than just anti-left prejudice. According to Hynes and Klehr, because of the Venona information, a White House directive ordered the national president of the FAECT to cease organizing in the Berkeley Radiation Lab for the duration of the war.

The work of Hynes and Klehr is useful in tempering the story of leftist persecution that is usually told about the post-war years. But the obsession with espionage and secrecy surrounding the bomb project—both in the 1940's and today—is somewhat misleading. It obscures the larger fact that no matter what political intrigues were going on at the time, the Soviet Union would have developed the bomb regardless, because the technology was based on fundamentals of nuclear science which no amount of U.S. secrecy could have hidden. Historians have designated this fact "complementarity," and its basic premise is that "if we could figure it out, so could they." In other words, Soviet atomic espionage in America didn't create their bomb; it only helped them get the bomb faster. Even without results gained from spying, Soviets could have used machines like Lawrence's cyclotron to eventually discover the nuclear physics necessary to create a bomb. Wartime physicists like Leo Szilard and Hans Bethe realized this crucial fact, and supported the establishment of an international community of scientists that would safely oversee the sharing of bomb technology in an open, transparent, and honest fashion. But such ideas were quickly tabled in the atmosphere of suspicion and hysteria that took hold of the country after the war. The U.S. wanted to jealously hold onto its secret, and when Russia got the bomb, it was assumed that leaky scientists were to blame.

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The cloud of suspicion hung most heavily around Oppenheimer himself. A tragic point in the entanglement of physics with politics was the ruination of Oppenheimer's career, as all of his Communist ghosts returned to haunt him, and his security clearance was revoked after a hearing in 1954. The story comes full circle when we learn that Lawrence, once Oppenheimer's friend, was then prepared to testify against him, and was only prevented from attending the hearing by a serious stomach ailment. What had caused the cyclotroneer's new animosity? At stake was the future direction of physics research: Lawrence's pre-war enthusiasm for bigger and bigger machines translated into a post-war fanaticism for bigger and bigger bombs. He was an energetic campaigner for research into the "Super," a thermonuclear device which promised to be many thousands of times more powerful than the existing bomb. Oppenheimer, on the other hand, was tentative about the need for Super research, stung by doubts about the ethics of bomb development.

Lawrence was ready to interpret Oppenheimer's opposition as a possible sign of disloyalty—though, conveniently enough, once Oppenheimer was removed from his important position with the Atomic Energy Commission, there was nothing stopping Lawrence's ambitions for the new bomb research. Lawrence easily raised the money for a new weapons research laboratory near Berkeley, the Livermore Lab, which began work after 1952 under the directorship of Edward Teller—the man whose testimony most damningly declared Oppenheimer to be a security risk at the 1954 trial. It's not really surprising that, as Brechin Gray points out, Oppenheimer's legacy was virtually effaced at Berkeley, his portrait conspicuously absent from the "Gallery of Greats" in the Lawrence Hall of Science. After all, the victors get to write history. As it was before the war, once again the interests of money and political power convened to influence the development of scientific research. The result of twenty years of accumulated developments in politicized physics was that Oppenheimer came out on the losing end. ■