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INTRODUCTION

Dmitry Mendeleev: 140 years from the presentation of the periodic system

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A symposium dedicated to the periodic system, 140 years after its presentation (1st March 1869), has been organized on 28–29 May 2009 in Palazzo Corsini (Rome) by Accademia Nazionale dei Lincei, with the support of Fondazione Donegani. The symposium was intended to celebrate one of the major discoveries of humanity by the Russian chemist Dmitri Ivanovič Mendeleev.

At that time it had been established that matter was formed by a certain number of elements, linked to each other by a regular progression of properties. As the science of transformation, Chemistry was expected to work out not only classification systems, but also criteria for passing from an element to another one and anticipating its properties. Fundamental to this aim was the concept of periodicity. Mendeleev noted that by ordering the elements known at that time according to their increasing atomic weight certain properties recurred: if elements were placed horizontally along lines corresponding to series (periods), those with similar properties (groups) appeared vertically in columns. It is appropriate to recall at this point that the great Italian chemist Stanislao Cannizzaro offered a fundamental contribution, which was acknowledged by Mendeleev himself. In the following years all the elements (now 118, of which 117 confirmed) were placed into a table where they were ordered no longer according to their atomic weight but according to their atomic number (corresponding to the number of electrons). Two transition series, where elements resemble each other more than in a group, were also included.

This systematization, achieved by Mendeleev incompletely when the electronic theory and quantum mechanics were not yet developed, represents one of the wonders of science because it is both an efficient mnemonic system and a predictive tool. It is sufficient to look at the position of an element in the Table for inferring its relevant properties. Already in its initial formulation the system revealed its extraordinary power in that it allowed to foresee the existence of not yet known elements, which corresponded to empty boxes in the Periodic Table. The predictive power of the system still was at its beginnings, however, and would allow later to foresee essential properties such as electronegativity (which is

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fundamental to account for the formation or cleavage of chemical bonds), magnetism and many other properties. A spectacular advancement occurred when electrons were associated with electromagnetic waves and a breakthrough was achieved by quantum mechanics (1927). A series of important theoretical developments, which cannot be analyzed here, followed. To make a long story short, we can state that the periodic system of the elements more and more revealed itself as a precious guide to chemical properties and reactivity as well as a fundamental support for scientific elaborations. The concept that inspires it is quite general and exerts a profound influence not only on chemical but also on the other disciplines. Thus, biologists are interested in predictive systems of biological properties such as protein ability to fold in a variety of ways, which are very important for life processes. Physicists too are attempting to order the properties of the large number of sub-nuclear particles that have been found until recently.

It turned out that the best way to celebrate the anniversary of the periodic system should include highlighting the creative potential of the periodic system.

The organizing committee, composed of representatives of the disciplines involved [Prof. Abbri (Siena), Ballio (Rome), Balzani (Bologna), Brunori (Rome), Calderazzo (Pisa), Califano (Florence), Carrà (Milan), Chiarotti (Rome), Chiusoli (Parma, coordinator)] planned the contributions as follows: Prof. I. Moiseev (Moscow) celebrated Mendeleev as a scientist, a man, and a citizen, Prof. F. Calderazzo outlined the work of Cannizzaro as a precursor; Prof. S. Califano, S. Carrà, and A. Zecchina (Turin) described the fundamental concepts underpinning the periodic system and talked, respectively, on the concept of atom, from Greek philosophers to the Karlsruhe conference, on the origin of the elements and the birth of chemistry; and on the properties of the transition elements. Prof. L. Cerruti (Turin) gave an epistemological analysis of the pathway toward the periodic system and the competition among different disciplines; Prof. R. J. P. Williams (Oxford) outlined the role of the elements in the life of the Universe; Prof. V. Balzani gave an outlook on the impact of the periodic system on molecular electronics and molecular machines; Prof. I. Bertini (Florence) reported on metal ions in systems biology; Prof. A. Tramontano (Naples) discussed the organization of a Periodic Table of structures and functions of proteins; Prof. H. B. Gray (La Jolla) described electron transfer processes in respiration and photosynthesis; Prof. L. Maiani (Rome) outlined the attempts to systematize the complex world of sub-nuclear particles.

The contributions will appear in successive issues of *Rendiconti Lincei* according to the order of their submission. As a whole, they represent the frontier line of scientific developments related to the periodic system. The discussions that followed each presentation were directed by highly reputed chairmen [Prof. M. Brunori, G. Giacometti (Padua), P. M. Maitlis (Sheffield), F. Minisci (Milan), G. Volpi (Perugia), R. Ugo (Milan)] and offered new perspectives of exciting scientific advancements.