Rudolf Janoschek (Ed.)

Chirality

From Weak Bosons to the α-Helix

With 80 Figures, 18 Tables
and 95 Schemes

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Preface

Les hypothèses, n'en déplaise à mon contradicteur, sont l'âme des progrès de la science.

Louis Pasteur

The concept of chirality, established 100 years ago, plays an important role in almost all domains and dimensions of our recent scientific view of life. Chiral properties can be found in fundamental nuclear particles, in molecules, and in the macroscopic world of living nature (plants and animals) and inanimate nature (crystals). In particular, chirality, or more precisely chiral excess, is evident in human beings. For example, the expected symmetry of the hands turns out to be functionally non-existent. Consequently chirality occurs in the technical sphere, where screws are the best-known examples, since most of them are made for right-handed people. Chirality is not confined to static objects but influences processes such as chemical reactions.

The occurrence of chiral objects on different dimensional scales has been treated in the past in mutually independent frameworks. There were, however, two remarkable events from which the conclusion can be drawn that the appearance of chirality in various fields has a common cause. On the one hand, physicists found evidence that the well-known biomolecular homochirality can be traced back to the chirality of weak bosons. At the same time, on the other hand, the so-called thalidomide tragedy occurred when thalidomide molecules of a certain chirality, taken by pregnant women, caused deformed children.

Spectacular events like these are reason enough for a group of authors to compile a survey on important aspects of chirality in a book which comprises topics from nuclear particle physics and various fields of chemistry to pharmacy. The authors agreed that they would not write for specialists in their respective fields of research but for anybody with a sound scientific education.

Although it is chemistry which dominates in this book, chirality is introduced in the chapter of fundamental-particle physics. There are two reasons for this. On the one hand, physicists carefully define the notions that will be applied later. On the other, the chirality of certain fundamental particles seems to be the origin

of biomolecular homochirality as mentioned before. Corresponding theories on the basis of molecular kinetics are introduced in the second chapter. The third chapter deals with the mathematical treatment of molecular chirality. Two crucial experimental methods for the determination of absolute stereochemistry, circular dichroism and anomalous X-ray diffraction, are presented in the fourth and fifth chapters.

The second half of the book is dedicated to the synthesis and separation of enantiomers of chiral chemical compounds. After a general introduction to chiral phenomena in organic chemistry, the main strategies for the production of chiral compounds are reviewed. These are enzymatic catalysis, synthesis using prochiral auxiliary compounds, and catalysis by means of chiral transition-metal complexes. Finally the separation of enantiomers by the technique of liquid chromatography is described. These contributions cover to a large extent the requirements in organic chemistry, biochemistry, and pharmaceutical chemistry. The closing chapter presents a study of biopolymeric structures, in particular the α-helix, which is the final point on our scale of dimensions for chiral objects.

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