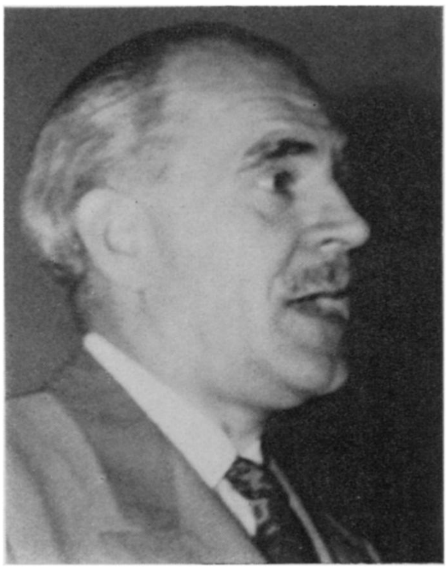
SCIENCE NEWS

OF THE WEEK

Nobelists in physics and chemistry

Bethe

Eigen



Norrish

Porter

The 1967 Nobel Prizes honor discoveries of the stoking mechanisms of stars and the understanding of microsecond chemical reactions.

DR. HANS A. BETHE

The stoking mechanism of stellar furnaces

Work performed nearly 30 years ago on how stars—specifically the sun—burn earned the 1967 Nobel Prize in Physics for Dr. Hans Albrecht Bethe, 61-year-old professor of theoretical physics at Cornell University.

When notified of the award at 6:15 a.m., four hours before the official cable arrived, Dr. Bethe said he did not know he was being considered.

To other physicists, this uncertainty is unthinkable; he should have won it years ago, they contend.

The citation by the Swedish Academy of Science specifically recognizes Dr. Bethe's "contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production of stars." But Dr. Bethe's scientific achievements span several vital fields in modern nuclear physics.

His contributions, besides stellar energy production, include the first theory of electron-positron pair creation and an improved theory of how charged particles interact.

The latter is essential to determining the amount of radiation shielding required by nuclear reactors or by astronauts and equipment in space, as well as in the interpretation of cosmic ray phenomenon and the design of experiments in high energy nuclear physics.

When Dr. Bethe first proposed his carbon cycle theory of sun stoking (SCIENCE NEWS LETTER 12/31/38), carbon was revealed as the transmuting catalyst in the sun which makes it possible for hydrogen atoms to combine into helium, releasing nuclear energy.

From purely mathematical theories on the behavior of atomic nuclei when they are smashed by swift-moving hydrogen nuclei in a thermonuclear furnace like the sun, Dr. Bethe determined that it is possible to explain the whole series of transmutations that occur, consuming the sun's hydrogen while leaving essentially the same amount of carbon.

The protons strike the carbon atoms, changing them into an unstable isotope of nitrogen which quickly disintegrate back into another isotope of carbon—carbon 13. When this isotope is hit by another proton, it changes again into the very ordinary form of nitrogen of atomic weight 14. When a third proton penetrates the nitrogen 14 nucleus, a very uncommon variety of oxygen with atomic weight 15 results. This quickly decays into nitrogen 15.

The fourth and last proton completes the cycle. When it is captured by the nitrogen 15, the unstable product splits into two parts, helium 4 and carbon 12. Thus, in a sense, hydrogen is the fuel and helium the ash of stellar furnaces.

The story is told that Dr. Bethe worked out his calculations leading to the carbon cycle theory on a train returning to Ithaca in 1938 after a meeting with astronomers in Washington.

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This story is "not true at all," the soft-spoken, mild-mannered physicist says.

The calculations were made in Ithaca "and took about two months to do." Most scientists would consider that a short time in which to solve a problem that had been puzzling man through the ages—the source of the radiation poured forth so prodigiously by the sun and other stars.

Dr. Bethe's favorite way of spending his leisure time is hiking in the mountains "on vacation every summer and on Sundays if it doesn't rain too much." The Nobelist took advantage of the little free time he did have during World War II to explore the mountains near Los Alamos, N.M., when he worked in and then became chief of the theoretical division of the famous laboratory where the world's first atomic bombs were produced.

It was also at the Los Alamos Laboratory that Dr. Bethe became concerned about the destructive use of atomic fission. He was one of the first members of the Los Alamos Association, many of whose members later joined with others equally concerned to form the Federation of American Scientists.

The FAS was instrumental in placing the control of the development of atomic energy in civilian hands for peacetime uses over the proverbial dead body of the military, which wanted to retain the control it had had during the war.

Dr. Bethe was also one of the group of leading scientists who firmly believed that, to maintain world peace, atomic energy should be under international control in the years immediately following the war when the United States was the only nation with atomic bombs.

Even though he worked out the equations governing the fusion of hydrogen and its isotopes, whether in the sun or in H-bombs, Dr. Bethe consistently opposed suggestions that the U.S. develop a hydrogen bomb—until the outbreak of the Korean conflict.

Until the Soviet Union resumed atmospheric testing of nuclear weapons in 1961, Dr. Bethe opposed all testing. He then modified his stand, but did work effectively for the limited test ban treaty of 1963, and is hoping to see that broadened in the future.

