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INTRODUCTION

Molecules at the mirror: chirality in chemistry and biophysics

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The international Conference on "Molecules at the Mirror: Chirality in Chemistry and Biophysics" was held at the Accademia dei Lincei, Palazzo Corsini, Rome, 29–30 October 2012. It was organized by the Academicians V. Aquilanti (Perugia), M. Catellani (Parma), V. Schettino (Florence), A. Zecchina (Turin), with the support of the Fondazione Guido Donegani and the auspices of the Italian Chemical Society (SCI).

The theme of the Conference, Molecular Chirality, pervades several areas of pure and applied science. The focus was on a sequence of topics including: (1) the basic *biochemical and physicochemical* aspects regarding structure and transformations of chiral molecules; (2) the *organic and industrial chemistry* of chiral recognition, asymmetric synthesis and heterogeneous catalysis, which are of prime interest for pharmaceutical and materials sciences; (3) the ubiquitous manifestations of *molecular chirality in Nature*, and specifically biological homochirality: most of the molecules found in living organisms have a well-defined handedness, for example all amino acids are left-handed, while sugars are right-handed. Extensive current efforts aiming at clarifying the origin of the phenomenon are relevant to key questions on the evolution of life.

Examples recording the curiosity of mankind about the symmetry relationship between an object and its mirror image can be traced back in arts and science since the birth of civilization.

The nineteenth century witnessed an impressive sequence of investigations, among which we quote here the crucial contributions from three major scientists active in widely separated fields: the mathematical formulation by Moebius, the astonishing discovery by Pasteur of selective "handedness" in matter at the molecular level (notably in biologically occurring substances), and the research on problems from physics by Lord Kelvin. The latter is also responsible for the introduction of the word chirality (from $\chi\varepsilon\acute{\imath}\rho$, Greek for hand), which comprehends a concept that nowadays appears transversally across many disciplines.

In the twentieth century, overwhelming evidence was accumulated that selective chirality governs the organic chemistry of biologically active molecules: familiar examples include the exclusive left handedness of amino acids and the right handedness of natural sugars, electing molecular homochirality as a signature of life at the molecular level. Physicists discovered that chirality acts selectively only when interactions designated as "weak nuclear forces" are operative. Since these forces are traditionally considered irrelevant in chemistry, the fact that biology distinguishes molecules and their mirror images is an intriguing theoretical challenge for the twenty first century—but not the only one: well known are implications

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for pharmaceutical sciences, and in general for applied chemistry. Indeed chirality-related issues involve a large fraction of world's research and industrial budget.

At the Conference general lectures were presented by internationally recognized experts: Laurence D. Barron (Glasgow), Martin Quack (Zurich), Josep M. Ribò (Barcelona), Hans-Ulrich Blaser (Basel), José Antonio Mayoral (Zaragoza), Karl-Michael Weitzel (Marburg), W. J. Buma (Amsterdam) and others.

A series of talks was presented by several colleagues from Italian groups who are currently active on these issues and also involved in interdisciplinary national and European research networks: Luigi Monsù-Scolaro (Messina), Roberto Purrello (Catania), Paolo Lazzeretti (Modena), Roberto Millini (Milan), Gaetano Guerra (Salerno), Vincenzo Barone (Pisa), Claudio Villani (Rome), Marco Bella (Rome) and Walter Cabri (Milan).The sessions have been chaired by Vincenzo Schettino, Antonio Sgamellotti, Maurizio Speranza, Tommaso Prosperi and Domenico Misiti.

Anna Giardini and Vincenzo Aquilanti coordinated the round table discussions, which have seen the active participation of (among others): Sergio Abbate (Brescia), Luciano Caglioti (Università di Roma), Chiara Cappelli (Pisa), Alessandro D'Urso (Catania); Serafino Gladiali (Sassari), Andrea Lombardi (Perugia), Savino Longo (Bari), Susanna Piccirillo (Rome), Tommaso Prosperi (Rome), Antonio Rizzo (Pisa), Francesco Ruffo (Naples), and Stefano Stranges (Rome).

Posters were presented by Maria Elisa Crestoni (Rome); Daniele Catone, S. Turchini, T. Prosperi, N. Zema, G. Contini, V. Feyer, K. C. Prince, M. Stener, P. Nitti and P. Decleva (Rome); Federico Palazzetti, Dock-Chil Che, Keita Kanda, Masaaki Nakamura, Glauciete S. Maciel, Andrea Lombardi, Gaia Grossi, Toshio Kasai, and Vincenzo Aquilanti (Perugia and Osaka); Alessandra Paladini, S. Piccirillo, F. Rondino, M. Satta, A. Ciavardini, A. Casavola, D. Catone, M. Speranza, and A. Giardini (Rome); Yeghis Keheyan (Rome); King-Chuen Lin (Taipei); Roger Anderson (Santa Cruz, California); Dorina Kotoni, Alessia Ciogli, Francesco Gasparrini, Domenico Misiti, Marco Pierini, and Claudio Villani (Rome); Debora Scuderi, P. Maitre, F. Rondino, K. Le Barbu-Debus, V. Lepere, and A. Zehnacker-Rentien (Paris); Elisa Frezza, G. Zanchetta, T. Bellini, and A. Ferrarini (Padova); F. Rondino, S. Piccirillo, A. Filippi, C. Fraschetti, B. Botta, I. D'Acquarica, A. Calcaterra, and M. Speranza (Rome).

Ample space was dedicated to the lively discussion, open to the contributions of participants: particularly encouraging was the involvement of doctoral students and post-docs.

The Springer journal *Rendiconti Lincei* is the publisher of this special issue containing peer-reviewed, selected papers contributed by the participants. Two years ago, a series of 18 papers appeared in this same journal (Lincei 2011) on the occasion of the Lincei Conference in 2010 on Astrochemistry. Included were several articles reporting research on chirality, presenting an updated account on information concerning this topic from the laboratory and from the cosmos. Accordingly, we can claim continuity between that event and the present one, providing the backstage to the topics tackled in the conference, which range from pure and applied chemistry towards biology.

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Reference

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