Angewandte 50 Years International Edition Chemie

## Jürgen Sauer (1931–2011)

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Jürgen Sauer, the first professor of chemistry at the University of Regensburg, is scientifically known for his significant insights into the Diels–Alder reaction and for journeys into the realm of short-lived intermediates.

Jürgen Sauer was born on June 11, 1931 in Halle (Saale) as the son of the economist Dr. Hans Sauer and his wife Thea. His mother went blind, which taught the children to take on responsibility at an early age. His outstanding *Abitur* grade of 1.0 (1950) earned Jürgen Sauer a scholarship from the Bavarian Fund for Highly Gifted, which allowed him to study chemistry at the Ludwig-Maximilians-Universität (LMU) München.

His doctoral thesis, the work on which was carried out in the laboratories of the author, dealt with "*Nucleophilic Substitutions via Arynes*"; the discovery that liberation of arynes (dehydroaromatics) from ArHal with lithium piperidide is more rapid than with the more basic phenyllithium[1] is still practiced today. In postdoctoral studies, he contributed to the total synthesis of chlorophyll with Robert B. Woodward (who was legendary even then) at Harvard University; the use of a thioaldehyde group allowed him to achieve an important step in the synthesis.

Back in Munich, Sauer chose "*Kinetics and Mechanism of the Diels–Alder Reaction*" for his *Habilitation* topic. Maleic anhydride acted as standard for comparing the rate constants of 1,3-dienes, while the reactivity of the dienophiles was determined versus cyclopentadiene and 9,10-dimethylanthracene.[2] Tetracyanoethylene (TCNE) and 1,2,4-triazoline-3,5-diones were several orders of magnitude faster than maleic anhydride.

In 1968, Sauer was called as professor and dean of science (1968–1970) to the newly founded University of Regensburg. The arrival of further colleagues meant that the planning of construction and teaching was spread over more shoulders. The first chemistry students were taught in a provisional building in 1972, and in 1975 the new laboratories were ready. The second organic chemist at Regensburg (1971), Gottfried Märkl, had gained experience in Würzburg. The book "*Integriertes Organisches Praktikum*" by S. Hünig, G. Märkl, and J. Sauer, was published in 1979.

The reaction of electron-rich 1,3-dienes with electron-poor dienophiles corresponds to the "Alder rule". In 1962, Sauer developed the counterpart, the "Diels–Alder reaction with inverse electron requirement", that is, the formation of six-membered rings from electron-poor 1,3-dienes with electron-rich dienophiles.[3] Here, 1,2,4,5-tetrazine-3,6-dicarboxylic acid ester acted as the standard diene, and for the activity of the dienophiles the sequence was observed: enamines > vinyl ethers > ethylene > styrene > acrylic esters. A stereospecificity of more than 99.98% was observed for the reaction of cyclopentadiene with maleic acid dimethyl ester, suggesting a concerted cycloaddition. Treatment of Diels–Alder reactivity with MO perturbation theory shows that the single-step concerted mechanism can also accommodate the very large substituent effect (with R. Sustmann[4]).

Short-lived intermediates were a favored research topic in the post-war years. Sauer's fine contribution involved the formation of benzoylnitrene, Ph–C(O)–N, in the photolysis of benzazide and in two new thermal reactions. Its generation in 2-methylbutane led to the insertion of the nitrene into the *tert-* > *sec-* > *prim*-C–H bond; the product ratios were independent of the nitrene generator, which indicates the occurrence of a common intermediate.[5] Oxidation of N-aminoheterocycles led to aminonitrenes (RR′N–N), which could be trapped with styrene as (1+2)-cycloadducts.[6]

Reactions of substituted 1,2,4,5-tetrazines with cyclopropenes led upon liberation of $N_2$ to 3,4-diazanorcaradienes, which equilibrate with 3,4-diazacycloheptatrienes upon warming. Using this method, homotropilidenes, semibullvalenes, and other fluxional structures were accessible. The still-young $^1$H NMR spectroscopic analysis was used to establish the valence-tautomeric equilibria. Azomethyne ylides were also prepared on this fertile "playing ground" and subjected to cycloadditions.

Even during his early years as a teaching assistant, Jürgen Sauer carried out his duties with enthusiasm and didactic skill. His charisma as an academic teacher and researcher gained him as many as 105 doctorate students, and 204 publications arose from the rich scientific harvest. Invitations for guest professorships to the Universities of New Mexico (Las Cruces, 1976), California (Santa Cruz, 1982), and Colorado (Boulder, 1986) indicate his reputation in the scientific community. When Sauer was made the benefactor of a substantial inheritance, he started a trust in 2000 from which the revenue was and is used to award very good chemistry exams in Regensburg.

For many years, Sauer was co-editor of *Chemische Berichte* and *Cheminform*; he was a referee for the German Research Foundation (DFG) for ten years. His bibliography contains many contributions on teaching.

The joint work of the author and Jürgen Sauer at the Munich institute was associated with mutual appreciation, which developed into a continuing friendship. J. Sauer had been married to Thea, née Niklas, since 1958; the happy marriage gave rise to the children Maria, Georg, and Monika. The Sauer family lived in Sinzing near Regensburg. The families were also involved in this friendship. The

passing of Thea Sauer and Trudl Huisgen in 2005 was a stroke of fate for both of us.

Sauer attained emeritus status in 1999. His last journey from Sinzing to Munich was in 2007, when the Faculty of Chemistry of the LMU renewed Sauer's doctorate after 50 years of very good research; his former doctoral supervisor delivered the laudation.

For Jürgen Sauer, the last year was overshadowed by illness. His self-discipline and his strong faith held him from complaining; on March 10, 2011 he passed away in his eightieth year. The memories remain of a man who took his mission in teaching and research seriously and who modeled his life in an exemplary fashion.

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DOI: 10.1002/anie.201104885

  