The Antiphysical Review

Founded and Edited by M. Apostol **62** (2003)

ISSN 1453-4436

**International Institute of Materials**

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

May 22, 2002

Dear Sir,

I thank you very much for your letter of May 16, 2002.

The present letter is in full support to your recent action of jointly establishing an International Materials Science Institute (IMI) on Magnetic Nanohybrids (IMIMN), with a broader overlap of Superconductivity, Magnetism, Semiconductors, Nanostructures and Materials Synthesis and Characterization, under the authority of the US National Science Foundation. My institution (Institute of Atomic Physics-Institute of Physics and Nuclear Engineering, Magurele-Bucharest, Romania), my research laboratory and group, and I myself, declare herewith that we are fully commited #1) to the collective effort of identifying new areas of important and innovative research for joint cooperative programs, #2) to coordinate visitor exchange programs between our researchers and the participating US and partner institutions' researchers, #3) to co-organize international workshops and scientific conferences, and #4) to sharing our experience in teaching physics and education, including post-graduate and PhD students, especially by means of the modern electronic audio-visual means.

As you probably know I head at the present a Laboratory of Condensed Matter in the Institute of Atomic Physics at Magurele-Bucharest, with a core of 5 theoreticians, a solid-state physics and chemistry team of 6 experimentalists, an applied physics team of 4 physicists and engineers, and 5 PhD students. They are distributed in the Institute of Physics and Nuclear Engineering, the Institute of Materials, the Institute of Plasma, Lasers and Radiations, and the Department of Physics of the University of Bucharest, all on the campus of the Institute of Atomic Physics at Magurele-Bucharest. In addition, the Laboratory has several associates and affiliates, with a broad range of scientific and professional interests, including modern means of teaching sciences, education, society information, etc. Our main themes of research at the present are the theory of the nanostructures, chemical bond, superconductivity, magnetism, transport and the superconducting, magnetic, semiconducting, infrared-active, thermoelectric, nano-structured and optically-active materials.

#1. a) With regard to identifying new themes of research, we have been engaged, as you know, in the last few years in formulating a practical and consistent way of accounting at the theoretical level for the aggregation of the nanostructures, and, more generally, we explored the theory of the chemical bond from first principles. We got preliminary results in this direction, especialy for the metallic cohesion. We plan to further develop this area of research, by tackling more complex structures, like hetero-atomic clusters, semiconducting and magnetic nano-structures, and clusters deposited on surfaces. It is one of our primary focuses now to set up a practical

way of computing the one-electron energy levels in nanostructures, both isolated and deposited on surfaces, or under other various geometric or dynamic constraints (as, for instance, under external applied forces). One of the main output of such an action will be the possibility of controlling from the outside, by varying external parameters, the electronic structures of the nano-objects, thus leading us to effectively designing nanoscale "smart materials". Another main output will be the estimation of the enhanced nano-magnetism, its complex behaviour, and its dependence on environment, in particular the so-called proximity effects. Single-molecule magnets belong to this research. We think this research project fits very well into the new concept of "magnetically controlled nanoscale magnetic hybrids" of the IMIMN. We plan to develop a consistent program of research for describing, in principle, any conceivable nano-aggregate, and providing as much relevant physical and chemical information as possible. We call this program the Nanome Mapping Research Project, and it would imply, in our vision, establishing a "Factory of Chemical Bonds", which would produce a database of physical and chemical description of every possible nano-object. I submit herewith to your attention the opportunity of jointly developing such a project within our IMIMN.

b) We have also investigated recently the formation of contacts and interfaces between two solids, with the aim of describing the transport through a ferromagnet-superconductor junction. This investigation is aimed at assessing the practical possibility of developing a spintronics device with transistor-like properties. We have already obtained encouraging preliminary results in this area, especially related to the Andreev-reflection at a ferromagnet-superconductor junction, both for electric and thermal transport. One of the main aspects of this investigation is the spin flip at the interface, as well as the destruction of the superconductivity over a limited range, and the inter-play between the mean-free path, coherence length, domain and vortex extension, etc. One of our main questions here is the way superconductivity and magnetism, for instance, partially may coexist over the junction. The ballistic transport in this context is another question. Such structural hybrid structures seem indeed to be tunable from the outside, and, being given the very high local magnetic fields, they may result into dramatically new nano-materials. Such a hybrid effect may in principle be applicable to other types of junctions too. I personally would be very interested to see how it goes for a similar junction between a ferromagnet and a semiconductor, or a magnetic semiconductor, as well as to extend such investigation to triplet structures of any relevant componence and succession. This investigation fits again the IMIMN concept, and I would suggest to you to analize the possibility of a cooperation on this subject within our IMIMN.

