

Manfred Eigen

Scientist and Musician

by

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His name is synonymous with relaxation methods, molecular self-organisation and the origin of information – and with piano music. The latter was perhaps the first influence to leave its mark on the life of Manfred Eigen, born in Bochum sixty years ago on the ninth of May. He grew up in a musical home and, not surprisingly, began to play the piano at the age of six. But after three years the pleasure began to wane, and he admitted as much to his father, who was a cellist in the Bochum Symphony Orchestra. Wisely, the father conceded his son's wish, but two conditions were imposed: the boy must give up the piano entirely (just tinkling around would not be tolerated!) and the time no longer spent in practising was to be devoted to serious occupations. Initially, these conditions caused the lad no difficulties. But the joys of music had a firmer grip on him than he had realised when making the agreement with his father. Chamber music evenings were a regular event at home, so that the young Manfred Eigen did not just see great artists on the concert and operatic stage – he met them and was introduced to them in his home surroundings. He felt again the call of the piano. The result of secret practis-

ing he presented to his father by suggesting, as a birthday surprise, that they should play Schubert's Arpeggio Sonata together as a duet. The father, impressed by his son's obvious autodidactic ability, sent him to a first-rate teacher. Manfred Eigen took up the piano with even greater dedication than before, and gave public performances including piano concerti by J.C. Bach, Haydn and Dittersdorf.

These childhood years were of decisive importance in their influence upon the later life of Manfred Eigen. Two or three times every week he would accompany his mother to the theatre. The Stadttheater Bochum was directed by Saladin Schmitt and was regarded as Germany's finest theatre of the time.

In this way, Manfred Eigen made early acquaintance with the German classics, while his study of Arts subjects at school introduced him to classical Greek. His interest in the humanities was thus awakened through his home and built up during his boyhood. Manfred Eigen is well versed in classical literature. Especially in later years, he has developed a particular predilection for Goethe; he admires above all the poet's fine and incisive gift of observation. He can, with impressive accuracy, give chapter and verse for quotations and *bons mots* – an ability that is a direct consequence

of his earlier, childish thirst for knowledge.

He would discuss zealously with his father his impressions of concert performances. Then as now, he liked Mozart best of all. His father would nod understandingly, and say, "But later on you will like Brahms just as much". He loved the receptions and musical soirées that were so frequent in his home, even though, as a child, he could hardly stay up for more than the arrival of the guests.

This idyll ended harshly and abruptly when Manfred Eigen was wrested from home and school and, along with his entire class, was drafted into war service in an anti-aircraft unit – at the age of fifteen.

The soul-destroying experiences undergone first during training and then as a soldier in the Luftwaffe are, still today, the darkest memories in Manfred Eigen's life. In American captivity, he was able to profit from his self-acquired knowledge of English: the connivance of an army captain and the skilful use of the right rubber stamp gave him and a friend the papers that would secure them right of passage. On his birthday in 1945 the nightmare ended. In poor health, but spurred on by the new-found freedom, he and his friend undertook a two-month-long homeward journey – on foot.

In September 1945, Manfred Eigen matriculated at the University of Göttingen, the first German university to re-open its doors. After a preliminary semester designed to make good the lost years of school, and short excursions into geophysics and astronomy, he became a full-time student of physics. This had been the counsel of Arnold Eucken, then the doyen of physical chemistry, to whom he had turned for advice at the start of his student career. Physical chemistry had also been the subject that had fascinated Manfred Eigen at school. Later, he began his doctoral work with Eucken.

