taken a joint appointment as professor of physics and civil engineering. **Jeff Kimble** has become assistant professor of physics.

Ronald D. Parks has been appointed to the faculty of the Polytechnic Institute of New York as professor of physics and chemistry. Parks, who had recently left Rochester University, will also serve as director of the new Surface Science Center at Polytechnic.

The following physicists have joined the faculty of Mississippi State University as assistant professors: **Leslie E. Bauman** (Texas A&M University); **John T. Foley,** (University of Rochester); **Edward J. Beiling III** (Rice University).

Executive vice president of General Electric Company, **Thomas A. Vanderslice,** has been named president and chief operating officer of the General Telephone and Electronics Company.

Stanley Deser has been appointed as the first Ancell Professor of Physics at Brandeis University.

George C. Pimentel, deputy director of the National Science Foundation, has been appointed head of Lawrence Berkeley Laboratory's Division of Chemical Biodynamics and an associate director of the laboratory.

Yeshiva University has named Nobel laureate **Roslyn S. Yalow** to be University (Distinguished) Professor.

obituaries

Otto Robert Frisch

Otto Robert Frisch, a pioneering nuclear physicist born in Vienna, Austria, died in Cambridge, England on 22 September. He was 75 years old.

Frisch's parents were remarkable people whose unusual influence helped determine their son's lifestyle. His mother interrupted a career as concert pianist when she got married and started teaching her son to play the piano at age five. Frisch became so accomplished a piano player that, had he not become a physicist, he could have been a concert pianist. His father, after obtaining his law degree, earned his living for a while by painting watercolors of resort hotels. It was from him that Frisch acquired his talent for sketching. And it was also his father who introduced the boy, then ten to eleven years old, to algebra, analytical geometry and trigonometry, building on his son's evident natural talent. When Frisch entered the University of Vienna in 1922, he noticed that there were a few other mathematical geniuses around, and since he had always enjoyed making things with his hands, he chose physics as his main subject and mathematics as his second.

Frisch's most famous contribution to physics is the conceptual understanding, together with his aunt, Lise Meitner, of the fission process. In 1938 Frisch was working at the Niels Bohr Institute in Copenhagen, while Meitner, having lost her job in Berlin when Hitler came to power, had found refuge in Stockholm. Otto Hahn, with whom Meitner had worked for many years, wrote her in late 1938 about a most exciting discovery: When uranium was bombarded with neutrons, at least one of the products was barium. In all previously discovered nuclear reactions only very light nuclear fragments were emitted, protons, neu-

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FRISCH

trons and alpha particles. How, then, could one get barium from uranium?

Being in fairly close proximity, Meitner and Frisch spent the Christmas holidays together in a small place near Göteborg. On a walk through snowy woods they found the explanation. It was Frisch who, in this connection, thought of the liquid drop model of the nucleus. But how could a liquid drop divide in two? The surface tension should prevent this, but Frisch and Meitner soon figured out that the Coulomb repulsion just about compensates for the surface tension in the neighborhood of uranium, making fission possible.

After his return to Copenhagen, Frisch demonstrated the high energy of fission fragments, in an experiment which took two days and was accomplished earlier than corresponding experiments in America. Niels Bohr subsequently developed the fundamental theory of the fission process with John Wheeler and showed that the fission should be attributed to the rare isotope U-235. Bohr argued that this would make an explosive chain reaction in uranium impossible.

Having moved from Copenhagen to Birmingham, Frisch wanted to separate U-235 by the Clusius thermal diffusion method. While working on this dead-end attempt, it occurred to him that maybe one could eventually produce enough U-235 to make a bomb. Using a formula developed by Francis Perrin in France and refined by Rudolf Peierls, and guessing the fission cross section, Frisch found a critical mass of about one kilogram.

This astonishingly small amount convinced him and Peierls, with whom he discussed his findings, that an atomic bomb could indeed be made, given a viable method of separating uranium isotopes. They reported their findings through intermediaries to the British government, a step which was decisive in convincing the government to take the atomic bomb seriously. Subsequently, in 1941, a group of British physicists persuaded their American counterparts also to take fission and the atomic bomb seriously, a step most important in starting the Manhattan Project. Thus Frisch's role was crucial not only in the understanding of fission, but also in the initiation of the atomic bomb development.

Frisch's main education in physics had been at the laboratory of Otto Stern in Hamburg, 1930–33. Stern was in the habit of inventing experiments, but letting his assistants carry them out, very good training for an experimenter. Stern and Frisch succeeded in demonstrating the diffraction of a molecular beam of helium from a crystal, thus showing that the de Broglie relation holds for a complex system like a helium atom as well as for elementary particles. Later, in Copenhagen 1934–39, Frisch measured the radioactivity produced by neutrons in rare earths. Frisch was present in Copenhagen when Bohr invented the compound nucleus. Together with George Placzek he established neutron resonances in cadmium and gold.

In 1940 Frisch accepted Sir James Chadwick's invitation to move to Liverpool and in 1943, again on Chadwick's initiative, he went to Los Alamos where most of the actual design of an atomic bomb was being done. Enough material had arrived at Los Alamos for a critical mass. To test the concept of an atomic bomb, Frisch proposed to shape this material into the form of a sphere with a central, vertical cylindrical hole. A solid cylinder of the same material was made that would fit exactly into this hole and could move through it on rails. Frisch proposed to let the cylinder drop through the hole, which would make the assembly critical for a very short time. The neutron burst could be measured, thereby giving information on the behavior of a critical assembly. Frisch's proposal was immediately accepted with the remark: "This is like tickling the dragon's tail." It was fully successful. In 1951 he married Ulla Blau, also Vienna born, a gifted graphic artist and well-known illustrator of children's books, who opened his eyes to the world of the visual arts. Their son followed his father into physics while their daughter became a social worker.

Returning from Los Alamos after the war, Frisch was made leader of the Division of Experimental Physics at Harwell Laboratory near Oxford. While the laboratory was being built, Frisch calculated the fluctuations in a nuclear pile and their effect on oscillator tests. In 1947 he accepted a professorship at Cambridge University, in fact the very chair that had previously been held by Lord Rutherford.

Frisch's chief interest was instrumentation. In 1942 he invented a "kicksorter," that is a pulse analyzer in which, by a combination of electronic measurements of pulses and of mechanical devices, he could measure the distribution of pulse sizes in a detector.

Probably the most interesting instrument Frisch invented in Cambridge was Sweepnik, a device for semi-automatic measurement of tracks in bubble chambers. With the help of a small laser beam, Sweepnik projects bubble chamber tracks onto a screen. This permits a most accurate location of bubble chamber tracks, or of any lines on a graph. A special firm, directed in scientific matters by Frisch, was founded to develop, produce and sell Sweepnik for a variety of applications.

His other chief interest was education in science. He wrote numerous articles on various fields of physics for review journals and educated the public in science even more widely by frequent lectures on the British Broadcasting Corporation, where he was a highly valued speaker.

A slim volume of memoirs *What Little I Remember* (Cambridge University Press) was published shortly before his death. It testifies to the fact that he has known, and worked with, almost all great figures in contemporary physics. Its closing paragraph sums up much of Otto Robert Frisch: "All my life I have been interested in the design of scientific devices, even more than in the results which I or others might obtain with their help. The firm we started for manufacturing Sweepnik is still growing and gives me scope to do what I like best. I can do much of my work at home and interrupt it to play the piano whenever I like. I am a lucky man."

H. A. Bethe
George Winter
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Ithaca, N.Y.