

## About the Author

Entropy formed a central theme of the scientific work of Mikhail Vladimirovich Volkenstein, especially during the last period of his life. Initially, from about 1933 to 1948, his scientific interests lay more in spectroscopy; during this period, his most significant work concerned the intensities of molecular oscillation spectra. In the next period of his life, from around 1948 to 1960, he turned his attention to the new field of macromolecules, becoming one of the most important contributors to the statistical theory of such molecules. In the 1960s and 70s his interests turned naturally to questions from molecular biology and molecular biophysics. It is to him that we owe much of our understanding of biomolecular conformation; in particular, his work shed light on the relations between the chemical structure of polymers and their plastic and elastic properties, and on the reactivity of biomolecules. Towards the end of the 1970s, Mikhail Vladimirovich set out to explore the deep questions of the origin of life, and so began his investigations of the complex of problems linking “entropy, information, and life”. It was at this time that I first met him, in Poland; his personality and his erudition made a profound impression on me. He subsequently attended several of our conferences in Berlin on the theme “Irreversible processes and self-organization”, where he met Ilya Prigogine and became friends with him. I remember clearly the wonderful conversations about science and culture, full of controversy, between these two brilliant polyhistorians, ranging from the dancing god Shiva to African sculpture, carried out now in one language,

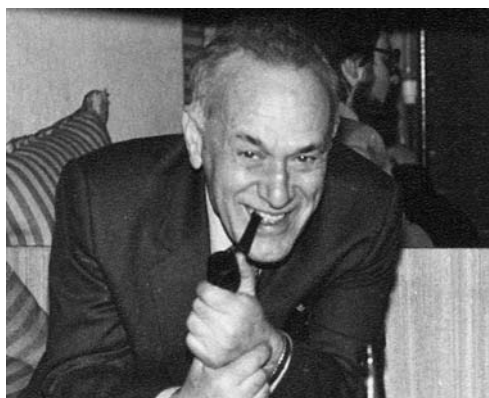


Figure 1: Mikhail Vladimirovich Volkenstein during a visit to Berlin in 1981. (Please note that he was not a heavy smoker.)

now in some other. At that time Mikhail Vladimirovich was profoundly impressed by Manfred Eigen's work on the evolution of biological macromolecules and the origins of biological information, and began corresponding with him. In Moscow, however, Mikhail Vladimirovich was then considered a dissident and not permitted to visit Western countries. I recall how proud he was of a birthday present from Manfred Eigen, a tape of a piano recital performed by Eigen himself. Only towards the end of the 1980s was Mikhail Vladimirovich able to accept invitations from his numerous friends to travel with his wife to the West. I remember in particular his mentioning, apropos of a visit to Spain, how his wife had fought there a half-century earlier on the barricades.

I now turn to the present book, written by Mikhail Vladimirovich in the 1980s. The book is a brilliant essay covering a great many topics, ranging from the early history of thermodynamics to the complexity and value of information. I am certain that the reader will receive great enjoyment from this masterpiece of popular science.

Werner Ebeling  
(Editor of the German translation  
of *Entropy and Information*)

## Translators' note

Our special thanks go to the following: Edwin F. Beschler for arranging publication and checking the typescript, Werner Ebeling for providing a biographical foreword about the author and a photograph of him, and also for correcting the spelling of some names, and Maria Volkenstein, the author's daughter, who, together with Aleksandr Y. Mozdakow and Vladimir Sychev of the publishing house Nauka, helped in obtaining the publication rights. We also thank Marc Herbsttritt of Birkhäuser for handling the publication process so efficiently and amicably, and Nina Iukhoveli for help with Russian. The poetical epigraphs at the beginning of each chapter were originally rhyming; for the sake of accuracy, no attempt was made to produce rhyming English translations (with two exceptions), although we did try for some degree of rhythm. The second translator (Burns) acknowledges with gratitude the assistance of staff members of the departments of mathematics (and statistics) at York University, Toronto, and The University of Queensland, Brisbane.

The footnotes have, with rare exception, been added by the second translator, who takes full responsibility for them.

# Preface

*This is just...entropy,  
he said, thinking that  
this explained everything,  
and he repeated the  
strange word a few times.*

Karel Čapek<sup>1</sup>, “Krakatit”

This “strange word” denotes one of the most basic quantities of the physics of heat phenomena, that is, of thermodynamics. Although the concept of entropy did indeed originate in thermodynamics, it later became clear that it was a more universal concept, of fundamental significance for chemistry and biology, as well as physics.

Although the concept of energy is usually considered more important and easier to grasp, it turns out, as we shall see, that the idea of entropy is just as substantial—and moreover not all that complicated. We can compute or measure the quantity of energy contained in this sheet of paper, and the same is true of its entropy. Furthermore, entropy has remarkable properties. Our galaxy, the solar system, and the biosphere all take their being from entropy, as a result of its transference to the surrounding medium. There is a surprising connection between entropy and information, that is, the total intelligence communicated by a message. All of this is expounded in the present book, thereby conveying information to the reader and decreasing his entropy; but it is up to the reader to decide how valuable this information might be.

The second half of the 20th century is notable for the creation and development of complex areas of science of the greatest importance not only for the natural sciences and technology, but also for the humanities. Such are cybernetics, information theory, and synergetics. Although these terms did not exist fifty years ago<sup>2</sup>, they now turn up constantly. In all three of these disciplines the concepts of entropy and information are absolutely indispensable, so that without them it is not possible to grasp the true essence of modern science. The final chapters of the

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<sup>1</sup>Karel Čapek (1890–1938), Czech playwright and novelist. Inventor of the word “robot” in its present sense, in his play *RUR*.

<sup>2</sup>Note that the original work appeared in 1986. *Trans.*

book contain brief, and of necessity incomplete, expositions of synergetics and information theory. The aim of the present account is to bring these new disciplines to the reader's attention, and introduce him or her to the circle of related ideas.

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