

To Manfred Eigen on his 70th birthday

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Manfred Eigen first saw the light of day in Bochum, Westfalia, on May 9th, 1927, as the son of Ernst Eigen and Hedwig Eigen, née Feld. On the day of his birth the sun was located in the zodiac at the coordinates R.A.=3h1m, Dec.=17°8' which is in the constellation *Aries*.

Hier stock ich schon! Wer hilft mir weiter fort?
Here now I'm balked! Who'll put me in accord?

Indeed, I have never caught a star lying; on the other hand, this is not true of astrologists. They claim that Eigen is a *Taurus*. Is this in contradiction to the facts? Well, so much the worse for the facts ...!

At the age of 15 Eigen and his schoolmates were forced to leave their school and homes and were drafted into an anti-aircraft unit. This nightmare lasted until the end of the war in 1945. After his dismissal¹ from an American prisoner-of-war camp Eigen could begin studying physics and mathematics in Göttingen.

Im Anfang war die Tat !
In the beginning was the Deed.

His first scientific research concerned the analysis of the association structure of water, carried out with Arnold Eucken as his mentor. Eucken was so deeply impressed with Eigen's research that he accepted the

work as a Ph.D. thesis, bypassing the requirements for a master's degree. This was a highly unorthodox procedure for a German university!

In the following years - together with Kurtze and Tamm - Eigen studied the absorption of ultrasonic energy in electrolyte solutions. These investigations were especially influential on his later research. They led him to the bold idea to resolve the time course of the neutralization reaction in water. Until then, this reaction had been considered to be "immeasurably fast".²

This research was carried out successfully after Eigen joined the Max-Planck-Institut für physikalische Chemie in Göttingen. At that time the highly esteemed physical chemist Karl Friedrich Bonhoeffer was the scientific head and director of the institute.

Eigen realized not only *one* but *several* different 'relaxation methods' for studying very rapid reactions with characteristic reaction times extending down to nanoseconds. He was accompanied by brilliant 'combatants', e.g. Leo de Maeyer. In 1967 Eigen's work on relaxation kinetics was honored with the Nobel Prize for chemistry. He has since received numerous other awards.

Doch will er diese Tat allein so hoch nicht schätzen, so müssen wir es anders übersetzen: Im Anfang war die Kraft!

1 A wealth of interesting details can be found in an article by Ruthild Winkler-Oswatitsch 'Manfred Eigen, Scientist and Musician' (1987) in 'Journal of Biophysical Chemistry'

2 Cf. *Die "unmeßbar" schnellen Reaktionen*, by Manfred Eigen, Ostwalds Klassiker der exakten Naturwissenschaften, Bd. 281, Verlag Harri Deutsch

This deed alone he doesn't prize extremely high, a new translation let us try: In the beginning was the Power!

In the 1970s, based on the epochal elucidation of the genetic code by Watson and Crick in 1954, Eigen had a *vision* of general importance for biology. He reduced the selection principle to a molecular level; the principle of the hypercycle, at first invented in his creative imagination, was discovered; the feedback between the phenotype and the genotype - not inherent in Darwin's principle - leads to the organization of higher complexity, i.e. to *biological* information.

This could only be accomplished by a scientist who has a perspicacious understanding of enzyme kinetics, as well as of the molecular diffusion of polymers in aqueous solutions; it required someone who is well acquainted with the nature of hydrogen bonding -partially defined by electrical forces and partially due to quantum-mechanical interactions - and who is able to integrate non-linear balance equations. It demands a scientist for whom the most abstract of physical disciplines - thermodynamics - is his daily bread. To cut a long story short, a genius with the combined knowledge of a mathematician, physicist, chemist and theoretical biologist is called for.

Wenn ich vom Geiste recht erleuchtet bin, geschrieben steht: Im Anfang war der Sinn!

If I am rightly by the Spirit taught, 'tis written: In the beginning was the Thought.

In 1971, in his publication entitled 'Self-organization of Matter and the Evolution of Biological Macromolecules', a new fundamental biological structure already took shape: the quasi-species. The concept was 'born', but the 'baptism' followed some years later. It establishes the Darwinian 'species' as a distribution of many similar but not identical genotypes with a (more or less hypothetical) median - the 'wild-type'. The quasi-species allows a quantitative evaluation of the interplay between mutation and selection.³ Thus, the 'survival of the fittest' is replaced by a balance equation that is governed by a 'quality factor'. Eigen's theory elucidates the cardinal importance of mutation in biological evolution - it is more important than could be anticipated from qualitative arguments. For future generations, it will presumably be the cornerstone for the transferral of

Darwin's ideas into an exact, quantitative framework - and, moreover, a fundamental extension of his principle. Eigen's theory became a 'germ cell' for many important papers worldwide.

