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NANOME MAPPING.
The NANOME Project

M. Apostol
Department of Theoretical Physics, Institute of Atomic Physics,
Magurele-Bucharest Mg-6, POBox Mg-35, Romania
email: apoma@theory.nipne.ro

The second half of the 19th century has witnessed a tremendous miniaturization of the electronic devices, a process started with the discovery of the electronic transistor.[1] ”Small is different”: dissipation is reduced, times are shorter, devices are lighter. In addition, small brings an increased functionality when integrated in organized ensembles, like integrated circuits.[2] Everything is more convenient, when worked out form large numbers structured on small scale. Consequently, cca every year and a half the size of the electronic devices gets diminished by a factor of 2, according to ”Moore’s law”. Today, their linear size is as small as 0.1μ, *i.e.* 1000 Å.

However, this trend has a limitation. The ultra-miniatural electronic devices are fine things; fine things are to be fabricated, manipulated and accessed delicately. Our tools are particle beams, like atoms, electrons or lasers. Molecular beam epitaxy and litography techniques are limited in this respect by Heisenberg’s uncertainty principle: the finer the radiation the longer its wavelength. The way out from this bottleneck would be that of starting from molecular, and supra-molecular synthesis in fabricating small things (the bottom-up approach). Molecular objects are more stable to increased energetic flows, which would be a bonus. This way has already been opened up by fullerene[3] and carbon nanotubes.[4] As regards the manipulation and access, the electron[5] and scaning tunneling[6] microscopy provide the incipient tools. The new range would stop at about 10Å in linear size; but between 10 Å and 1000 Å is enough space: ”there is plenty of room at the bottom”.[7]

A new realm is comprised between 10 and 1000 Å, a completely new world. It is something very new because the size (non-thermodynamic) and quantal effects arise, or are enhanced. One of the smallest things up to now was deemed to be the quantum dot. But it is a two-dimensional electron gas restricted in space over cca 0.1μ or more in linear size, which indeed exhibits a lot of strange particularities. Mainly, they are relevant for the one-electron energy levels, and are best seen in transport, which displays chaotic behaviour, phase coherence, Coulomb blockade, charge quantization, etc. These quantum dots belong to the mesoscopic world (as compared to the microscopic, or the macroscopic, world). The new world extending from 10 Å to 1000 Å in linear size is the nano-world; it is populated with **Atomic Quantum Dots**, which are atomic aggregates, either isolated or deposited, or under various other geometric or dynamic (like applied external forces) constraints. They are supra-molecules or the smallest bits of solids, the nuclei of the condensed matter.

Apart from being possible, the nano-world produces a new science and a new technology: nanoscience and nanotechnology. Nanotechnology is an enabling technology: apart from nanoelectronics, it fabricates highly efficient and functional nano-drugs, tools, devices, materials, processes. Quantal effects are definitely involved here, and a typical quantal object is the electron spin; electric flows with controlled spin polarization produces the spintronics. Quantal variations are comparatively small on the large, macroscopic scale, where the quantities vary slowly, comparatively; on the contrary, the quantal effects are comparatively large on the small quantal scale, so an enhanced nano-magnetism is expected.

What the nanoscience would mean? Nothing but the knowledge of the nanostructures. What the nanostructures look like? They look like atomic aggregates, consisting either of alike or distinct atoms, they are homo- or hetero-atomic clusters, isolated or in various environments. The main problem would be that of knowing the electron energy levels, whose computing imply the knowledge of the potential and the knowledge of the atomic positions. This raises again an old problem of the condensed matter, that of matter aggregation and chemical bond. That is, being given N_1 atoms of one species, N_2 atoms of another, N_3 of other, and so on, being given the Coulomb interaction, both attraction and repulsion, between electrons and atomic nuclei, do such an ensemble bind together, and, if yes, under what circumstances, and how does the resulting aggregate looks? This problem can now be solved, in a reasonably consistent and controllable way, under certain limitations, in two, or three successive steps. A cca 3% accuracy may be attained at most in such a computation, and all the relevant physical and chemical information may be derived thereby. Each atomic combination may be studied this way, and the resulting description recorded in a database. The production of such scientific knowledge is the output of a **”Factory of Chemical Bonds”**,[8] whose main aim would be that of pursuing the **NANOME MAPPING Project.**

Nano means small and ten to minus nine, *i.e.* 10 Å, while nomous is knowledge, name, which we believe the knowledge comes by. The **NANOME** project would describe all the nano-objects the nano-world is populated with, drawing thereby a map of this world in much a similar way to the mapping of the humane genome. Macroscopic bodies are amorphous, or are almost continuously filling up the space, or, when atomic-like, their translational symmetry classes are finite. For the nanos things are different; they are almost only individually describable, at least at this level of kowledge, like particular beings; their regularities, if any, are a few. For instance, some are indeed of a possibly predictable icosahedral symmetry, but this is by far a restricted class; some exhibit certain repetitive, or individually distinct combinatorial structural elements, like cores, shells; but they are scarce. Some are symmetrical enough, with disturbing little irregularities, some others are made of locally irregular elements resulting into a global balance, of exquisite harmony. The nano-world derives its consistency from the necessary relations between natural things. In addition, the isomers enrich considerably the picture, as the same number of the same atoms may bind together in slightly different forms, enormously large in numbers, with small amounts of energy. Statistical ensembles of such objects, may well have a liquid surface and a solid inner core, which obviously correspond to a novel state of matter. Quasi-liquid clusters are good candidates for the building blocks of the living matter, in view of their quasi-stability, non-equilibrium, and the aperiodic crystal relevance.[9]

Almost anything relevant is known already on the macroscopic, or the microscopic scale nowadys. Sub- and sub-sub-nuclear world touches upon the very large scale of the Universe, by their extremely high energies; this zone could not be assessed as being relevant yet. Building close to the atomic scale is the only virgin domain forgotten untill today. It will bring us closer to the quantal nature of our world, and, thereby, has good chances of explaining the physical-chemical mystery of life.

Through the **NANOME** project the Quantal Mechanics will regain its destiny as theory of the chemical world.

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