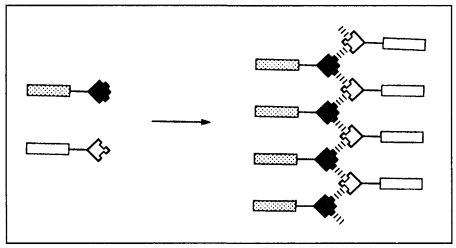
Molecular Collectives

Supramolecular Chemistry. Concepts and Perspectives. JEAN-MARIE LEHN. VCH, New York, 1995. x, 271 pp., illus. $80, DM 128, öS 998, or SFr 128; paper, $39.95, DM 58, öS 452, or SFr 58.

If chemistry is the structure of matter and its transformations, which in a modern sense is the arrangement and rearrangement of atoms in space, then what is supramolecular chemistry? The term "supramolecular," meaning higher in organization than a molecule or composed of many molecules, which first appears formally defined in the *Century Dictionary* 1909 supplement, can be seen as a classical term for an area that has evolved to encompass all intermolecular phenomena and is predicated on the observation that molecular collectives manifest chemistry beyond what can be rationalized in terms of the "molecular entity." The bridge between molecular and supramolecular parallels that between inter- and intramolecular and rests on the basic definition of the chemical bond. Supramolecular chemistry in transcending molecular chemistry crosses the boundaries of chemistry with physics, biology, and information science. Areas as diverse as superconductivity, optical computing, and membrane signal transduction rely on molecular collectives to transfer information and fall within its realm.

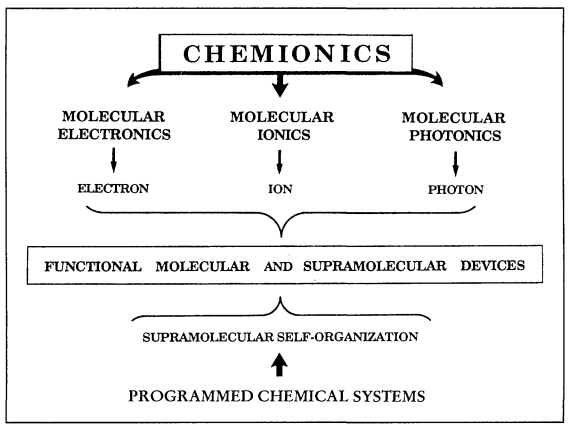
Jean-Marie Lehn, 1987 Nobel Prize winner in chemistry, presents his personal answer to the opening question in the present book. This treatise streams from pre-archean creation to a futuristic molecular brave new world in an anthropomorphic brief history of chemical time. Lehn's perspective on this area compacts most of "supramolecular history" into the first 40% of the book and then gives the bulk of the text (that is, chapters 8 and 9, on molecular and supramolecular devices and on self-processes—programmed supramolecular chemistry) over to the frontiers of the field. In a philosophical finale we see Lehn's personal motivations and aspirations for a field that will long carry his mark. Although the text is terse, at times choppy, and slanted in its examples toward Lehn's own work, it provocatively represents the accomplishments (over 1100 references) and dreams of one of modern chemistry's most productive fields.



"Schematic representation of the formation of an ordered supramolecular strand by the molecular-recognition-induced association of two different molecular units; each unit contains a group that possesses two identical binding sites complementary to those of the other unit." [From *Supramolecular Chemistry*]

Jargon arises quite often in the language of supramolecular chemistry, and precise meanings for trendy terms can be difficult to pin down. Lehn sees this fuzziness as a facilitator of scientific imagination. In the zeal to show the broad-ranging infiltration of the term supramolecular, one can lose sight of the fact that classical concepts à la Pauling or Mislow often suffice. Although creative terminology can be a powerful tool for invention or taxonomy, it is important to remember that there are no special laws of nature for supramolecules.

Lehn gives primary importance to three concepts, fixation, recognition, and coordination, as the foundation of supramoleuclar chemistry and cites contributions of about a century ago from the Germanic chemists Werner, Fischer, and Ehrlich. One could, however, argue that fixation and coordination are gradations of affinity and that affinity and recognition are the essence of Pasteur's 1860 "Researches on the Molecular Asymmetry of Natural Organic Products." Because Pasteur had no bonds to bother him, he saw immediately that there exist chemical phenomena inherent to the molecule and others beholden to ensembles of molecules (that is, supramolecules). This duality was stated clearly in his distinction of chirality in quartz vis-à-vis tartaric acid and in his description of the formation of conglomerates and diastereomeric salts.



"Sets of instructed components endowed with photoactive, electroactive, ionoactive or switching features constitute programmed systems capable of generating functional (photonic, electronic, ionic) supramolecular devices by recognition-directed self-assembly into well defined architectures, patterns and networks possessing novel optical, electrical, ionic, etc. properties. Such components and devices define areas of molecular and supramolecular photonics, electronics and ionics belonging to an intriguing and rather futuristic field of chemistry that may be termed "*chemionics*," the design and operation of programmed systems for information and signal handling at the molecular and supramolecular levels." [From *Supramolecular Chemistry*]

The front end of Lehn's book rapidly surveys molecular recognition, anion coordination, multiple recognition, catalysis, transport, and assemblies. These subjects have been the subject of numerous reviews and books, most of which are cited in the text. For details the reader is best advised to refer to the cited review articles, because the text gives more of a bird's-eye view. This part of the book takes on something of the character of tertiary reference material, even though primary works are abstracted and cited. Some significant Lehn insights that make it clear why he has been a leader in this area are included among the examples.

An intense concern with chemical semiotics characterizes Lehn's present research pursuits, and this comes through strongly in the discussion of molecular devices and programmed supramolecular systems. The design and development of molecular photonics, electronics, ionics, and other such ramifications of the supramolecular approach, dominate these chapters and therefore the book. Lehn spins a wonderful tale that begins with information science on the molecular level and evolves in complexity through programmed switching devices and instructed molecules to culminate in the future goal of chemionics. Lehn's vision of nanochemistry and molecular machines emphasizes information, not size, and he defiantly responds to Feynman's aphorism that "there's plenty of room at the bottom" with the riposte that in "reaching higher levels of organization and behaviour, it is clear that through supramolecular chemistry 'there's even more room at the top'!"

Lehn is both a scientist and an artist, and his final chapter reveals this duality explicitly. *Supramolecular Chemistry* is a book I would recommend because of the new horizons it can induce you to seek. My only caveat is that although the book begins with creation it should be taken as a prospectus and not a bible.

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