From Strange Simplicity to Complex Familiarity

The subtitle of the book already provides a hint: this is about the big picture, the scientific understanding of the entire physical world and its principles. In the words of the author, the physical chemist, chemistry Nobel laureate and polymath Manfred Eigen: it is about "the physical nature of information and its role in life processes."

The author begins his treatise with a concise presentation of the physical foundations of the material world. This serves to explain the "strange simplicity" that characterizes present day fundamental physics – the concepts underlying the "simple" fundamental laws by which all basic physical phenomena can be described and explained are in fact quite abstract and far from everyday experience, they appear "strange" to us. By contrast, the material world of chemistry and biology is much more familiar, but at the same time it is extremely complex. The book is devoted to just this transition from simple to complex, from the inanimate to the animate.

The transition already becomes apparent when comparing different levels of organization of matter—while quarks combine with each other according to specific rules to produce a small, defined number of elementary particles, and interactions between protons, neutrons, and electrons result in the just over 100 elements of the periodic table, the number of combinations and possibilities explodes at the molecular level of chemistry. Specifically for the pivotal biological molecules DNA, RNA and proteins, the additional notion of "sequence" comes into play. As one of several alternative monomers (the four nucleotides or 20 amino acids) can be present at each position in these heteropolymers, an incredibly large combinatorial diversity of different polymers of the same length but differing sequence is possible.

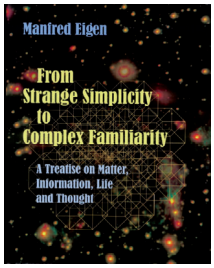
Hence, the probability of generating a specific sequence with "semantic information" by pure chance is vanishingly small, and it is this thought that leads to the central theme of the book: what is information, how can information emerge from a self-organization process, how can it be transmitted, and how preserved? The answer of the author is that ultimately only an evolutionary process—the interplay of replication, mutation and selection—can produce new information. Many of the thoughts and concepts presented in this context can already be found in one of the central publications of Manfred Eigen, the 1971 article "Selforganization of matter and the evolution of biological macromolecules".[1] In a sense, this book provides a modernized and expanded "update" of this work, in which the central ideas of the earlier publication have been embedded within a larger context.

To this end, the author provides a fascinating, 700 page long compilation of some of the most influential scientific theories and concepts of the last century—from the theory of relativity over quantum mechanics to particle physics and cosmology, from Maxwell's demon and Gödel's incompleteness theorem to Turing machines. It contains detailed discussions of the concepts of entropy and information, critical phenomena, cellular automata and self-replicators, and of course the author's own contributions to the theory of molecular evolution, such as the quasi-species concept, the hypercycle and the error threshold. It is worth noting that here an attempt to develop a consistent, all-encompassing physical worldview is not made from the viewpoint of fundamental theoretical physics, but, quite unusually, comes from a scientist who made pioneering contributions to the study of reaction kinetics and evolutionary theory—and this renders the elaborations on self-organization and complexity just much more contentful.

But what makes this book—besides its scientific contents—especially worth reading are the many anecdotes it contains from the long scientific career of the author; he surprises with personal memories of many eminent scientists such as Werner Heisenberg, Mark Kac, Motoo Kimura, Lars Onsager, Norbert Wiener, and even Theodor Kaluza, whose mathematics lectures he attended in Göttingen. What's more, numerous ideas of the book are illustrated with photographs and works of art from the personal collection of the author.

As a caveat one should note at this point that this book is not the easiest to swallow, and it by no means represents a "popular science" account of its theme. Although the author repeatedly states that he attempted to restrict use of "mathematics" to a necessary minimum, the book is still pervaded by many quite sophisticated (and not always easy to understand) mathematical elaborations. For instance, the geometry of high-dimensional spaces is discussed in considerable detail, and the book contains references to differential geometry and Lie groups, information theory and cryptography. An additional mathematical appendix with further explanations of the author also provides a "crash course" in quantum mechanics and a description of the mathematics of Darwinian systems that were contributed by Eigen's former colleagues and companions, Peter Richter and Peter Schuster.

The book therefore is likely to be much more accessible to those with a solid mathematical and physical background—for others, it will certainly be a (worthwhile) challenge. Apart from that "the treatise" decidedly is necessary reading for all



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chemists, physicists and biologists with an interest in fundamental questions of molecular self-organization, evolution and the origin of life, and the transdisciplinary "big picture". Only after reading approximately half of the present book it becomes clear that its all-encompassing scientific program is scheduled to be expanded in a second "biological" volume, which will treat more complex levels of organization in nature: life, thought, culture and—the future. Something we can definitely look forward to.

Friedrich Simmel
Physik-Department E14 und ZNN/WSI
Technische Universität München (Germany)

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[1] M. Eigen, *Naturwissenschaften*, **1971**, *58*(10), 465–523.

