ESF RESEARCH CONFERENCES

Rapporteur Report

Partnership:	ESF-FWF conference in Partnership with LFUI
Conference Title:	Quantum Engineering of States and Devices: Theory and Experiments
Dates:	**5.6.2010 – 10.6.2010**
Chair:	Prof. P. Sodano
Rapporteur:	Dr. A. Ekers

General Comments

Any general comments you might have concerning the conference, your role, the scientific area covered by this conference, etc.

The conference brought together solid state and gas phase physicist communities working on quantum engineering and quantum information. Such interfacing is very important for scientific cross-fertilization of both communities, which are often talking similar language expressed in terms of different experimental conditions. The range of addressed systems was very broad and reflected the various angles of attack of the physical problem summarized by the title of the conference, including cold atom gases, 2D electron gases, trapped ions, quantum hybrid systems, quantum dots, superconductors, Josephson junctions, quantum Hall states, quantum hybrid systems, and even intriguing quantum phenomena in biological systems. The theory covered a number of topics of quantum engineering like quantum entanglement, various implementations of qubits, Kondo effect, Coulomb blockade, superfluidity of polaritons, various versions of quantum interferometry, topological order in quantum computing, etc. Reports by both solid state and gas phase physicist communities demonstrated a well documented and significant progress towards the ultimate goal – the creation of a quantum computer. Quantum logic operations can now be performed on more than just a few particles, and improvement in terms of scale is anticipated and well in sight, although it is evident that there is still long way to go before the first quantum computer can be built. Probably, even more important than the very demonstration of a quantum computer is the richness and content of scientific discoveries and technical/methodological progress that are being made on this way. As the conference demonstrated, these discoveries have far-reaching scientific and technological implications beyond the field of quantum information and its components, for example quantum tweezers, levitation of small objects, or metrology applications, and only now scientist begin to realize how high is the relevance of quantum phenomena in biological systems.

The overall climate of the conference was very friendly and stimulating. The conference programme was very dense, while one could see intense discussions of the participants during the breaks and poster sessions. Well in spirit of ESF conferences, the involvement of young scientists was strong: more than a third of speakers were young scientists, one could see them getting involved in discussions, including those during the session breaks, and they were making the main body of poster presentations

.

Quality of Scientific Programme, Presentations and Discussion

Comments on the balance and scope of the scientific programme, the scientific quality of the presentations and discussions.

The programme was a well balanced (60/40) mixture of invited (40 min) and short talks (15 min), the latter being given mainly by young scientists. Apart from the European prominence, the list of invited speakers included scientists form US, Canada, Israel, Ukraine, and Korea. A short summary of the topics addressed by the conference is given above. For a more detailed insight I recommend the dedicated website (http://people.sissa.it/~andreatr/SLIDES_OBERGURGL/) including presentation slides and recorded

movies of all talks of the conference. Availability of such website does not only serve the educative purposes of young scientists; it also increases the visibility of ESF Conferences scheme.

The quality of the science presented during the talks and the poster sessions was certainly very high and reflected both some overview and the latest developments in the field. Some of the theory talks were very specialised, which might have made problems for the participating experimentalists to follow them, but in overall a good effort was made to make sure there is a cross-talk between theorists and experimentalists. Discussions after the oral presentations were very active and lively, and they continued more informal during coffee breaks, meals, and other free moments. There were two lively poster sessions (about 25 posters each), mainly presented by students and postdocs. That was a very good opportunity for young researchers to get involved in extensive discussions with senior scientists, and such interaction between both scientist generations could be observed well beyond the poster sessions.

In summary, the conference organisers have done an excellent job done in selecting a balanced mix of very high level contributions of renown and young scientists, and arranging them in a way that enabled a cross-talk between the solid-state and gas-phase physicist communities.

Informal Networking and Exchange; Atmosphere

Was the schedule and the atmosphere conducive to an easy exchange of information? Was there time and space for an informal discussion? Were younger researchers integrated?

Schedule of the conference was very rich and intense, sometimes close to being tense. Somewhat larger time for discussions might have been useful, while the organisers had chosen to have a very reasonable compromise between topical richness of the conference and the discussion time. The general atmosphere was relaxed and stimulating; all occasions for discussion, including coffee and meal breaks, poster sessions, and evening socializing in the lobby or at the bar were intensively used. Young researchers had chances (and used them) to discuss their work, new ideas, and experiments with leading and more experienced scientists. Half day off in the afternoon of the third day was used either for joint hikes in voluntary groups or for discussions of physics, which, especially for young scientists, allowed learning closer both experienced and young members of the quantum physicist community under very informal conditions. Internet and e-mail access was provided throughout the conference venue, enabling the participants to connect to the outside world whenever necessary. It is interesting to note that among conference participants there were a few members of the ESF EUROCORES programmes EuroQUASAR and EuroQUAM, which is a good sign of synergy among the different ESF instruments (i.e., Conferences and Eurocores) and an additional indicator of importance of the conference topic.

Balance of Participants

Was there an appropriate balance between young and senior participants? Was a balance of national groups and researchers from different (sub)fields achieved?

