# Biography of Arnim Henglein†

Arnim Henglein was born in 1926 in Cologne, but grew up mainly in Karlsruhe, where his father, Friedrich August Henglein, was a Professor of Chemical Technology. During his teenage years, Arnim became interested in science, because of the enchanting lectures given by Professor Götz, his high school physics teacher. He became an amateur short-wave radio enthusiast, which supplied him with many skills that would later be useful in his scientific career. The chemical environment in which he grew up strongly affected Arnim's choice in becoming a physical chemist. His father was a good friend of Hermann Staudinger, and by listening to their conversations as a teenager, Arnim received a good introduction to polymer chemistry. Sometimes the two friends discussed colloid chemistry, Straudinger setting a high value on the separation of colloid chemistry from macromolecular chemistry. These discussions aroused the curiosity of the young Henglein, who would become deeply involved in colloid chemistry in later years.

Arnim formally studied chemistry at Karlsruhe, obtaining the degree of Dipl. Chem. in 1949. During a three month stay in the laboratory of Professor Paul Günther (who was the successor of Nernst in Berlin until he moved to Karlsruhe), he made an interesting observation, the fact that water containing xenon emits a strong luminescence when exposed to ultrasound. This luminescence has subsequently been investigated in many laboratories around the world over the last 40 years.

At the end of 1949, Arnim was accepted as a doctoral fellow in the nuclear physics department of the famous Otto-Hahn Institut für Chemie in Mainz. He worked on mass spectroscopy under the supervision of Prof. Joseph Mattauch and Heinz Ewald and obtained his doctor's degree at Mainz University in 1951. After working for two more years in mass spectroscopy, Arnim became a physicist at Farbenfabriken Bayer in Wuppertal-Elberfeld, where he was involved in research on insecticides, radiation chemistry, and sonolytical degradation of polymers. In 1954 (102), he observed for the first time the polymerization of a monomer (acrylamide) in the solid state. Solid-state polymerization later became a popular field of research in many laboratories. In 1955, Arnim left Bayer to become first an Assistant and then later Privatdozent at the Institute for Physical and Colloid Chemistry at Köln University. In his dissertation for habilitation, he investigated various reactions of the macroradicals that are formed in the mechanical degradation of polymers (57−59). He also continued $\gamma$-radiation chemical studies in Köln and introduced tetranitromethane as a quantitative reagent for reducing free radicals (109). This method was later used in various laboratories, for example, by Max Matheson and Joseph Rabani at Argonne National Laboratory to determine the absorption coefficient of the hydrated electron and, more recently, by Dan Meisel to determine the number of electrons emitted in the irradiation of silica nanoparticles in solution (388).

In 1958, Arnim left Köln University to become a Fellow in the Radiation Laboratory at the Mellon Institute in Pittsburgh. He enjoyed research work and many discussions with Robert H. Schuler in the friendly atmosphere of the laboratory. In 1961, he become Professor of Physical Chemistry at the Technical University of Berlin and Director of Research at the Hahn-Meitner Institut, a federal research establishment in Berlin. His research developed into two main directions: using mass spectrometry in studies of the dynamics of chemical reactions and using pulse radiolysis in studies of fast reactions in solution.

In 1962, he discovered for the first time "stripping" reactions, that is, chemical reactions that occur impulsively even at room temperature, without the formation of an intermediate complex that decays isotropically (14). The stripping mechanism was later employed in various laboratories to describe the dynamics of alkali atom−halide reactions and other processes. Some reactions were shown by Henglein and co-workers to occur through a complex at low translational energies and via stripping at higher energies (36). In the pulse radiolysis studies, he developed with the late Gerhard Beck sensitive time-resolved conductivity methods (162) and with Jochen Lilie and Michael Grätzel the polarography of short-lived free radicals on a tiny mercury drop (211). He used pulse radiolysis not only as a tool in radiation chemistry but also to shed light on complex reaction mechanisms. Typical examples are the redox behavior of nitrous gases (198), which later became of interest in atmospheric chemistry, and the kinetics of the iodine−starch reaction (210).

