

## Romanian Science within EU and Superconductors

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**Abstract - On January 01, 2007 Romania joined European Community. In the view of this important event we present some aspects of the historical background, current status and future prospects of the Romanian science emphasizing superconductors' research. Although the general conclusion is that today there is a relatively fast and positive development dynamics, some issues related to funding, organization, marketing and management of Romanian science are proposed for debate.**

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This is the first time for us to write about Romanian science, and in particular about the superconductivity research, at an international forum. Perhaps a good starting point is to mention that from January 01, 2007, Romania is part of the European family. There is no doubt that this is an important event for Romanian science and scientists, which might be also of interest to our colleagues in Europe and elsewhere. It is easy to guess that Romania's joining the EU will have many consequences, and may result in new problems, rising expectations, contradictory feelings and identity searching. At European and international level, not much is known about Romanian science, and in particular about superconductor research. We are thus very pleased to contribute on this subject. Our presentation will not always conform to the official viewpoint and we hope that in the tradition of pure science this will generate a debate hopefully leading to progress in Romanian science, or - let us rephrase - of Romanian science within Europe. It may be also useful and interesting for the colleagues involved in superconductivity and related fields to find here some details of our history and the current status.

Before 1989, the Romanian research on superconductivity was mainly linked with similar research performed in other countries of the "Soviet Block" (e.g., Soviet Union, Poland) on low- $T_c$  superconductors. Generally, three parallel structures were then strongly involved in Romanian science and development. Namely, they were the Romanian Academy of Science, the Institute of Atomic Physics (a conglomerate of several institutes and development centers) and the so-called "departmental institutes" or institutes affiliated with different industries, usually involved in product development and expertise (environment, standards, safety, and others). The first two structures are alive today, but in a relatively new form and the relationship between them also changed. They are also adapting to the new European environment. With the huge transformations in the Romanian industry that took place in the 90<sup>th</sup>, many of the industrial institutes lost their meaning and disappeared or transformed into commercial units, sometimes keeping their initial name. We note that superconductivity was usually not pursued in such institutes. Information on results is scarce partly because there was no 'habit' to publish the results in international journals.

Fundamental research and some applied research (e.g., design of processes, production lines, equipment and systems) were also approached in universities, but, generally, the model was arguably more of a "teaching" university (*versus* today's "research" university of American or Japanese type). Some laboratories were available, but mostly used for teaching and training purposes rather than for scientific research performed by students. Partly, this explains why the concept of full-time PhD student was not a common practice, and why students below the doctoral level were hardly involved in scientific research.

The discovery of high- $T_c$  superconductors (HTS) opened new opportunities. In the beginning of 1990s several groups approached the field with some success and most of these results can be found in the international journals of that period. We note here results on synthesis, vortex dynamics, microstructure-processing-properties interplay, irradiation, additions, substitutions and others. However, the childhood of HTS was soon over and it became clear that for further developments serious financial support is necessary. Up to this juncture, Romanian groups did a good work by building in-house equipment, improvising and adjusting or modifying the old equipment with minimum investments, and using raw materials kept in storage from previous 5-10 years. Lack of investment in science as well as poor economical situation generated by huge transformations of that time made difficult the development of science and education in general. In some cases international collaborations helped a lot, and through donations some equipment was transferred to Romania. We would like to acknowledge here the involved researchers and the support of organizations such as the Alexander von Humboldt Foundation, the Marie Curie Foundation, NATO, JSPS, STA, NEDO, the Fulbright Foundation, ARC and others, and of some collaborative international projects.

Although during 1990s the conditions generally got worse, many researchers improved their records and, paradoxically, the number of ISI publications increased. It is important to emphasize that the ISI system was taken into consideration very late and in some cases even today a mixture of old evaluation criteria and ISI criteria persist. Such situation worked against the formation of a real image of the Romanian science even when some results were available, and sometime it is still difficult to find out who's who in Romanian science. Superconductors' research followed the same pattern.

