Francis Birch FREE

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IN BRIEF

The recipient of the 18th Marconi International Fellowship Award is **James L. Flanagan**, Board of Governors Professor of Electrical and Computer Engineering at Rutgers University and the director of the Center for Computer Aids for Industrial Productivity there. The award, given by the Marconi International Fellowship Council, cites "his pioneering contributions to speech technology."

The 1992 Harvey Prize in Technology, which is given by the Technion in Haifa, Israel, was awarded in June to **Amnon Yariv**, the Thomas G. Myers Professor of Electrical Engineering and professor of applied physics at Caltech. The award recognizes his contributions toward human progress in science and technology.

The first International Ceramics Prize of the Academy of Ceramics was given to **Robert E. Newnham**, the Alcoa Professor of Solid State Science at Pennsylvania State University, in June. He was cited for "distinguished, creative and exceptional interdisciplinary contributions to the advancement of ceramic science and culture, especially in composite electroceramics, including intelligent ceramics."

The Royal Society gave the 1992 Rumford Medal to **H. N. V. Temperley**, emeritus professor of applied mathematics at the University of Wales. He was cited for his "contributions to applied mathematics and statistical physics, especially in the physical properties of liquids and the development of the Temperley–Lieb algebra." **M. J. Seaton**, emeritus professor of physics at University College, London, was given the 1992 Hughes Medal by the Royal Society for his "theoretical research in atomic physics, and leadership of the Opacity Project."

OBITUARIES

Francis Birch

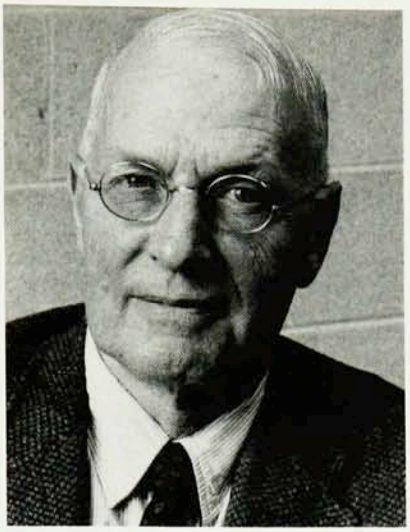
Francis Birch died of cancer on 30 January 1992 at his home in Cambridge, Massachusetts, at the age of 88. Birch was a pioneer in applying condensed matter physics to physical properties of minerals and rocks and to the deduction of the Earth's internal composition, mineralogy and temperature.

Born in Washington, DC, Birch received his undergraduate degree in engineering from Harvard College in 1924. He then worked for two years at the New York Telephone Company. An American Field Service fellowship enabled him to spend 1926–28 at the Institut de Physique in Strasbourg under Pierre Weiss. This experience reinforced his determination to do research, and he returned to Harvard, where he completed a PhD in physics under Percy W. Bridgman in 1932. Recognizing the need to understand geological materials at high pressures and temperatures in order to comprehend the nature of the Earth's deep interior, Bridgman and Reginald Daly of Harvard's geology department set up the Committee on Experimental Geology and Geophysics, and Birch headed its research efforts. This work was done in the Dunbar Laboratory until 1963, when they moved to the newly built Hoffman Laboratory.

During World War II Birch was a Navy officer and worked at the MIT Radiation Laboratory and at Los Alamos on developing the atomic bomb, matters that he rarely discussed. He rose from his first position at Harvard, as research associate in 1933 to become Sturgis Hooper Professor of Geology at Harvard in 1949 and professor emeritus in 1974; he still continued his research after retiring. Through Birch's laboratory passed students and postdoctoral fellows who became leaders of geophysics in subsequent years.

One measure of a scientist's contribution is the number of new fields that develop from his initial work, and by this standard Birch stands as one of the creators of geophysics during its formative years in the middle of the 20th century. Several areas of research in Earth sciences virtually originated with his work on equations of state, thermal conductivity, determination of continental heat flow and inference of the Earth's composition.

