- A physical justification of molecular models is suggested in quantum chemistry.
- The emergence of a chemical phenomenon is reduced to a physical symmetry breaking.

What Mainzer is saying is (to paraphrase Kant's terms): to the extent that chemistry can be reduced to quantum mechanics it is a proper science.[3] Of course, chemistry as a practice is autonomous, but it is not an autonomous *science*. Hence, as Dingle puts it:[4] "Chemistry rightly figures prominently in the history of science; in the philosophy of science it should not figure at all." Presumably, it was not the purpose of the 3rd Erlenmeyer Colloquy to support this view.

Notes

[1] Herbert Dingle in *The James Scott Lecture* delivered July 5, 1948 to the Royal Society of Edinburgh.

[2] "The underlying laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that exact applications of these laws lead to equations which are too complicated to be soluble."

[3] I. Kant, *Schriften*, 4:470; *cf.* 4:471, 14:470, 29:173, 31:288, 31:316.

[4] Dingle, *op. cit.*

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Chemical Research – 2000 and Beyond: Challenges and Visions, ed. by PAUL BARKAN, Oxford Univ. Pr., New York-Oxford, 1998, xiii + 218 pp. [ISBN: 0-8412-3575-9]

In many fields, the millenium makes people reflecting upon past achievements, future objectives, and the basic principles of their own field. Such a reflection presupposes both the willingness and capacity to question former habits, to comprehend the field at a more general level detached from everyday business, and to try unconventional lines of thought, or even visions. In a sense, the millenium makes people 'more philosophical' for a while.

Chemical Research – 2000 and Beyond arose from a symposium at the Rockefeller University, NY, October 18, 1997 that was sponsored by the ACS and an impressive list of chemical companies. (p. xiii). The editor and organizer, P. BARKAN, was able to win over a lot of 'big names' from the U.S.A., "five Nobel laureates in chemistry, prominent chemists from academia and industry, and a U.S. congressman", as the blurb reads. Rather than taking the opportunity of a more relaxed and open-minded reflection, the Introductions already rings the alarm bell (p. ix): "global political, economic and social changes […] are threatening the pace of progress through scientific research". It stresses "the urgency for the chemical community to assume an active role in convincing policy makers and the public that the quality of life in the 21st century will depend on a strong national science agenda that fosters basic scientific research." And more clearly, it promises "perspectives on the conditions necessary for our nation to maintain a leadership research environment".

In his introductory essay, P. BARKAN goes into details (p. 7): "Our leadership in science and technology is being threatened by the rapidly emerging global industrial competition", "trade deficit", "the loss of dominance in some critical technologies", "short-sighted poli-

cies", "stock holder demands", "increasing scientific illiteracy", and "the rising influence of deconstructionists debunking established scientific truths". Because "chemistry, as the central science through its impact on biology, medicine and technology, has been and should continue to be essential to the growth and prosperity of our nation", it should receive "support for basic research and science education".

Apparently, the book is addressed to U.S. citizens, especially to U.S. policy makers, so that one might wonder why Oxford UP offers it to an international readership without indicating the national concerns in the title. Moreover, parts of the book are written in such a political language, that any doubts or questions about past achievements, future objectives, and the basic principles of chemistry are vanishing. The style neither invites a dialogue, nor does it allow philosophical reflection.

Why do I review the book at all in an international journal for the philosophy of chemistry? Unlike the authors, I think that chemists of many countries are concerned with similar problems, if we ignore the endemic 'leadership problem'. The global problem arise from the growing costs of chemical research that put increasing pressure upon chemists to justify their research, and as such has impact on the image and identity of chemistry. Traditionally the economic pressure is higher in the USA, where so many outstanding chemists live and work, which makes global symptoms easier to analyze there. Thus, the book provides learning opportunities for others in order to avoid the failures.