The balance between experienced scientists, which included world's leading experts, and young scientists (both PhD student and postdoctoral level) was very well chosen. As mentioned above, more than one third of oral contributions were delivered by young scientists, which gave them a very good chance and experience to present and discuss their scientific results in front of an expert auditorium. There were also presentations by young mid-career academics. The large number of young and highly competent participants is a good indicator that the field of quantum engineering is active and vibrant, with good momentum for future development. National balance of participants was representative for this field in Europe, while the relevant communities from outside Europe were also well represented. The list of speakers included experienced and young scientists from both Europe (Austria, France, UK, Germany, Italy, Netherlands, Spain, Switzerland, Sweden, Bulgaria) and from outside Europe (US, Israel, Canada, Ukraine, Korea). Topical balance was achieved by arranging dedicated topical sessions on Quantum Systems, Quantum Entanglement, Modern Trends in Field Theory, Quantum States, Quantum Interferometry, Topological Field Theory and Quantum Computing (see conference program for more

detail).

Outlook and Future Developments

Will new collaborations emerge from this conference? (How) could the conference outcomes be utilized further? Are there suitable (ESF) programmes or instruments to further the work of the conference?

New contacts and new linkage of scientific topics and methodologies were established by involving both solid state and gas phase physics communities in one and the same event, and new collaborations are very likely to result. The conference also involved a Forward Looking Plenary Discussion, during which several prominent scientists were asked to briefly express their opinion about the future perspectives of the topics covered by the conference, while questions from the audience and discussion followed. Generally no one could tell when the first quantum computer will be made, as this is a very complex and multi-faceted task, but the new physics developed on this way is exciting, and interest in continuation of this type of research was unequivocally formulated. A few qubits have been experimentally demonstrated to work in superconducting quantum circuits, while it is also clear that building a >100 qubit quantum computer will require very large resources in terms of manpower, time, and funds. But quantum computer alone is not the goal; there is also a clear interest in other aspects of this research, like quantum communication, new exotic materials, or in combining the new physics that has been developed so far. Links were identified from particle physics, field theory, and gauge theory to solid state physics, involvement of BECs was acknowledged as exciting perspective, and living matter is probably the next one in which to look for examples of quantum computing. There was interest from the side of a number of conference participants in various ESF instruments; unfortunately, ESF decided to postpone for unknown time launching of the call for Research Networking Programmes (RNPs), which might have been very adequate for the continuation of this some topics of this conference. Nonetheless, some of the conference participants might find it interesting to participate in the newly launched RNP POLATOM (Common perspectives for cold atoms, semiconductor polaritons and nanoscience). Furthermore, a new Forward Look on future perspectives of quantum information is expected to launch this autumn, which might involve participants of the consortium of this conference in the strategic foresight action.

Organisation and Infrastructure

Were venue, catering and accommodation appropriate for this conference? Were participants satisfied with the on-site administration and support?

The conference on Quantum Engineering of States and Devices took place in the Obergurgl conference centre maintained by the University of Innsbruck. This centre is situated in a beautiful location in Austrian Alps and is excellently suited for medium size meetings; some logistical inconveniences in reaching the conference sight are full rewarded by the location and scenery. The conference centre is equipped with all the necessary infrastructure for presentations and size of the lecture hall was perfectly suited for the present meeting. The centre has own rooms for accommodation which are clean and equipped with all basic needed comfort, with sauna available for conference participants. Free wireless internet access was provided. The local personnel were very friendly and helpful. Catering was well organised and food was of high quality. There was a flexibility to opt for take-away lunch packs for those participants who preferred to spend lunchtime hiking in the surrounding mountain area. Participants were generally well satisfied of both the venue and the on-site administration and support, and the local staff responded to requests promptly and in a very friendly and helpful manner. In summary, the Obergurgl conference centre provided an excellent service and a stimulating working environment for the conference.

Summary & Overall Assessment

Was the conference successful; were its aims achieved?

In summary, the conference was a very stimulating and successful event. It was a very informative update on recent developments in the field of Quantum Engineering of States and Devices. It brought together

solid state and gas-phase physicist communities, it enabled building new contacts, it looked into the future perspectives of this field of research, and there was a very good level of young scientist involvement. New scientific collaborations are likely to result, and one can expect new applications from the side of this community to ESF synergy instruments, if those will be maintained in the future. Based on those observations I conclude that aims of the conference were fully achieved.

About ESF Research Conferences

The Scheme

This conference is part of the European Science Foundation's (ESF) Research Conferences Scheme. The Scheme aims to promote scientific excellence and frontier level research throughout Europe and the rest of the world. Conferences aim to provide leading scientists and other participants, including young researchers, with a platform to present their work, to discuss the most recent developments in their fields of research and to network.

Conference Format

The core activities should be based on lectures by invited speakers, who are leaders in their respective fields, followed by extensive discussion periods. An informal exchange of ideas, both inside and outside the lecture room, should be encouraged, and the number of sessions in the daily timetable should be limited in order to allow sufficient time for interaction between the participants. Time should be reserved for a 'Forward Look Plenary Discussion' about future developments in the field.

Participants can take all their meals together to encourage further contact and networking, which can be particularly beneficial to younger researchers who may be less outspoken in the formal lecture room setting. In order to gain optimum benefit from the conference, both the speakers and the participants are asked to stay for the whole duration.

Division of Tasks

The Conference Chair is responsible for ensuring the quality of the scientific programme through the selection and invitation of speakers, and through the selection of participants.

The ESF Conferences Unit is responsible for managing all the logistical aspects of the conference organisation, including the provision of an on-site secretariat.

Further information: www.esf.org/conferences