c) We plan, and did some exploratory investigations to this end, to re-examine the magnetic inter-layer coupling in order to get reliable knowledge upon the dimensionality effect in highly-anisotropic magnetic structures. We plan to set up a similar project upon the superconducting layers. We hope to employ the experience gathered this way for re-analyzing the thermodynamics of the magnetic and superconducting vortex liquids. Such enterprises would probably have the best chance with PhD students, or post-docs. I propose to examine the possibility of such a cooperation.

d) I also bring to your attention the opportunity of including in our IMIMN research plans, beside the topics already mentioned in your letter, the Atomic Quantum Dots. The latter are distinct from classical quantum dots in that they do not consist of a restricted two-dimensional electron gas, but are three-dimensional atomic aggregates with their own, distinct, electronic and magnetic properties; in particular they enjoy enhanced quantum and size efffects, and an enhanced magnetism. As you are probably aware, such structures have a good chance to be candidates for the new generation of ultra-miniatural, nanoscale electronic and spintronic building blocks for conducting devices. Of particular relevance in our context might be the magnetic core-shell nano-dots.

e) We would also be interested in developing joint studies of structural neutron analysis, electronic and magnetic structural studies, transport and conducting properties of particular structures with constrained geometries, kinematic, dynamic, quantum and statistical correlations, for materials characterization. Of particular interest in this respect are the superconducting and magnetic phase transitions, as well as the statistical physics of quantum liquids. Our experimental team members are also interested in having access to various nanofabrication facilities and materials characterization techniques.

#2) As regards the visitor exchange program we suggest an amount of 2 months/person/year for the first year, distributed among your University, Texas University A&M, Northern Illinois University, Argonne Laboratory and other partners, for working stays, seminars and exploratory talks, as well as an ensemble reunion of the Institute at least once per year for a General Seminar. We may revisite this suggestions for the next years.

#3) Co-organization of Workshops and Conferences are to be discussed in such a General Seminar, where the scientific program, list of speakers, participation, location and funding and responsabilities will also be established. The role of the General Seminar will also be that of establishing the plans of research and the calendar of scheduled activities. In this regard, it is my feeling that the IMIMN must have an organizational structure and a corresponding scientific and executive staff. The scientific reports upon our IMIMN activity will also be assumed by this staff. It will also be responsible for the external reviewing of our activities.

#4) As you know probably, some years ago we have faced the problem of conveying new scientific results regarding our nanostructures in a direct, visual form. Consequently, prompted by such a new situation, not encountered before, we set up here a Laboratory of Scientific Multi-Media, aimed at communicating scientific results by means of the electronic audio-visual techniques. We have produced already four scientific movies (Atomic Clusters, Thermoelectrics, Electric Flow through Ferromagnet-Superconductor Junctions, Cluster Deposited on Surfaces), with animated pictures, sound, music, voice comments, etc, available on CDs. We improve continuously on these techniques, added electronic presentations to various conferences, meetings, workshops we participated in, and even course lectures for our students. Our scientific multi-media products enjoy popularity among our audience, and we plan to further develop this activity in the future. We are ready to share it with the members of our IMIMN, and to meet new challenges provided by your more extensive teaching and educational experience. As I use to say, I have our own apoma Pictures Studio, where we produce these scientific movies, as I have also our own apoma Publishing House, where we publish our books, booklets, etc (both non-commercial). As you know, I have also funded and am currently editing electronically The Journal of Theoretical Physics, as an international medium for conveying scientific results in theoretical phsyics. We are ready to share all this experience we our partners in the proposed IMIMN. I also suggest herewith, the delivery of more or less extended courses on either general or specialized topics for various levels students, as an additional activity within our IMIMN. I also propose to establish a regional branch of our IMIMN on our campus at Magurele-Bucharest, where part of our activities would be going to be carried out. We are fully prepared to seriously consider such an offer. Beside our research Institutes on the campus at Magurele, our non-profit professional society Profysica will help in developing such a project.

We are prepared here to participate with the adequate infrastructure for workshops, conferences facilities, summer schools, etc, the local acommodation and secretarial work, and to support the matching costs for promoting such activities as well as for carrying out collaborative research projects.

Concluding this letter, I would say again that we fully support the formation of the proposed

IMIMN, and are fully commited to set up its activities and to participate in these activities. We hope, and will work to this end, to enhance thereby the scientific and societal relevance of our professional work.

I would like to thank you for considering our suggestions.

With my very best personal wishes,

Sincerely,

Marian Apostol

---