The following episode may serve as a snapshot of Manfred Eigen's period as a pre-doctoral student. His project involved precision measurements of the specific heat of heavy water over a wide range of temperature, with the aim of testing Eucken's theory of the structure of water. Eucken needed experimental data correct to four or five decimal places, which called for the development

of an adiabatic calorimeter. With a highly sensitive resistance thermometer, the rise in temperature could be measured as a function of the heat put into the calorimeter vessel. For reasons of purity and stability, the vessel was made of thick Duran (Pyrex) glass, and the heavy water was sealed in. The measurements were to cover the temperature range 25 to 200 °C, requiring that the vessel withstand a pressure of around 12 atmospheres. Eucken thought that it could take up to ten atmospheres, while his assistant was unwilling to risk more than five. With trembling hands, Eucken gave the heavy water into the care of his student. There were 300 ml of it, produced with the highest degree of purity – for those days an inestimable treasure. (Heavy water was at that time impossible to procure in Germany: its production had been forbidden by the Allied Powers and its purchase was ruled out by the then astronomical prices.) Manfred Eigen started the measurements, and suggested stopping them at 165 °C – the golden mean of the two experts' suggestions. Around 168 °C the vessel disintegrated with an ear-shattering detonation. Everyone rushed into the room, Arnold Eucken loudly lamenting his precious heavy water. He was so angry that his student could not intervene with a single word of explanation. So the pupil, in any case dazed by the shock, kept his silence and, with a bad grace, began to clear up. On the next day, the professor entered the laboratory and greeted him sternly with: "What will become of your doctorate now?" Manfred Eigen replied quietly that he intended to complete the project, with a new calorimeter, just as planned. He thereupon opened the cupboard and handed the astounded Eucken his heavy water, saying "You cannot seriously believe that I would use heavy water in the first experiment!" From then on, professor and student enjoyed a special relationship of trust and confidence.

In Arnold Eucken, Manfred Eigen had found a generous supporter. With the help of his professor, he was able (in spite of university regulations) to turn his diploma thesis, unexamined, into a doctoral one. Thus Manfred Eigen received his doctorate in 1951, at the age of 23. Eucken had died six months previously, and been replaced as supervisor by his junior colleague Ewald Wicke.

The intellectual patronage of his highly regarded teacher has given Manfred Eigen the impetus to support young, talented students. This personal commitment has led him into the presidency of the 'Studienstiftung des Deutschen Volkes'. He has often expressed regret that present-day legal formalities make it impossible to do nearly as much for the free development of young talent as used to be possible. For him, gifted people come first and regulations second, just as was the case in his student days.

In Manfred Eigen's recollection, his student life was a succession of happy and fulfilled years, even though – like all students at that time – he lived in extremely modest circumstances. There was little to eat, but much, of the highest quality, to satisfy intellectual hunger. It was usual not just to attend the lectures of one's own faculty, but also to visit those of others: not only Werner Heisenberg, Max von Laue, Richard W. Pohl and Hans Kopfermann, but also the philosopher Nicolai Hartmann, the physiologist Hermann Rein, the professor of music Rudolf Gerber and, not least, the lectures in jurisprudence by Paul Bockelmann. The theatre, carnival parties, birthdays and similar occasions were universally popular. But most important of all were studies and laboratory work, often late into the night and on week-ends. During this time Manfred Eigen found little time for the piano.

After some years of post-doctoral work, Manfred Eigen had the good fortune to be able to move to the institute of Karl-Friedrich Bonhoeffer, who gave him generous working conditions and whose outstanding personality left its stamp on his scientific attitude. Years before, Manfred Eigen had recognised the problem of extremely rapid reactions in the liquid phase. In Arnold Eucken's textbook these were described as being immeasurably fast. Were they really in principle immeasurable, or were they just immeasurable by the methods then available? He made it his task to resolve this question. First, together with Konrad Tamm and Günther Kurtze, later above all with Leo De Maeyer (who provided expertise in electronics), he combined theory and experiment to develop the now famous relaxation methods, that allowed the observation of chemical reactions in

solution in time ranges down to 10^{-9} seconds. A new field of research had been opened. New lands, in which many discoveries would be made, lay before him.

