IN MEMORIAM

I. I. RABI

I. I. Rabi died on January 11, 1988. An obituary which appeared on the front page of The New York Times on January 12, 1988 is reprinted below, with the permission of The New York Times. The photograph is from Rabi's last appearance at the Frequency Control Symposium, in 1986.

Isidor Isaac Rabi, a Pioneer In Atomic Physics, Dies at 89

By MARILYN BERGER

Isidor Isaac Rabi, a pioneer in exploring the atom and a major force in 20th-century physics, died yesterday at his home on Riverside Drive after a long illness. He was 89 years old.

Dr. Rabi, who won the 1944 Nobel Prize in Physics, was a strong intellectual influence on succeeding generations of physicists and a moral influence in the debate over controlling the power of the atom. The center for physics that he established at Columbia University became a training ground for scientists who went on to establish other major centers.

He was awarded the Nobel Prize for developing a method of measuring the magnetic properties of atoms, molecules and atomic nuclei. His work in turn made possible the precise measurements necessary for the development of the atomic clock, the laser and diagnostic scanning of the human body by nuclear magnetic resonance.

I. I. Rabi

Tailor or Physicist

The man who was known as I. I. Rabi to his students at Columbia, and as Rab to his wife and friends, was born July 29, 1898, in the town of Rymanow, Austria-Hungary. He was a baby when his parents brought him to New York's Lower East Side. When his father worked, he worked as a tailor. When he did not work, the family went hungry.

"It's a miracle," Dr. Rabi said years later, "how a sickly child from a Lower East Side poverty-stricken family moved in one generation to where I did. Had we stayed in Europe, I probably would have become a tailor."

Fellow scientists admired what they called his "street smarts" and came to regard him as a conscience of their community. Dr. Rabi (pronounced RAH-bee) devoted much of his life to channeling man's knowledge of the

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Isidor Isaac Rabi, Leader in

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forces of the atom to peaceful purposes. He was the originator of the idea for the CERN nuclear research center in Geneva, which was instrumental in the rebirth of science in post-war Europe.

In this country he played a major role in the creation and style of the Brookhaven National Laboratory on Long Island. He devoted a great deal of his energy to reforming science education in the United States and ending the isolation of science from the humanities.

Physics as a Discipline: Noble and Fundamental

Physics, to Dr. Rabi, was the most ennobling of disciplines, as well as the most fundamental. He said he had always tried to impart to his students a certain point of view of physics, its greatness. "You're wrestling with a champ," he recalled telling them. "You're trying to find out how God made the world, just like Jacob wrestling with the angel."

Although most of Dr. Rabi's pure scientific research was over by the 1940's, he was a major force in the world of 20th-century science. Sidney Drell, the theoretical physicist, described Dr. Rabi as "a very great giant on the scientific scene."

Not only was Dr. Rabi a great research scientist, Mr. Drell said, but he was also the founder of a great center of research in physics, at Columbia. He also cited Dr. Rabi's contributions to science policy in World War II, his role in reviving European science through the creation of CERN and "his clear speaking out on the deep moral issues" involving nuclear weapons.

In World War II, Dr. Rabi was a leader of the research team in Cambridge, Mass., that helped in the development of radar. He also served as a senior adviser on the Manhattan Project, which developed the atomic bomb, and later as a science adviser to President Eisenhower.

As a professor, Dr. Rabi did not enjoy a reputation as a great lecturer and was feared by students as a tough taskmaster. But he is remembered for his moral integrity and for an impeccable taste that set a style for the study of physics in the United States.

One former Columbia faculty member said: "The most spectacular thing about Rabi was that during a 15-year period there were four Nobel Prizes all in different fields of physics at Columbia. Although Rabi wasn't directly involved in the specific work, he was the key motivating person. He built a great physics department so far beyond anything else in the world at the time that nobody could hold a candle to it."

Many of the teachers in most of the great centers of physics in the United States studied in Dr. Rabi's physics department. Of his many honors, Dr. Rabi was especially proud of one from the American Association of Physics Teachers, the Hans Christian Oersted award for his notable contribution to the teaching of physics.

Dr. Rabi actually stumbled into physics after he had already graduated from college with a degree in chemistry but with an abiding interest in the structure of matter.

"It was a time," he remembered, "of great revolution in fundamental physical ideas of time and space and causality. It was a little like landing on Ellis Island and going west and discovering a whole continent."

As a young man, Dr. Rabi won a scholarship to Cornell University, after graduating from Manual Training High School in Brooklyn.

"I turned away from the Old World," he said one day as he reminisced about his life. "I realized I had to be an American, not a Jewish-American. In all of my reading, I tried to become an American. I read a tremendous amount of colonial history. It takes a person like me to really understand what a wonderful country America is."

"I'm an omnivorous reader," he said, looking back at his discovery of the local branch of the Brooklyn Public Library after moving to the Brownsville section of Brooklyn when he was a child. He was about 10 years old when he started reading through the shelves of books, finally coming upon one about Copernicus that changed his idea of the world. "I was small for my age; I still am," the 5-foot 4-inch tall physicist said in his 88th year. "The librarian made me read to her from one of the books I was borrowing to prove I could read before she let me leave."