Using Francis D. Murnaghan's finite-strain theory, Birch developed what is termed the Birch or Birch–Murnaghan equation of state for isotropic solids in 1938. With a single parameter, the isothermal bulk modulus, this equation of state provides density–pressure relations for compressions up to several tens of percent. It was a valuable guide for extrapolation to conditions of planetary interiors before diamond anvil cells and shock compression attained the corresponding pressures, and it is now widely used to interpret elastic properties obtained from those techniques. Combining equations of state with thermodynamic relations, Birch wrote one of the classic papers in



Francis Birch

geophysics in 1952. This work was not only a research paper: He presented the material so lucidly that it is a valuable teaching resource even now. In this paper he demonstrated that the outermost mantle and the lower mantle are basically homogeneous and are separated by a transition zone that is compressed with depth more than a homogeneous material would be. His interpretation was that the transition zone is associated with phase transitions in silicates from fourfold- to sixfold-coordinated silicon. Subsequent measurements have supported this general picture of the structure and state of the mantle.

In 1961 Birch pointed out that sound speeds could be plotted as simple functions of density and that the curves would spread out according to atomic weight (mean atomic weight for compounds). This observation became known as Birch's law. Because velocities and densities are the principal data from seismic models, this approach helped determine the Earth's bulk chemical composition. In particular it is the most sensitive indicator that the fluid outer core cannot be iron or an iron–nickel alloy, as studies of meteorites would suggest, but instead must include a lighter element such as oxygen, sulfur or silicon. Such advances inspired the development of the field of mineral physics for understanding Earth materials and for interpreting geophysical measurements.

From the start of his work in the Dunbar Lab, Birch was interested in thermal properties. Measurements of terrestrial heat flow had their beginnings in England and South Africa, and Birch had measured thermal conductivities of rocks in the 1930s. In 1947 he determined the conductivity of the same rocks from the Colorado Front Range in which temperature gradients also had been measured. This result helped establish continental heat flow as one of the boundary values of terrestrial geophysics. Birch recognized heat flow and its regional distribution as primary information about the Earth's interior, and today we see them as revealing the thermal engine responsible for plate tectonics.

Francis Birch was elected to the National Academy of Sciences in 1950, and he was president of the Geological Society of America in 1964. He was a gracious man with a wry sense of humor, and his colleagues, friends and former students will feel his absence.

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Herman F. Mark

Herman Francis Mark was born in Vienna on 3 May 1895, and he died in Austin, Texas, on 6 April 1992.

After a distinguished four years in the Austrian army during World War I and a year as a prisoner of war in Italy, Mark studied chemistry at the University of Vienna under the guidance of Wilhelm Schlenk. His thesis, dealing with the synthesis and characterization of the pentaphenylethyl free radical, influenced his lifelong interest in the relation between structure and physical properties.

In 1921 Schlenk moved to the University of Berlin, and he asked Mark to come with him as his assistant. In the following year Schlenk recommended Mark for a position at the Kaiser Wilhelm Institut. Mark remained at the KWI, then one of the foremost centers of scientific research, for five years. With Michael Polanyi, Karl Weissenberg and Rudolf Brill as his colleagues, Mark embarked on a study of the crystal structure of a broad variety of materials, encompassing metals and low-molecular-weight compounds. Particularly important was his study of the crystal structure of graphite, since it demonstrated to him that the covalently bonded structure need not be limited by the size of the crystallographic unit cell, as was then widely believed. He also carried out pioneering work on x-ray physics, publishing papers on the natural breadth of x rays, their indices of refraction and their polarizations.

Herman F. Mark

In 1926 Kurt H. Meyer, a director of Germany's largest chemical company, I. G. Farbenindustrie, persuaded Mark to become head of a laboratory charged with the clarification of the structures of cellulose, starch, rubber and silk and the use of this knowledge for the synthesis of technically useful materials. The collaboration of Mark and Meyer led in 1928 to the first successful crystallographic characterizations of cellulose, silk fibroin and chitin, clearly establishing them as long-chain molecules. In a most innovative paper, published in 1932, Mark used crystallographic and spectroscopic data to estimate the mechanical strength of an "ideal" cellulose fiber. Somehow in his "spare time" Mark pioneered the determination of molecular structures by electron diffraction of gases. (The young Linus Pauling visited Mark's laboratory and was given an early instrument used in this research.)

With the rise of Hitler, the position of Mark—whose father had been Jewish—at IG Farben became increasingly precarious, and in 1932 he moved to the University of Vienna as a professor. There he created the first academic curriculum in polymer science. His Vienna years were marked by some important advances in the understanding of polymers, most notably the first statistical theory of rubber elasticity, developed with Eugene Guth.

It is impossible to review Mark's European career without touching on the bitter attacks to which he was subjected by Hermann Staudinger. Staudinger regarded himself, justifiably, as the originator of the concept of polymer chain molecules, but insisted that they should be visualized as stiff rods—a concept unacceptable