During this fruitful period of the late fifties and early sixties, Manfred Eigen was able to give more time to piano music. This was furthered by several study periods in Munich in the house of Rudolf Hindemith (the younger brother of Paul Hindemith, living under the pseudonym Hans Lofer), and his wife Maria Hindemith-Landes. In this musical enclave, far from the bustle of the institute, he felt at home, and flourished, in spite of the strict discipline of piano lessons.

Manfred Eigen had by now advanced to the position of director of the independent Department of Chemical Kinetics at the Max Planck Institute for Physical Chemistry. His department soon became the Mecca of the study of rapid reactions. By means of the relaxation methods pioneered there, not only inorganic but also complex organic, enzymic and molecular-biological processes could be dissected down to their elementary steps. Mechanisms of reactions such as acid-base catalysis, ligand substitution in metal complex formation and base pairing in nucleic acids were unravelled, as were enzymic processes, in particular allosteric regulation.

In the meantime, Karl-Friedrich Bonhoeffer had infected Manfred Eigen with his enthusiasm for biology, so that Eigen's own interest moved strongly towards molecular biology, to the processes of regulation and control that make life possible. He was likewise deeply interested in the reactions that lead to the storage of information in the central nervous system.

The award of the Nobel Prize for Chemistry in 1967 meant for Manfred Eigen that his own scientific research and its contribution to that of others had received world-wide recognition.

There followed, however, a short interval of absence from the laboratory, caused by severe illness. He, endured this painful period with self-discipline and good humour.

When his house was built, Manfred Eigen fulfilled a wish inherited from his parental home, by designing it both to be a social meeting-point and to provide a place for house music. Here he

played, and plays, chamber music along with colleagues from his institute.

As might be expected of one in whose nature the explorer is most prominent, Manfred Eigen then turned to a completely new theme: molecular self-organisation and the origin of life. Earlier, while investigating reaction mechanisms of biochemical processes – in particular the regulated catalysis of allosteric enzymes – he had been fascinated again and again by the optimal efficiency and precision of molecular co-operation in biology. His ambition was always to comprehend the ‘miraculous’ and to put it into place in an overall picture. With a purely phenomenological explanation, such as optimal adaption in the Darwinian sense, he could never feel satisfied. Who does the selecting? What is the nature of the driving forces of evolutionary optimisation on the molecular level? These questions burned to be answered. The phenomenon of life, its origin from non-living matter and the evolution of this highly sophisticated molecular machinery became the objects of his undivided attention. With this new emphasis, Manfred Eigen composed a counterpoint to his earlier work. Just as the subject of his research at the beginning was ‘infinitely fast’ reactions, so now it became the ‘infinitely gradual’ reaction of evolution. With his characteristic vision, he had already made this the object of his scientific curiosity at the end of the sixties.

Charles Darwin’s idea of evolution by natural selection was placed on a sound physical basis and applied to molecular systems. This has led to a fundamental change in our conception of Nature, since Eigen succeeded in building a bridge between physics and biology. His creativity in this area has given impetus to research groups throughout the world for nearly two decades.

A brilliant lecturer, Manfred Eigen has mastered the art of conveying to his audience the importance of theoretical biology in understanding the origin of life. He takes pains to point out the relationship between his own conclusions and those from other sciences, and to make each theory fulfil its task – that of leading to new experiments. His smile seldom fails when he is lecturing – the joys and the enthusiasm of his work are to be communicated to, and shared with, his hearers.

Engagements and duties today leave less and less time for his first loves, science and music. Yet, in spite of this, he performs at the piano with a seriousness of purpose that sets him apart from other amateurs. In recent years, Manfred Eigen has repeatedly performed together with renowned ensembles, as soloist in Mozart’s piano concerti, and has often made an musical contribution to conferences. He has also made gramophone records: one with stipend-holders of the ‘Studiens-tiftung des Deutschen Volkes’ and students of the ‘Folkwang-Hochschule’ in Essen, and one with a Basle chamber orchestra under the direction of Paul Sacher.

