



On Chirality and the Universal Asymmetry: Reflections on Image and Mirror Image

By Georges H. Wagnière

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Until half a century ago, it was assumed that the forces of nature were symmetric and that they did not distinguish between right and left, between image and mirror image. The discovery of the violation of parity in 1956 was more than a sensation, for some it was a shock. It implied that the universe displays handedness, or chirality, and that it is fundamentally asymmetric.

Remarkably, a most striking asymmetry is encountered in the realm of biology. Living organisms contain proteins built almost exclusively from L-amino acids, and nucleic acids derived from D-sugars only. Yet a mirror-image biochemistry, based on D-amino acids and L-sugars is, from a purely chemical standpoint, entirely conceivable. Where, then, does this extraordinary natural selectivity come from? Is it directly, or indirectly, connected to the universal violation of parity?

This book is meant as a brief review of the various manifestations of handedness, or chirality, in the universe. It does not attempt to present a solution to basic questions which perhaps will never be unambiguously and conclusively answered. Rather, it is an excursion through nature, to observe and recognize how the chirality manifests itself at different structural levels. The excursion starts in the chemistry and physics laboratory. Then a journey into outer space and back in time is undertaken. After a return to our planet Earth, the focus is on the development of living organisms.

The text should be accessible to anyone having the equivalent of a first-year university instruction in physics and chemistry. It is also hoped that a layperson with a more modest scientific formation may gain a general impression of the basic asymmetry in nature and of the fundamental significance of chirality. Mathematical expressions, wherever they occur, may then be overlooked. Some more difficult sections may be skipped. A Glossary preceding the Subject Index should be helpful.

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- Sales Rank: #4299629 in Books
- Published on: 2007-07-23
- Original language: English
- Number of items: 1
- Dimensions: 9.50" h x .60" w x 6.70" l, 1.44 pounds
- Binding: Paperback
- 256 pages

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Review

"...accessible, stimulating and beautifully written book that has something for everyone..." (*Chemistry World*, November 2007)

"...informative and readable...I must confess that once I picked up the book I found it hard to put down..." (*Angewandte Chemie, Intern, Edition*, December 2007)

From the Back Cover

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About the Author

Georges H. Wagnière was born in Bern, Switzerland, in 1933. Following undergraduate studies at the Federal Institute of Technology in Zurich, he obtained a Ph.D. in Chemical Physics from Harvard University in the USA. After working for a few years in the chemical industry in Basel, he was appointed assistant professor at the University of Zurich in 1965, and promoted to associate professor in 1969. He became a full professor of physical chemistry in 1978. In the years 1990-92 he acted as dean of the Faculty of Science of the University of Zurich. From 1996-2000 he was president of the board of experts for the Swiss National Research Program on Nanosciences. He has been a visiting scientist at the IBM Research Center in San Jose, California, at the High Magnetic Field Laboratory in Grenoble, France, and an invited lecturer at the University of Lausanne. He retired officially from the University of Zurich in 1999, remaining scientifically active since.

His research interests concern the electronic and optical properties of large molecules, focusing on natural optical activity, magneto-optics, magnetochirality, and nonlinear optics. Beside research papers in chemical and physical journals, ranging from *Helvetica Chimica Acta* to *Physical Review A*, he has published two books, *Introduction to Elementary Molecular Orbital Theory and to Semiempirical Methods* (1976), and *Linear and Nonlinear Optical Properties of Molecules* (1993).

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