ESF RESEARCH CONFERENCES

Rapporteur Report

Partnership:	ESF-LFUI
Conference Title:	Cold and Ultracold Molecules
Dates:	18-23 November 2012
Chair:	**Dr. Guido Pupillo**, ISIS-IPCMS, Université de Strasbourg and CNRS, Strasbourg, FR
Rapporteur:	**Dr. Aigars Ekers**, European Science Foundation, FR

General Comments

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

Probably the best summary of what we have heard at this conference was formulated by one of the founders of ultracold molecule research Prof. Paul Julienne from NIST during the plenary discussion of this conference: "I could have never imagined the progress that has been achieved since 1990-ties". And indeed, mere 20 years ago the dream of a still-standing diatomic molecule in its ultimate ground state was more in realm of theoretical ideas than it was on the menu of experimentalists' optical tables. What we saw at this conference is breathtaking if we keep in mind how young the field of ultracold molecule research is. Not only ultracold molecules have been obtained in the ground rovibrational level of the electronic ground state a few years ago via photoassociation. There are by now a number of established ways how cold molecules are being made. In fact, the cold molecule research is being pursued by three communities – the one assembling molecules from ultracold atoms, the one slowing molecules using Stark and Zeeman decelerators, and the one relying on ion trapping. Importantly, this conference brought together leading scientists from all three communities, and we witnessed a vivid cross-talk and among them. And this is just the beginning of the journey into the ultracold molecule research, since the most exciting part – when we can start using ultracold molecules for doing new kind of physics – and chemistry – is just beginning.

The art of making of cold molecules is now armed with a variety of approaches, some demonstrated, and some being developed. The 'traditional' techniques of photoassociation and exploitation of Feshbach resonances are now well established tools. These are complemented by a number of other techniques, such as direct laser cooling of molecules with favourable transition probabilities that effectively enable a cycling transition, the analogue of Sisyphus cooling that has been exploited in atomic gases and is now for adapted for polar molecules using Stark force, evaporative cooling, exploitation of the effect of collective dipoles to implement vibrational cooling via superradiance, radiative association of ion-atom pairs, or sympathetic cooling of molecule-Rydberg atom pairs. The non-cold-atom based techniques such as Stark and Zeeman deceleration, demonstrate novel developments, too - such as deceleration of Rydberg molecules by electric fields with very strong gradients or a new type of centrifuge decelerator of polar molecules.

The research goes far beyond the mere obtaining ultracold samples of molecules. We heard about molecular quantum gases, both bosonic and fermionic, reactive and nonreactive scattering, both theory and experiments, and ultracold few- and many-body systems. Intriguing are the first attempts to achieve control over ultracold bimolecular reactions. These early attempts define very much the aim of the emerging field of ultracold chemistry – that of ultimate chemical process control. Yet there are major problems faced by both experimentalists and theorists. On the theory side, there do exist long-range capture models, yet the description of the dynamics at short-range, where the real chemistry happens, is a major challenge. On the side of experiment, the inelastic processes can be inferred from trap losses, but direct detection of the reaction products and measurement of the respective absolute cross sections are problematic. However, given the achievements of the cold molecule community demonstrated at this conference, and the high

motivation of the participants, we can anticipate exciting future for this field and major breakthroughs to come soon.

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 mix of the presented topics was very well balanced, representing a full spectrum research and methods that are currently being pursued and used in the area of cold molecules. The focus of the organisers was obviously to involve top speakers from the field regardless the country of affiliation. Apart from speakers from Europe, the keynotes included scientists from US, Canada, Japan, and Israel. In fact, about 1/3 of speakers were from the US, which gave to the conference a strong international dimension and ensured that the substantial body of cold molecule research that is done outside Europe is fully included. In that sense, the scientific programme of the conference was outstanding. Relatively few talks were given by young scientists. However, this is not seen as disadvantage given that programme was populated by top actors of cold molecule research and young scientists had an excellent opportunity to learn from best first-hand sources. Overall, the quality of the presentations was very high, corresponding to standing of the speakers.

The quality of science presented during the talks and the poster sessions was very high and reflected both some overview and the latest developments in the field. Almost with no exceptions all talks were followed by active and lively discussions. Importantly, there was a very strong mutually stimulating interaction between experimentalists and theorists, and discussions continued more informal during coffee breaks, meals, and other free moments. There were two lively poster sessions (about 35 posters each), mainly presented by students and postdocs. These were very well attended, and they partly continued beyond the formal ending hours, with discussions between young researchers and with senior scientists occurring naturally.

