Okazaki Conference

The 73rd Okazaki Conference
Coherent and Incoherent Wave Packet Dynamics

(October 30–November 2, 2013)

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The topics discussed at the Coherent and Incoherent Wave Packet Dynamics colloquium are at a forefront of a number of rapidly expanding interdisciplinary areas of research, spanning atomic, molecular, and optical physics, condensed-matter physics, chemical physics, physical chemistry, quantum optics, and quantum information, with the number of groups interested in applying coherent control to such diverse areas of research increasing rapidly from year to year. Of particular interest will be the implementations of recent technological breakthroughs in molecular and laser science, which offer new ways of creating and manipulating molecular processes using quantum effects.

The main objectives of the workshop are: 1) To discuss strategies of making progress in subfields which have so far resisted the application of coherent control. 2) To advance innovative future technologies, and in particular the development of new optical tools to exercise control on the nanoscale. 3) To discuss ways of enhancing the interactions between theoreticians and experimentalists that are absolutely crucial for making progress in such an interdisciplinary field. 4) To lay the foundation for a strong and vibrant hub of activity in coherent control across the Pacific, which will facilitate the exchange of UBC and Japanese scientists and students and the organization of joint workshops and conferences. 5) To make the public more aware of the tremendous potentials of coherent control, and UBC's leadership in this field.

As for the public event, the participants enjoyed an excursion to Asuke village, which is a historical village that used to be a hub of salt trading along "Sanshu Highway" in Edo era. They also enjoyed Samurai performance played by a volunteer group in Okazaki. These events helped participants to develop their personal friendships.

Listed below is the list of invited speakers.

Prof. Ilya Averbukh (Weizmann Institute of Science)
Prof. Thomas Baumert (University of Kassel)
Prof. Jianshu Cao (Massachusetts Institute of Technology)
Prof. Akihito Ishizaki (Institute for Molecular Science)
Prof. Ronnie Kosloff (The Hebrew University of Jerusalem)
Prof. Roman Krems (The University of British Columbia)
Prof. Robert J. Levis (Temple University)
Prof. Valery Milner (The University of British Columbia)
Prof. Takamasa Momose (The University of British Columbia)
Prof. Kazutaka Nakamura (Tokyo Institute of Technology)
Prof. Ed Narevicius (Weizmann Institute of Science)
Prof. Keith Nelson (Massachusetts Institute of Technology)
Prof. Yasuhiro Ohshima (Institute for Molecular Science)
Prof. Hiromi Okamoto (Institute for Molecular Science)
Dr. Leonardo Pachon (University of Toronto)
Dr. Benjamin Sussman (National Research Council, Canada)
Prof. Matthias Weidemuller (University of Heidelberg)

The colloquium yielded a coherent control network across a variety of disciplines raging from atomic physics to biosciences. It has also laid the foundation for a strong and vibrant hub of activity in coherent control across the Pacific between UBC and Japanese scientists, and has made the public more aware of the tremendous potentials of coherent control and UBC's leadership in this field.

The invited speakers gave excellent lectures on the frontiers of a variety of disciplines ranging from AMO physics, nano-sciences, condensed matter physics, and biosciences from a viewpoint of quantum coherence. There was a good balance between experimentalists and theoreticians. Such arrangement of speakers activated interdisciplinary discussion among all the participants to discuss each subject for its new perspective and concept, and to further promote coherent control network across those various disciplines.

Examples of innovative approaches or creative ways of knowing that were developed or expanded through this Colloquium are as follows.

1) New schemes of optical control and observation of molecular rotation, strong-laser induced molecular dissociation and ionization, high bit-rate information processing with molecular vibration, formation of ultracold molecules, and ultracold molecular collisions.
2) Exploring many-body physics with ultracold Rydberg gases and ultracold molecules in an optical lattice.
3) Optical control of collective motion in condensed phases such as plasmon, coherent phonons, and photo-induced phase transitions in bulk solids and nano-materials.
4) Exploring the role of coherence in biological systems such as photosynthesis and circadian rhythm.

The colloquium generated a new research model in which coherent control, which has originally been developed for isolated small molecules, is now being applied to many-body systems ranging from strongly correlated ensembles of ultracold atoms and molecules to biological systems such as photosynthesis. Such active control offers a new possibility for better understanding of those complicated many-body phenomena than that obtained by passive observation.

The colloquium has demonstrated a possibility of new collaborations of two different disciplines such as ultracold physics and ultrafast coherent control, quantum optics and photosynthesis, and quantum information processing and molecular science. It has also promoted collaborations in each discipline among top researchers of Canada, USA, Europe, Israel, and Japan.

Although we initially planned to simulate the exchange of idea and concepts between participants belonging to different research fields, the varieties and diversities of the topics discussed in the colloquia were far more extended than we expected. Some representative examples, exhibiting the present state-of-the-art status of coherent control, includes: Creation of a uni-directionally rotating molecular ensemble with its internal energy reaching to hundred times of thermal ensembles, bimolecular reaction with finely tuned collisional energy ranging from a few tens of K to mK, and spatio-temporal tracking of excitation-energy transfer from a single ultracold Rydberg atom to surrounding ground-state atoms. Still, the discussions were not simply scattered into each specific problems, but always linked to a common concept, *i.e.*, coherent/incoherent nature of the systems under discussions. It was impressive to observe unexpectedly intensive exchange of thoughts between the researchers with different disciplines.

At the beginning, we had always to spend some times to clarify the difference in meaning of the same words or terms among the people with different research backgrounds, before we were able to find out the bottom line of the discussions we shared in the colloquia. After managing this little bit time-consuming process, it became possible to extract the similarity in the underlying physics and the uniqueness of each system, from apparently different two phenomena observed in separated fields, *e.g.*, energy transfer in ultracold atoms and biosystems. It was also of much appreciation to find out plenty of possibilities of state-of-the-art new technology developed in some research field transferable to a far remote scientific area, for instance, ultrafast laser technology to be implemented in ultracold atomic physics and coherent control of molecular degrees of freedom into quantum information processing.

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