He said Jack London's writings made him a Marxist by the time he was 13 years old. "What appealed to me was the democratic idea that anybody could become anything," he said. But he later decided that Marxism could not work. "The ideas are very appealing," he said, "but they're not meant for humans."

> His work led to the development of the laser and the atomic clock.

At Cornell, he signed up for engineering and chemistry on a scholarship so meager that he lost several teeth because of malnutrition. "I was living on a dollar a day," he said, "and I didn't see wasting the money on vegetables."

After graduating from Cornell, he got a job as a chemist analyzing furniture polish and mothers' milk, put out a local newspaper in Brooklyn and worked for a time in a lawyer's office dealing with accounts receivable. When he was 25 years old, he said, he decided it was time "to stop horsing around." He went back to Cornell for graduate work in chemistry.

"Now comes the celebration," he said, looking back with relish at what happened to him. "I applied for a fellowship and I didn't get it. So I decided to study physics, and it was then that I realized that this was my field."

Dr. Rabi transferred to Columbia, not only because a fellowship was available to him there, but also, as he put it many years later, because he had met "the most beautiful girl in the world," who lived in New York. Three years later, on Aug. 17, 1926, that girl,

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Helen Newmark, became his wife. She survives him, and do their two daughters, Nancy Lichtenstein of Princeton, N.J., and Margaret Beels of New York, and four grandchildren.

After receiving his doctorate from Columbia in 1927, Dr. Rabi obtained a small fellowship for postgraduate study in Europe, where the major work in physics was being done. He went from Munich to Copenhagen to Hamburg to Leipzig to Zurich. Arriving in Copenhagen, he presented himself at the institute of Niels Bohr, was given a key and allowed to go to work on his own.

Making First Contact With Top Physicists

In Europe he met and worked with some of the outstanding physicists of the time: Bohr, Wolfgang Pauli, Pascual Jordan, Arnold Sommerfeld and Werner Heisenberg. Perhaps the most influential, in Dr. Rabi's work, was Otto Stern, who won the Nobel Prize in Physics the year before Dr. Rabi.

Among the scholars traveling in Europe were other scientists from the United States who were to become lifelong friends: Hans Bethe, Linus Pauling, E. U. Condon and J. Robert Oppenheimer. With Dr. Rabi, these men became the link between European and American science at a time of tremendous ferment.

With his fellowship money running out, Dr. Rabi faced returning to America with no prospect of a job. He said he knew that anti-Semitism in the universities made it unlikely that he would be accepted anywhere, and he was thunderstruck when in 1929 he received a cablegram from Columbia offering him a job at $3,000 a year, a princely sum on the eve of the Depression. He believed he was the first Jew on the faculty of the Columbia physics department, advancing from lecturer to assistant professor to Higgins Professor of Physics to professor emeritus. In 1964 he was named Columbia's first University Professor and in 1985 a chair in physics was named for him.

At the beginning he had to fight to keep his research appropriation and even offered to take a cut in salary rather than a cut in his research funds. When Harold Urey, a professor at Columbia, won the Nobel Prize in Chemistry in 1934, he astonished Dr. Rabi by giving him half the prize money so he could continue his research.

By 1937 that research had led him to the technique for which he won his Nobel Prize. It followed directly from his association with Otto Stern at the University of Hamburg, where Dr. Stern applied magnetic fields to beams of molecules. He confirmed that the proton, a particle found in the nucleus of all atoms, generated a weak magnetic field by its spin.

This method for measuring the spin of the core of the atom, or nuclear magnetic moments, became the central technique of all modern molecular and atomic beam experiments, and that won for him the Nobel Prize.

Dr. Rabi's research led to the ability to make the most precise measurements that today are necessary for the guidance systems of missiles and satellites. It also led to the advanced medical diagnostic technique of magnetic resonance imaging.

It was in 1945 that Dr. Rabi proposed the construction of an atomic clock, capable of tuning in on atomic frequencies.

When word of the Nobel Prize reached him, Dr. Rabi was working at the Radiation Laboratory of the Massachusetts Institute of Technology, developing radar. He had refused Oppenheimer's invitation to become deputy director of the Manhattan Project, although he occasionally went to the atomic bomb laboratory at Los Alamos, N.M., to serve as a troubleshooter and consultant.

Dr. Rabi said he believed it might be possible to win the war without the bomb, but that without radar the war would be lost. Furthermore, he reportedly had reservations about a weapon of mass destruction becoming the culmination of three centuries of physics.

Nevertheless, Dr. Rabi said that in the war he was ready to support any idea that would contribute to the defeat of Hitler. "Some person would come along with a bright idea and I'd say, 'How many Germans will it kill?' " he recounted. With that in mind, he supported the push to develop the atomic bomb and overcame his doubts about using it.

He witnessed the first nuclear explosion on July 16, 1945, and later told an interviewer that for the first moment he was thrilled. "Then, a few minutes afterward," he said, "I had gooseflesh all over me when I realized what this meant for the future of humanity."