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, including an after-dinner lecture in the evening of day one, and two poster sessions after dinner other two evenings. The speakers were kept well in time by the respective session chairs, enabling a discussion time which was sufficient and was always used out. The atmosphere of the conference was stimulating with respect to information exchange, including a relatively long lunch break which was used very diversely, starting from physical activities on ski slopes, hiking in mountains, or scientific discussions at the conference venue. Even the opportunities for evening socialization in the lobby or at the bar after poster sessions were intensively used. Young researchers had chances (and used them) to discuss their work, for example during the poster sessions, which usually lasted late in the night. All in all, there was ample time and space for informal discussions at the conference, which was quite enthusiastically used by the participants. In fact, the atmosphere and setting was akin to the spirit of Gordon Research Conferences, which would be good to try to maintain in the future.

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?

Without doing a precise head-count, the number of participants can be estimated as about 100-120. The balance between experienced scientists, which included world leading experts, and young scientists (both PhD student and postdoctoral level) was very well chosen. Few of the young scientists gave oral

presentations, which is outweighed by the impressive list of invited speakers who are top experts from the field worldwide. In that sense, the organisers had done an excellent job in putting together a really rich content of oral sessions. It should be noted that the lecture room was always full and all sessions were equally well attended regardless hour of the day or title of the presentation. This indicates that representatives of all sub-fields at the conference were actually interested in each-other's research, there was nothing like "not-in-my-field" effect in session attendance that can occasionally be observed at other meetings.

The number of young participants was relatively high; certainly more than a half of the participants could be attributed to being postdocs or PhD students. About 40% of participants were actually PhD students. National balance of European participants was representative for this field in Europe. Importantly, the list of invited speakers included top people from US, Canada, Japan, and Israel, giving the conference a true international dimension. There was also a well-chosen balance of subfields that are currently representative to the research field of the conference, including communities working with ultracold neutral gases, slowing of molecules, and trapped ions.

It is interesting to note that among conference participants there were a number of members of two finished ESF EUROCORES programmes - EuroQUASAR and EuroQUAM. It is an excellent example of synergy among the different ESF instruments (i.e., Conferences and Eurocores); it also serves as an indirect success and impact indicator of these two programmes.

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 collaborations are highly likely to emerge from the interactions of scientists at this conference. The round table discussion did assess the on-going trends and the anticipated future trends in cold molecule research. The state-of-the-art of the field has now reached the level when it is ripe for a quantum leap into real ultracold chemistry, and there is interest to work more closely with chemists and also with physicists working on coherent control using shaped femtosecond pulses. Under normal circumstances it would have been highly appropriate to start a new EUROCORES programme on ultracold chemistry. There were in fact two proposals for such a new ultracold chemistry network submitted to the last two EUROCORES theme calls, yet the potential of the programme was not fully recognised by the ranking committee despite all top scores given to the proposal by the independent referees. Given the discontinuation of all ESF funding schemes, there remains nothing of ESF instruments that can be recommended. On the positive side, it was a pleasure to see the determination of the conference chairpersons to go ahead with cold and ultracold molecules conferences in the future by other arrangements than support via the ESF conference scheme.

Follow-up

What immediate and long term follow-up would benefit collaborations and dialogues that may have begun at the conference?

There are two active and very successful networks on ultracold molecules in the US supported by the AFOSR Multidisciplinary Research Program of the University Research Initiative (MURI). There are no large scale networking programmes on ultracold molecules in Europe, which means there is no formal networking mechanism in place that would facilitate the collaboration European scientists in this area beyond the usual bilateral level. It would be highly advisable to initiate a new COST action on ultracold chemistry to create and overall networking framework. An additional ERA-NET on ultracold chemistry could secure several smaller size funded subgroups focusing on specific aspects of ultracold chemistry research, complementing the overall network created by a potential COST 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 took place in the Obergurgl conference centre maintained by the University of Innsbruck. This centre is situated in a beautiful location in Ötztal valley of Austrian Alps and is excellently suited for medium size meetings. Some logistical inconveniences in reaching the conference site are fully rewarded by scenery of the location and its recreational facilities that were available to those participants wishing to use them during the breaks. The conference centre is equipped with all necessary infrastructure for presentations and size of the lecture hall was perfectly suited for this meeting. Free wireless internet access was available throughout the conference venue, enabling the participants to connect to the outside world whenever necessary. The centre has own rooms for accommodation, which are clean and equipped with all basic needed comfort, with sauna facilities available for conference participants in house. The local personnel were very friendly and helpful. Catering was well organised and food was of high quality, respectful to and selective with respect to people with special dietary requirements. There was a flexibility to opt for take-away lunch packs for those participants who preferred to spend lunchtime skiing or 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?

Overall, the conference was a very stimulating and successful event. It was a very informative update on recent developments within the various subfields of cold molecule research. The conference brought together a good mix of top scientists and young researchers representing those subfields, leading to a vivid dialogue and discussions. New scientific collaborations are likely to result, and it would be advisable for someone to take initiative of creating a new large scale collaboration framework for ultracold chemistry at large, e.g., in form of a new COST action. Based on the above observations, I conclude that aims of the conference were fully achieved. This conference can be surely added to the list of success stories of the ESF Conferences scheme.

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