Scientifically, Dr. Bethe says, he is now working on "the problem of the structure of nuclei and the relationship between structure and nuclear properties." (SN: 2/11).

Dr. Bethe was born in Strasbourg, Alsace-Lorraine on July 2, 1906, and was educated at the University of Frankfurt and Munich University, where he received a Ph.D. in physics in 1928. During the first two years of the 1930s he worked with Lord Rutherford at Cambridge University and with Dr. Enrico Fermi in Rome. He then returned to Germany's University of Tübingen as an assistant professor. He was one of the many who fled to the United States when Hitler came to power and is a naturalized citizen.

His wife, the former Rose Ewald whom he married in 1939, is the daughter of one of his professors in Germany. They have two children, Henry and Monica. ◆

EIGEN, NORRISH, PORTER

Defining sections of the chemical blur

Until two decades ago, chemists had to content themselves with the study of reactions that take a second or more to take place. Anything that happened faster was just a blur.

They lived with it, but they weren't happy. Reaction rates in chemical processes are vital to understanding of the processes, and the inability to understand fast chemical reactions was an imposing gap.

For bridging this gap three chemists won the Nobel Prize last week.

Techniques which Dr. George Porter, one of the new Nobelists, likens to flash photography, allow chemists to measure the reaction time of processes that take a billionth of a second.

Knowledge gained from the work of Dr. Porter and his fellow Englishman Dr. Ronald G. W. Norrish, and of German chemist Dr. Manfred Eigen is so widely applicable that chemists consulted on the significance of the techniques developed by the three Nobelists were reluctant to pinpoint any one or two. They range from the study of enzymes to some very fast reactions of water, and from the formation of new plastics to nosecone reentry.

Drs. Norrish and Porter, working together after World War II, found that some reactions could be timed by shining a very high-energy flash of light into the chemical to be tested. Chlorine gas for instance, normally is a molecule with two chlorine atoms, but sometimes free chlorine atoms can exist, briefly, individually. An intense flash of light creates a large number of such free atoms, and the rate at which they recombine in pairs can be measured electronically. So the reaction time of chlorine combination can be known.

"In classical chemistry," says Dr. Richard L. Wolfgang of Yale, "you mix reagents and watch the change progress. But many reagents (such as free chlorine atoms) you can't take off the shelf. What Norrish and Porter did was make these reagents right on the spot, and then time their reactions."

Dr. Eigen's work, developed in the mid-1950s, was concerned with fast reactions of molecules in their normal state, rather than the excited free atoms and radicals which Drs. Norrish and Porter studied.

In a chemical reaction, the process usually is reversible: reactants go to products, and some of the products change back to reactants. The proportion of reactants and products under given conditions is called the equilibrium constant.

Dr. Eigen found that he could change the equilibrium constant by suddenly increasing the temperature or pressure of the material. When this happens, some of the reactants change to products in order to reach the new equilibrium point. The time it takes to reach that new point can be measured electronically, so the rate at which the reaction takes place is determined.

In both techniques, the problem was not so much detecting chemicals that exist only for a very short time. Often, one chemical is colored differently from another, and most of them can be distinguished by the way they absorb different kinds of radiation.

The problem rested in the need to know when to start timing the reaction. In the Norrish-Porter technique, known as flash photolysis, the reagents were created on the spot and at the instant the timing process started. In Eigen's process, called relaxation technique, the timing started when the equilibrium was upset and further chemical action was stimulated.

Out of the whole new world of research opened up by the fast reaction techniques, a few of the practical applications include:

- Increased knowledge of body chemistry, including particularly the action of enzymes to carry out biological functions such as growth, digestion and temperature regulation;
- Development of new plastics, which depend on complex reactions to form cross-linking of long molecules;
- Design of nosecones to resist the action of the atmosphere on various materials;
- Development of more practical, light-weight batteries for auto propulsion. ◆

Dr. Manfred Eigen

Dr. Manfred Eigen likes to ski and climb mountains. But his major interest outside the laboratory is music. He plays the piano expertly and especially enjoys chamber music.

His love for music, however, has never seduced him from his laboratory, where he earned the Nobel Prize in Chemistry. Dr. Eigen, with his two fellow Laureates, sought a solution for measuring the rate of fast reactions.

Born in Bochum, Germany, on May 9, 1927, Dr. Eigen studied physics and chemistry in the local gymnasium. He then entered Göttingen University. He received his doctorate in 1951 from the Georg-August University in Göttingen and was an assistant at the Institute for Physical Chemistry at the university from 1951 to 1952. He became research associate at the Max-Planck Institute for Physical Chemistry in 1953, its director in 1964. He is now its chairman.

Winner of many awards, including the Bodenstein Award of the Bunsen Society and the Otto-Hahn Award for Chemistry and Physics, he has also received two awards from the American Chemical Society. On Dec. 2 he will receive the second Pauling Medal of the American Chemical Society's Puget Sound and Oregon Sections.

Nobelist Dr. Linus Pauling was the medal's first winner.