In the last few years, after it became clear that Romania will join EU, things started to change gradually in the right direction. Based on the European model, Romanian Research Council for Academic Research (CNCSIS) organized and administrated competition-based scientific projects. The evaluation process was mostly fair, but with relatively many deficiencies. It is still too early to draw a line and to make any conclusion on the success of this experiment due to the following reasons. The project funding provided chances to buy some equipment, and in many places this was the first time in about 15 or more years! Some other measures of direct investment and salary increase followed. In many cases it was necessary to start with reparation of the buildings: walls, roofs, heating, water supply, furniture, and so on. Unfortunately, while the financial support by a competitive project might be relatively good for an established laboratory, it is largely insufficient for laboratories, institutes or universities in which it is necessary to seriously upgrade the infrastructure and equipment. For financial and legislative reasons, acquisition of large or very expensive top-modern facilities remains a problem. Such facilities are vital in some fields of research, including that of superconductors. All this will inevitably reduce the competitiveness of Romanian groups especially short term, but also medium and long term, especially if the financial support will continue to be clearly insufficient and difficult to access. Romanian government officials are expecting the current measures to give Romanian groups a good chance to compete for European funds for science. In the recent past, although Romania was allowed to participate in EU programs as a Partner Country, the success rate of the Romanian proposals was extremely low. This has many reasons, but among them figures prominently the insufficient infrastructure (especially the research equipment). As if this would not be a serious enough problem, the recent tendency in the Government policy on science is to condition further financial support via national projects and investment in equipment upon the Romanian success in applications for European projects (FP7). Considering that in FP7 the applied projects, which usually require adequate equipment, obtain substantially better chances of success and higher level of financial support than those of fundamental science with no immediate practical relevance, it is quite unclear how to reach Government's expectations and targets in attracting significant research funding from the EU. In addition, acquisition, setup and building of equipment takes time (sometimes years!) and this is once again pointing to somewhat unrealistic approach of Romanian authorities to science. However, some other programs designed to support infrastructure and enable formation of new laboratories are to be implemented (e.g., IMPACT).

Many of the encouraging measures supporting science came too late for some groups involved in the early 1990s in superconductivity or related subjects. Groups decomposed, researchers moved to

other labs, from Romania to other countries, quit science or retired. Some scientists continue to approach superconductors on individual basis within groups of different orientation. Currently, active groups, still researching superconductors, exist at the National Institute of Materials Physics (INCDFM) Bucharest (1 group) and at the University Babes-Bolyai, Cluj (2 groups). These groups are included in the Guide to European Superconductivity. Other groups or researchers that were or are active in the research of superconductors are from University of Bucharest, University 'Politehnica' Bucharest, Institute of Physical Chemistry of the Romanian Academy of Sciences 'I.G. Murgulescu', Bucharest, and National Institute for Laser, Plasma and Radiation Physics, Bucharest. To our knowledge, no existing company in Romania is active in superconductor manufacturing or applications.

Today, there is an ongoing public and media debate on the future development pattern of Romania. The two models under discussion are of development emphasizing in the first place high-tech or infrastructure, respectively. However, the debate is rather weak and mostly attracts highly educated population. On the other side, except for the above indicated measures in science, education and the public declarations on knowledge-based-economy, the government is really concerned about infrastructure only. The position is that high-tech is the problem of companies interested to invest in Romania and not of the government: government puts relatively much effort into attracting companies, but seems not to be aware that profit rates are among the highest from high tech investments. Also, it seems that it is not concerned with the necessity to have this high-tech originating in the country, and, currently most of high-tech is imported to Romania. In such conditions the shift of Romania to high-tech economy is not likely to occur in the near future. This problem, combined with the related one of emigration of the young highly skilled labor, makes uncertain the sustainability of the present positive economy growth rate in the coming years. We also note that very few of the new companies arriving on the Romanian market are interested to initiate research and development in Romania, although some signals indicate that situation may start changing. Their contacts with the Romanian academia are still extremely weak with respect to research and development.

Improvement of the Romanian scientific environment can be observed from other points of view. Some Romanian scientific journals succeeded in being selected among the ISI mainstream journals. We mention the Journal of Optoelectronics Advanced Materials (JOAM; <http://inoe.inoe.ro/joam/index.php>), which covers also superconductors. This journal had in 2005 - 2006 the highest impact factor growth among the ISI 'Materials Science' journals (<http://in-cites.com/journals/JofOptoelectronics-Adv-Mat.html>). In late 2006, the web site of the non-governmental association of Romanian Science and Community, Ad-Astra, published on-line (<http://ad-astra.ro/>) "The White Book of Romanian Research". Here can be found Romanian science makers over a period of 5 years (2000-2005), institutions as well as researchers and rankings. Only ISI mainstream publications were taken into consideration. The site also presents different pertinent and documented opinions and analyses on Romanian science and education, but most of them are written in Romanian language.

There are many things to be done to improve Romanian science, and the research into superconductors, in terms of organization, funding, administration, legislation, working and promotion conditions, infrastructure, output, visibility, quality, development, commercialization, advertising and impact. The need to improve education is another key issue. For groups from other European countries, the first chance to get involved with Romanian science is to apply together this spring for projects within FP7.