Am Ende steht das Wort!

At the end is the Word!

The theory of 1971 shows, in principle, how life could evolve on our globe. The contributions in this special edition by some of Eigen's young co-workers will bear evidence to the progress that has been made in carrying out evolution experiments in the laboratory. In this context, Eigen is the originator and 'pre-thinker' of a *school* that is devoted to the general field of evolution - yet with its center of gravity in biology. This school allows some parallels to those of Bohr and Sommerfeld in physics in the 1920s. Eigen's "winter seminars" are a meeting place for outstanding scientists from all continents; without any doubt they are a forum where many new scientific ideas originate.

Ende und Anfang eint die Konkordanz!

End and beginning are united by concordance.

It would be an incomplete characterization to portray our 'birthday boy' as only a prominent scientist and researcher. Eigen is no less impressive as an art-loving personage. He is an excellent pianist, verifying his parental heritage; his father was cellist in the Bochum Symphony Orchestra. Some of Manfred Eigen's friends are internationally renowned musicians. Recordings have been made of concerts where Eigen has interpreted Mozart's piano concertos.

His pursuit of the fathomless beauty and appeal of genuine art is comparable to his motivation for acquiring a deeper understanding of the surrounding universe.

Eigen takes a courageous stand on the most urgent questions of our time, more so than many of his colleagues. His book 'Perspektiven der Wissenschaft'⁴ endeavors to find answers 'beyond ideologies or wishful-thinking'. For that, we express our special gratitude.

There is one parameter in which I am definitely ahead of Manfred: my age! I had the privilege of meeting him in Göttingen in the physics lectures of R. Becker, W. Heisenberg and M. v. Laue, and to work in the same institute for several years, and sometimes to

3 Cf. in this connection p.e. later contributions by Peter Schuster

4 Deutsche Verlags-Anstalt, Stuttgart, 2. Aufl. 1989

play chamber music with him in a small group. Not only did our families live in the same 'Max Planck Ghetto', but his son and my daughter also were schoolmates and employed their fantasies in playing common larks. Sometimes, returning home from the institute we both found the time for a scientific discourse. His home was in block n of the residential area, mine in block $n+2$. Once, after wandering peripatetically back and forth, we decided we should not let our families wait any longer. We were somewhat bewildered to find that we had separately but synchronously arrived at two different apartments in our neighborhood, neither one of which belonged to us. The next time we met, the discussion focused on the question: Was it a phase shift modulo 1, or was it an induction from n to $n+1$?

It is a fascinating experience to meet a person who can obviously think more quickly than most people - and yet with utmost precision. Eigen possesses these qualities. Such a person needs a great deal of patience when confronted with a faddy contemporary. Eigen may be startled for a moment, but he will never lose his patience - he will give a fair chance to everybody. Fairness is one of his most lovable characteristics.

To his seventieth birthday we wish Manfred Eigen health and the preservation of his creative powers - and

his humor - in the following decades!

A mysterious cryptogram appeared on the monitor of the writer of these lines just as he located the approaching comet Hale-Bopp in his telescope

$$\text{Manfred Eigen} \rightarrow 2^{1/12} / z(8) \cdot CG^2 / a$$

The suspicion that this might be a message from the Oort's cloud of our solar system seems rather obvious. However, no explanation has been found yet. Undoubtedly, the first factor is related to Manfred's musical gifts. The power $1/12$ is self-evident for any pianist. The symbol ζ could describe an old instrument, located temporally between the zink and the serpent. No question, 8 designates the octave! Concerning the second factor, interpretations diverge. Clearly, α is a dimensionless natural constant, somehow related to relaxation phenomena. Could C stand for California and G for Göttingen? It is claimed that C , G and ζ can be calculated easily via

$$C = -\int_0^\infty e^{-t} \ln t \cdot dt, \quad G = \int_0^1 \arctg(x) / x \cdot dx,$$

$$\zeta(z) = (1 - 2^{1-z} \Gamma(z))^{-1} \int_0^\infty t^{z-1} / (e^t + 1) \cdot dt$$