Manfred Eigen

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OBITUARIES

Manfred Eigen

German Nobel laureate Manfred Eigen, who made towering contributions to chemical physics, biophysics, and molecular evolution, died in Göttingen, Germany, on 6 February 2019.

Eigen was born on 9 May 1927 in Bochum, Germany. His formal studies were interrupted by World War II. In 1942, at age 15, he was drafted into the German air force. Toward the end of the war, he was taken prisoner by the Allies but managed to escape and return home on foot, walking nearly 1000 km. He resumed his education at the University of Göttingen when the institution reopened its doors after the war. Eigen enrolled in geophysics, not his first choice but the closest match given the scarcity of available slots. Werner Heisenberg was one of his professors. Eigen earned a doctorate in 1951 under the tutelage of Arnold Eucken with a dissertation on the specific heat of aqueous electrolyte solutions and heavy water.

Eigen then took a research post at the Max Planck Institute for Physical Chemistry, which had recently been established in Göttingen. He conducted research into such topics as proton-transfer reactions in ice crystals, thermal conductivity, sound absorption, and reactions of metal-ion complexes. He also learned that certain chemical reactions were deemed "immeasurably fast," a description he found particularly disturbing. Unsatisfied, he took up the challenge of determining the rates of such elusive processes, an effort that proved most rewarding.

In the early 1960s, Eigen's career took a meteoric rise when he demonstrated how to measure ultrafast chemical reactions that occur on submicrosecond and even nanosecond time scales. Those reactions were deemed unmeasurable because the time scales were shorter than the times required for the reactants to be fully mixed. Particularly opaque were proton-transfer reactions in aqueous media, which are ubiquitous in biochemical processes. In a brilliant turn, Eigen let the reaction reach equilibrium, perturbed that state with an ultrafast sonic or light pulse, and spectroscopically monitored the system's relaxation back to equilibrium. The relaxation parameters provided the necessary information to obtain the reaction rates and even provided mechanistic insights on how the reactions took place.

In 1964 Eigen presented his research at the Faraday Society in London and achieved instant fame as one of the foremost experimentalists of his day. That same year he became head of the Max Planck Institute in Göttingen, which would later become the Max Planck Institute for Biophysical Chemistry. In 1967 Eigen shared the Nobel Prize in Chemistry with Ronald Norrish and George Porter for his work on ultrafast reaction measurements.

Eigen's research in the 1970s took a different direction: He became more involved in the field of molecular evolution. He built a kinetic scheme known as a hypercycle that he believed would capture the essential features of self-organization in prebiotic systems at molecular scales and would contribute to a cogent explanation for the emergence of biological information. Novel concepts like quasispecies arose from such forays.

In 1971 Eigen posed an information-theoretic paradox that still stands today: Without editing enzymes, the size of a replicating molecule is limited, since otherwise an error catastrophe would arise from accrued mutations over generations. Yet for a replicating molecule to encode editing enzymes, it must be substantially larger than that limit. That line of work proved inspirational to a generation of researchers, including 2018 Nobel laureate Frances Arnold, who tested Darwinian scenarios at the molecular level. It also fostered multidisciplinary efforts that became the hallmark of the Max Planck Institute under Eigen's leadership.

With a Nobel Prize to his name, Eigen became an icon of postwar German science and a key player in the restoration of its former glory. Predictably, he was a commanding figure in the German scientific establishment. In 1971 the Max Planck Society created—essentially for him—the Institute for Biophysical Chemistry. Although he personally supervised its foundational work, Eigen eventually turned down the post of permanent director and instead headed the institute's department of biochemical kinetics until his retirement in 1995.

Eigen was a great communicator. Akin to his beloved Wolfgang Amadeus Mozart, Eigen had a style marked by clarity and rigor. He published three books aimed at a general audience: *Laws of the Game: How the Principles of Nature Govern Chance* (1981), *Steps Towards Life: A Perspective on Evolution* (1992), and *From Strange Simplicity to Complex Familiarity: A Treatise on Matter, Information, Life and Thought* (2013). He and his scientific partner Ruthild Winkler-Oswatitsch, who eventually became his second wife, collaborated on those popular accounts.

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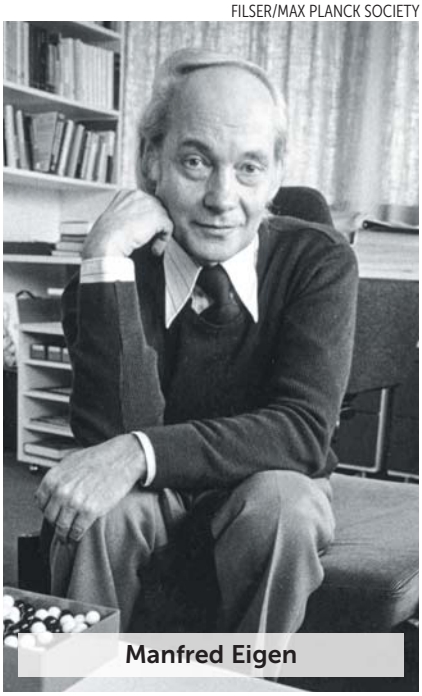

Manfred Eigen

Eigen was inspirational and humorous, with a sense of irony. As a former senior researcher in his division at the Max Planck Institute, I recall once giving a complicated mathematical presentation on a scenario for the origin of biological information, with Eigen and his group in full attendance. As my derivations were getting more and more convoluted, Eigen politely interrupted me and said, "Ariel, if you want to go to Stockholm, never get past the linear approximation."

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