While blaming shortsighted policies, many authors of the book seem to be unaware that they are running the risk to foster what they blame. The basic shortcoming of the book is that nobody gives a clear-cut definition of basic research, whereas many stress the economically beneficial applications of so-called basic research. However, once the economic measure is taken for granted as the *only* measure for scientific value, scientists should be prepared to argue in economical terms proper. For instance, it is insufficient to argue that "curiosity-driven" long-term research *also* brings about some helpful applications, as W.N. LIPSCOMB and R. BRESLOW do by presenting impressive lists of cases. Instead, it would be necessary to prove that such a kind of research is, in economic terms, *more efficient* than any other kind. Unless such a proof is provided, and there is none, it appears to be an *economically* reasonable strategy for many to invest only in research with strict constraints and clear-cut goals that promise short-term performance. The lesson to learn is that, if chemists give up their *sovereignty*, *i.e.* their right to self-determine the values and aims of their own field, as many authors seem to have done, they leave all decisions to economical reason. What makes the book so disappointing is that a sovereign discussion about the values and aims of chemistry is banned in favor of presenting an adapted appeal to politicians. In some sense this is surprising, if one recalls the discussion of the late 1980s caused by the so-called *Pimentel-Report* "Opportunities in Chemistry" (1985) that only one author mentions in passing. In general, the lack of reference to pertinent publications in science policy and innovation research is telling; *e.g.*, nobody seems to be aware that the general ideas were already published half a century ago (V. Bush, *Science – The Endless Frontier*, 1945) and have been vividly discussed on a professional level since then.

Another lesson from the book is that while 'big names' surely add political weight to an appeal, they do not automatically provide good arguments. There is no doubt that the book contains some excellent chemical work. However, if Nobel laureates are invited to present their own honorable research to a handpicked audience of chemists, the outcome as a whole need not necessarily be representative of future challenges; nor does it guarantee that nonchemists, the expected readership, will gain understanding. Educated chemists will certain-

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ly enjoy some new and fascinating advances, in particular, R.F. CURL's portable and tunable infrared laser system for measuring gaseous pollution, and D.R. HERSCHBACH's approach to "hyperquantum chemical dynamics" of trapped molecules. However, even chemists get bored by a listing of 46 (!) complex organic reactions schemes that K.C. NICOLAOU and J.L. GUNZER find necessary to argue for organic synthesis as being "the enabling technology for biology and medicine". Nonchemists will definitely benefit from M.J. MOLINA's survey of the two main problems of atmospheric pollution, stratospheric ozone depletion and tropospheric smog. However, they will have difficulties to follow G.A. OLAH's argumentation: starting with an alarming scenario of future energy crisis, he recommends his *energy consuming* electrochemical method to produce hydrocarbon from carbondioxide ("Recycling Carbon Dioxide to Produce Energy", p. 45) and emphatically votes for nuclear plants.

Four papers deal with the chemical and pharmaceutical industry by high representatives of four companies. P.S. ANDERSON's (DuPont Merck) review of *Technology Vision 2020: The U.S. Chemical Industry* (1996) gives the impression that the visionary capacity of that branch is rather poor. Nearly everything is derived from his primary "vision statement" (p. 133): "The U.S. Chemical Industry leads the world in technology development, manufacturing, and profitability", which should be achieved by "efforts to double the federal investment in science and technology" (p. 136). A highly recommended source of information is however F.A. VIA's (Akzo Nobel) survey of recent trends in the chemical industry concerning economy, R&D, and partnership between industry, universities, and national labs. Procter & Gamble manager B.H. WIERS argues for changes of the U.S. *Research and Experimentation Tax Credit* program that allows companies to reduce their taxes depending on investments in 'basic research' at universities. It is hardly surprising that he suggests, among other things such as increased credit levels, an "extended definition of basic research" that includes "basic technology research" relevant to commercial purposes. Obviously, he has been realizing that weak definitions may serve political and economic purposes. A.J. MAIN (Novartis) gives us an impressive outlook of how future drug discovery may become "standardized", *i.e.* routine work without any more R&D efforts and, consequently, without much need to employ chemists and biologists. This vision reminds us that, in economic terms, ideal R&D tries to make itself superfluous.

A real vision is W.O. BAKER's idea to implement a "populistic understanding of matter and its transformations", such that it becomes "part of human culture, in the deep sense of doings and feelings in daily life" (p. 197). How far that is from reality gets clear from *Science* writer R.F. SERVICE's sobering analysis of the media coverage of science in the U.S.: only from 1989 to 1995 the number of newspapers with own science sections has dropped down from over 100 to some 35. Chemists will learn a lot about the public image of and interest in science from his fine analysis of selection rules for science news. That is much more informative than the political 'selection rules' presented by Congressman R.S. WALKER.

In sum, the book does not come up to the promise of its title. Rather than presenting a general or visionary reflection on chemistry, it is more an appeal to U.S. politicians to spend more money for chemistry, by using the weight of 'big names' instead of good arguments from the pertinent discussion. While several papers are instructive and inspiring on their own, the concept of the book as a whole does not call for imitation.

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