Dr. Rabi joined with Enrico Fermi to oppose the next step in the arms race, the "Super," a weapon proposed by Dr. Edward Teller and others that eventually was developed as the hydrogen bomb. Oppenheimer had also opposed it as a potential "weapon of genocide."

Dr. Rabi and Fermi wrote: "The fact that no limits exist to the destructiveness of this weapon makes its very existence and the knowledge of its construction a danger to humanity as a whole. It is necessarily an evil thing. We think it is wrong on fundamental ethical principles to initiate the development of such a weapon."

Speaking to his last class at Columbia in 1967, Dr. Rabi said he had realized early on that "just because we got there first doesn't mean that we should have the power of life and death over the whole world."

Years of Devotion To Controlling Arms

Immediately after the war, Dr. Rabi started his efforts to control the atom, working first with Oppenheimer to devise what became known as the Baruch Plan for international control of atomic energy.

Forty years later, reminiscing about the ideas behind the Baruch Plan, Dr. Rabi said: "It had to be self-enforcing and universal. I think it was our finest moment in America. People wouldn't believe it today. The Russians turned it down, but that was expected, it was such a new and revolutionary idea. We wanted to internationalize everything. We should have gone back to the Russians when they said no."

In his later years, his eyesight failing, his face still unlined, Dr. Rabi grew increasingly impatient with the ever-increasing stockpiles of weapons, convinced that each new weapon would inevitably produce a countermeasure. He wanted nothing less than a reeducation of the American people.

"The more you talk about arms control, the more you become morally obtuse," he said. "You have to recoil from the horror of it. You have to arouse the imagination of people building bombs in peacetime to use against an ally in two world wars.

"Americans are a moral people. They have respect for human life even where there are differences of opinion. Most Americans have enjoyed Russian novels, Russian music. We've yet to produce novels or music as great as theirs. What you're talking about is killing individuals because you don't like their government. I say that's un-American. That hatred is un-American."

Dr. Rabi did not speak out often. He usually confined his opinions to the inner councils of government. He succeeded Oppenheimer as head of the General Advisory Committee of the Atomic Energy Commission and was a member of what became the President's Science Advisory Committee from its 1952 birth in the Office of Defense Mobilization until 1968.

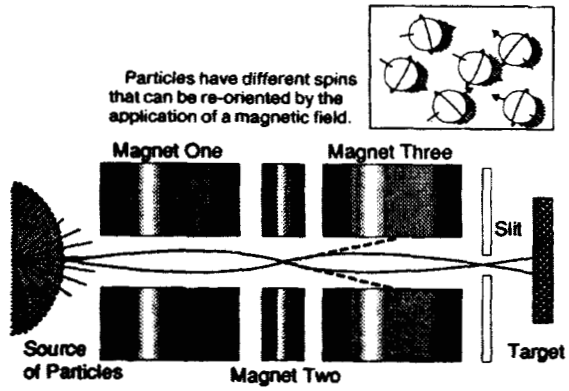
But he won the respect of many scientists for his forthright and spirited defense of Oppenheimer at hearings in 1954 of the Atomic Energy Commission, which ultimately stripped the former head of the Manhattan Project of his security clearance over questions raised in the McCarthy era about his loyalty to the country. "I was sore at pygmies trying a great man like Oppenheimer," Dr. Rabi said years later.

Dr. Rabi told the committee that because of the leadership of Oppenheimer, the United States had the atomic bomb, a whole series of them. In a burst exasperation, he asked, "What more do you want — mermaids?"

In a life filled with honors, Dr. Rabi gave so little thought to making money that he even promised himself never to patent any of his ideas, including the atomic clock. "In the late 1930's," he once recalled, "I and my friends sat around and talked about what we'd do if we had a million dollars. I thought and thought and finally I said, 'I think I'd buy a new hat.' "

Mrs. Rabi said funeral services for her husband would be private and that a memorial service would be held at a date to be announced later.

Precise Measurement of Atoms: A Major Contribution From Rabi



An extremely sensitive method of revealing the magnetic properties of atomic particles was one of I. I. Rabi's central contributions to physics. It led to scientific and practical applications that include the atomic clock and the medical imaging technique known as magnetic resonance imaging.

Dr. Rabi created a device that guides a beam of particles through a series of magnets. Depending on the direction of each particle's spin, the magnets push the particle up or down.

The first and third magnets are aligned to oppose each other, so their effects cancel out. Some atoms curve up and then down; others down and then up — and either way they pass through a slit to a detector.

The key to the device is the middle magnet, which can be precisely tuned to different frequencies. When the frequency matches the exact frequency of the particles in the beam — when they are in "resonance" — the spins flip to the opposite direction. As a result, the particles that curved upward under the first magnet will now curve upward again, and the particles that curved downward will curve downward (dotted lines), and they fail to reach the detector. Thus when the frequency of the magnetic is set correctly, the detector shows a sudden dip in the number of particles reaching it. That signal allows exact measurement of the particles' magnetic properties.

Source: Richard P. Feynman, "The Feynman Lectures on Physics"