During a sabbatical stay in 1979 at the Radiation Laboratory of Notre Dame University, Arnim started the first experiments on the interaction of short-lived free radicals with colloid particles in solution. He generated 1-hydroxyalkyl radicals in an aqueous solution of silver particles and observed the formation of hydrogen. The radicals transferred electrons to the particles. Up to several hundred electrons could be stored on a single colloid particle, which thus acted as a "nanocathode" with a sufficiently negative potential to reduce water. The stored electrons could also be used to reduce dissolved substances. When the paper was first submitted to a journal, it was rejected by the referees and the editor, who did not believe that such a large number of excess electrons could be stored on a nanoparticle in solution. Fortunately, the referees of *The Journal of Physical Chemistry* were more receptive (261), and Arnim's experiment opened up the field of catalysis of unusual free radical reactions by colloid particles, as well as the synthesis and modification of colloid particles using the electron pool effect. His laboratory became more and more a place for the investigation of the electronic properties of colloid nanoparticles and subnanometer-sized clusters of metals and semiconductors. Typical topics of investigation were size quantization effects in semiconductors, the photochemistry and photophysics of nanoparticles, and the reactivity of atoms and oligomers of metals in unusual valence states. Henglein's laboratory was one of the nuclei for nanoresearch, which has become one of the fastest growing areas in physical chemistry in the past two decades. A number of students, postdocs, and collaborators have emerged from Arnim's laboratory, who are now the leaders in this field of research.

In the 1980s, Henglein resumed his sonochemical studies, particularly in collaboration with Edwin J. Hart, the former head of the radiation chemical group at Argonne National Laboratory. On the basis of their knowledge about the elementary processes in radiation chemistry, Henglein and Hart were able to elucidate

† Numbers in parentheses refer to the "List of Publications of Arnim Henglein".

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the mechanism of many processes in cavitation chemistry (92). Thus, the Hahn-Meitner Institut became a place where radiation and sonochemical studies could be carried out in a parallel manner.

He spent the last few years of his career (1998−2000) in the Radiation Laboratory of the University of Notre Dame, where he enjoyed collaborations with faculty in both the Radiation Laboratory and the Department of Chemistry and Biochemistry.

Arnim Henglein was an active referee and teacher. He served on the editorial boards of *Die Makromolekulare Chemie* (1960−1992), *The Journal of Physical Chemistry* (1991−1995), *International Journal of Chemical Kinetics* (1983−1985), *International Journal of Radiation Physics and Chemistry* (1969−1982), and *Ultrasonics-Sonochemistry* (1994−present), as well as on several academic committees in Germany and abroad. He was Visiting Professor at the Mellon Institute, Pittsburgh, Pennsylvania (1961, 1962, and 1963, 3 months each), Kyoto University, Japan (1972, 3 months), University of Florida, Gainesville, Florida (1972, 2 months), Université de Paris Sud at Orsay, France (1978, 2 months), Ecole Polytechnique de Lausanne (1979, 3 months), and University of Notre Dame, Notre Dame, Indiana (1979/1980, 1 year, and 1993, Reilly Lecturer). After his retirement in 1994, he taught at various places, Georgia Institute of Technology, Atlanta, Georgia (Eminent Professor, 1995, 3 months), University of Utrecht, Netherlands (Donders Chair, 1996, 3 months), and Université Libre de Bruxelles, Belgium (2 months), and carried out research at Clarkson University, Potsdam, New York (1997, 1 year), and at Argonne National Laboratory (1998, 4 months). He was awarded the J. J. Weiss medal of the Association of Radiation Research, London, 1978, and the Golden Heyrovsky medal of the Czechoslovakian Academy of Sciences at Prague, 1988.

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