

Colombian physics education boosted by cooperation with Spain

Prof. Dr. William Javier Herrera of the National University of Colombia, Physics Department, in Bogota, Colombia visited a group working on electronic transport in nanostructures at the Autonomous University Madrid in Spain.

What have you worked on during your visit?

I have been doing basic physics research in cooperation with colleagues of the Universidad Autonoma de Madrid-Spain. I have worked in the theory of electronic transport in superconductors coupled to metallic electrodes at nanoscale distances. The interest of this study is associated with the possibility of detecting “quantum entanglement” between pairs of electrons in such solid state devices. I have also studied these properties in the case of nanostructures based on graphene (i.e. a monolayer of carbon atoms) in contact with a superconductor.

Why is that important for your research and for progress in nanotechnology?

These studies constitute a novel and interesting application of the work I had been doing during my PhD. thesis. The final aim of these studies is the production and detection of entangled electron pairs in nanoscale devices which could be the basis of future applications related to quantum computation. A quantum computer is a device which makes direct use of quantum mechanical phenomena in contrast to the traditional classical computation. At present the field is at a very preliminary stage but is motivating a large amount of basic research.

Why did you come to this European research centre to do this project?

I came to the Universidad Autónoma de Madrid (UAM) because in this University there is a group working in theory of electronic transport in nanostructures, which is one of my research interests. Additionally, I had been visiting this group in 2004 and this was an opportunity to strengthen our collaboration and begin new projects.

What are the results? How will you disseminate them?

We have shown that quantum correlations between different leads connected to a high temperature superconductor do not decay exponentially as previously believed but in a much slower (algebraic) way. This property would allow detecting electronic entanglement at distances several times larger than the characteristic coherence length (of the order of 1 nm) in these systems. On the other hand, we have studied the same phenomena between two leads

deposited on a graphene sheet. In this case the superconductivity in the graphene can be induced by the proximity effect through a third electrode. To disseminate these results we have submitted a manuscript entitled “Long range crossed Andreev reflections in high T_c superconductors” to Physical Review Letters and we are preparing another one on transport in graphene-superconductor structures.

Is this the first contact between both organizations or is your visit part of existing collaboration?

No, it is not the first contact. I was in 2004 at UAM for initiating my collaboration with the group of the professors Alvaro Martín-Rodero and Alfredo Levy Yeyati. At that time I became familiar with the use of special theoretical methods developed by this group to study the electric current and the shot noise in superconducting systems.

What are the plans for future collaboration?

We are going to continue working in transport properties of graphene-superconductor nanostructures and to collaborate in the development of projects for PhD students of both universities. The idea is that UNC PhD students in nanotechnology could stay at the Universidad Autónoma de Madrid and, in the reverse way students from UAM could visit UNC for short periods. For this it would be very important to participate in future research projects funded by the EU and to obtain support to finance the doctoral students.

Do you intend to apply for funding in the EU 7th Framework Programme for RTD?

Not at present but may be in the future if I find an appropriate call within EU-Latin America collaboration. For us it would be of great help to get support from the EU to finance the exchange of students.

How may your project in the long term benefit the development of your country or Latin America in general?

Although the investigation proposed in this project does not have a practical application at the moment, it could become of importance in future technological developments related to nanoelectronics. From the social point of view, the development of this research will have the following implication:

- A strengthening of research groups at the Universidad Nacional de Colombia. This will facilitate a theoretical and experimental development in nanotechnology at this University in the future.
- I will teach and supervise thesis projects on this subject. This will contribute to the formation of human resources within this field in Colombia.

What are your plans for disseminating the results of your visit outside the research community in your country?

In order to disseminate the results and the NanoforumEULA program I hope:

- To publish the results of the research work in scientific journals of recognized international prestige.

- To participate in local and Latin American scientific events of solid state, like the National Congress of Physics, SLAFES (The Latin American Symposium of Solid State Physics) or CLACSA (Latin American Congress of Surface Science and its applications).
- To participate in scientific events organized in Europe, which are related to the field of nanotechnology.
- To introduce other research groups of the Universidad Nacional de Colombia to the methodology developed in this work by means of postgraduate courses.
- To give seminars in the Colloquium of the Department of Physics of the Universidad Nacional de Colombia or of another Colombian University.
- To give an interview and/or write a note for popular press, such as the University newspaper, or other local magazines.

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