Dr. Eigen has lectured in universities in the United States and has been named honorary doctor of science at Harvard University, Washington University in St. Louis, Mo., and the University of Chicago.

More recently his interests have turned to molecular biology, in which area he is applying the methods he devised in his research on fast reaction.

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Dr. Ronald G. W. Norrish

Dr. Ronald G. W. Norrish, although retired in 1963, continues to be active as professor emeritus at the University of Cambridge where he has spent most of his academic life.

Dr. Norrish, who has spent much of physical chemistry and director of the department of physical chemistry for almost 30 years. He did his prize-winning work between 1946 and 1952.

He has received many honors and awards, including an honorary doctorate from the University of Paris and two more honorary doctorates from Leeds University and Sheffield University.

Dr. Norrish, who has spent much of the past two years in traveling in the Soviet Union, Canada and the United States, looks forward to more traveling.

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Dr. George Porter

Sailing is the favorite sport of Dr. George Porter whose research with his former teacher (Dr. Norrish) led him to be named one of the winners of the Nobel Prize in Chemistry.

Born in Satainforth, Yorkshire, in 1920, Dr. Porter first studied at the University of Leeds where he received his bachelor of science degree in 1941. He then went on to Cambridge University after service in World War II, obtaining his doctorate in 1949.

Dr. Porter was assistant director of the department of physical chemistry at Cambridge from 1952 to 1954. He then moved to the University of Sheffield as professor of physical chemistry.

He became a fellow of the Royal Society in 1960 and is now director of the Royal Institution in London which devotes itself to furthering scientific knowledge by research and public lectures.

He is the author of the book "Chemistry for the Modern World," published in 1962, and editor of a two-volume study, "Progress in Reaction Kinetics."

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LSD

Broken chromosomes: more evidence

Last spring Dr. Maimon Cohen of Buffalo's Children's Hospital supplied ammunition to scientists warning of dangers from LSD when he reported that if the hallucinatory drug is added to cultures of white blood cells, an abnormally high number of chromosomes in the cells break—which could, if common to other cells, fracture heredity. His findings were backed by Oregon researchers who found a high incidence of chromosomal breakage in white cells in the blood of LSD users (SN: 6/3).

To support his in vitro experiments with human trials, Dr. Cohen collaborated with Dr. Kurt Hirschhorn of New York's Mount Sinai Hospital to study the effects of LSD in 18 adult users and four children exposed to LSD before birth. Their results, which are expected to appear within a few weeks in the NEW ENGLAND JOURNAL OF MEDICINE, were reported last month to a New York Academy of Sciences meeting on pharmacogenetics.

Chromosomal breakage in white cells first was measured in 12 drug-free controls who showed an average breakage of 3.8 percent. But the 18 adults who had taken LSD showed an average breakage of 13.2 percent, Dr. Hirschhorn says, with individual ranges between 5.3 and 25.1 percent damage. Of the four children, two, whose mothers had taken only low doses of LSD while pregnant, showed no significant abnormalities but in the other two, whose mothers were heavy LSD-users, breakage was about 13 percent.

Hints from early reports that LSD might cause genetic abnormalities, lead to leukemia or trigger an autoimmune disease in which the body destroys its own tissues, prompted a number of researchers to study LSD. Among them are three California scientists who moved into the field after Dr. Cohen's initial report of in vitro damage and before his most recent work with Dr. Hirschhorn was completed. In the Oct. 27 issue of SCIENCE, in a report that was admittedly hurried and inconclusive, Drs. William D. Loughman, Thornton W. Sargent and David M. Israelstam of the University of California at Berkeley, challenge the relevancy of Dr. Cohen's test tube studies on the basis of their own experiments on eight hippies who were clients of a San Francisco welfare agency. In a study that was run, they say, "quickly because subjects were available," they found no chromosomal abnormalities in white cells of the subjects who had taken large amounts of LSD.

In some cases, among the subjects they studied, the LSD was taken alone; in others it was taken in combination with other drugs, including mescaline and DMT or dimethyltriptamine. Because of the speed with which the work was done, however, some effects might have gone undetected.

In Dr. Cohen's test tubes, they say, pure LSD was applied to dividing white cells and extraneous influences were controlled. Extrapolation of these results to humans is risky because circulating blood cells normally do not undergo cell division and because a variety of unknown quantities, including the effects of other drugs and factors of metabolism, may be at work. So far, they have not seen the results of Drs. Cohen and Hirschhorn's human experiments.

In spite of strong evidence that LSD does cause chromosomal abnormalities, none of the scientists studying the drug is prepared to make any definitive statement about what the chromosomal breakage means. "Even within our group of 18 subjects, there was a wide spectrum of degree of damage," Dr. Cohen says, "because everyone does not react to a drug in the same way." According to Dr. Loughman, "there is enough conflicting evidence to make a thoughtful man cautious about making pronouncements." Carefully controlled animal work and in vivo tests of other types of human cells—perhaps from bone marrow or connective tissue—are needed to positively establish LSD's effects. Such studies have not been done; nor are they known to be planned at this time.

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