Paul Sacher is one of his closest friends, and has been for twenty years, since the time when they put their combined efforts into a project designed to bring science and music closer together. The idea was a kind of ‘Music Bauhaus’, within the Max-Planck-Society. Leading scientists and musicians met for regular discussions in the ‘Hinterzartener Kreis’. However, the discussions, already weakened by the chill winds of financial and application-oriented thinking, were fated to die the death of a thousand committees. Manfred Eigen has regretted this greatly. In the meantime, the idea has been realised elsewhere – in the Centre Beaubourg in Paris.

The name of Manfred Eigen is associated by friends and colleagues with the Winter Seminar. His idea was simple: freed from the distractions of the daily scientific nitty-gritty, in a tranquil place in wintery surroundings, he and his co-researchers could ‘take on’ one or two topical scientific themes in a concentrated manner otherwise impossible. During the light hours, the programme consisted of ski-ing: when darkness fell, the science would start. In the course of the evening discussions, current problems would be purposefully worked through, projects concluded and new ones conceived. All in all, Manfred Eigen was in his element, and he enriched the circle with ideas, criticisms and suggestions for the advancement of the scientific work of his co-workers and students. Neither was the human side lacking in these winter meetings. The seminars gave a harmonious interplay between sport and science. The first Winter Seminar in January 1966 was a great success, and

everyone was clear that the institution would become permanent.

Naturally, the Winter Seminar was also subject to evolution in the course of time. It began in the narrowest circle of co-workers, and soon other scientists, from home and abroad, began to come too. Under the general theme 'Molecules, Information and Memory' the Winter Seminar became an established tradition. At first there was just a tentative programme, later an organised one, with speakers invited from all over the world. The basic idea has remained unchanged – the framework and the number of participants have undergone dynamic variation. Manfred Eigen finds a topic from molecular biology and neuroscience, and invites suitable guest speakers. With a sixth sense for originality and scientific quality, he succeeds each time in assembling a programme that is animated by pioneering spirit and by far-sightedness. The Winter Seminar has become a fixed point in the life of Manfred Eigen. He rushes down the pistes and charts tracks through the fresh snows around Klosters with great glee and no less expertise. He follows the scientific discussions with incisive understanding, and enjoys them – not least, the discussions that unfold late in the evening over a carafe of Veltliner.

At the root of his intuitive thinking and his visionary perspicacity lies the art of grasping complexity in terms of its underlying *gestalt*. Only in

this way can the brilliant 'evolution reactor' project be understood: an apparatus inspired by Manfred Eigen's interdisciplinary creativity, in which the process of evolution is accelerated by theoretically based manipulation and which will allow evolution on a laboratory time scale – an evolutive biotechnology. The technical realisation of this project lies in the hands of talented and industrious young research students.

The human picture of Manfred Eigen is incomplete without a reference to his passion for climbing and walking. He loves the mountain scenery. In its solitude and stillness, he can abandon himself to his thoughts and can combine and recombine elements of his scientific experience so as to put together fundamentally new insights and ideas. This intellectual occupation by no means prevents him from seeking and finding interesting or attractive minerals. His rucksack is perpetually full of 'stony' discoveries. By now, Manfred Eigen has become a true collector. His showcase of minerals contains many geological treasures – works of Nature magical in colour and form.

"*A-t-il fortune?*" Napoleon was wont to demand of his generals. *Fortune* is a quality that one either has or does not have. It cannot be learned. Having *fortune* is not the result of good luck, but of intuition and instinct for the importance and solubility of a problem. In science Manfred Eigen has *fortune*.



Relaxation at the Winter Seminar ... From left to right: Ruthild Winkler-Oswatitsch, Eberhard Neumann, Hans-Wolfgang Bellwinkel, Manfred Eigen and (reclining) Günter Maass.



... over a glass of Veltliner at the Winter Seminar: Manfred Eigen and Christopher Longuet-Higgins; in the second row: Gerhild Oswatitsch and Hermann Haken.



By D. Lehmann, Zürich.