

Bloch Oscillations and Landau-Zener Tunneling: From Hot Electrons to Ultracold Atoms

Seminar and Workshop

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Bloch oscillations and Landau-Zener tunneling are the fundamental properties of quantum dynamics of a particle in a periodic potential subject to an external static force. The wave-particle dualism leads to a completely counterintuitive behavior of the Bloch-oscillating wavepacket-particle. Since many years this behavior attracted substantial interest in its deep theoretical understanding and clear experimental observation. The main purpose of this International Seminar and Workshop was to bring together leading experts in the study of Bloch oscillations and Landau-Zener tunneling in different systems and materials, such as semiconductor superlattices and devices for hot electrons, optical waveguide arrays, optical superlattices and photonic crystals for photonic wavepackets, ultrasonic superlattices and superlattices made of acoustic micro- and nanocavities for acoustic and phononic wavepackets, optical lattices for ensembles of ultracold atoms and Bose-Einstein condensates.

The Seminar (April 14 - May 01, 2009) was devoted to lectures, research work and synergetic discussions. During the Seminar, several invited and contributed speakers (Bastard, Cataliotti, Holthaus, Ishkanyan, Jusserand, Khomeriki, Kolovsky, Krimer, Manevitch, Oberthaler, O'Dell, Renk, Ruffo, Weitz) have given comprehensive lectures for young researchers, researchers from the mpipks and participants of our event from different fields of physics. Each week around 15 participants attended Seminar lectures.

During the Workshop week (May 04 - 08, 2009), the invited and contributed talks were focused on the fundamental concepts, appealing physical analogies and interdisciplinary exchange of ideas, as well as on novel applications of Bloch oscillations and Landau-Zener tunneling in a broad spectrum of modern materials and actual systems. The total number of participants was more than 60 coming from all over the world.

The participants represented an appropriate mixture of senior scientists and less experienced young researchers. The program provided opportunities to both groups to interact on various levels on the specific topics in the broad scope of the event. In particular the young researchers have been given the chance to interact and to present themselves during the poster sessions which have been organized along with the workshop program. In addition several talks have been given by the next generation scientist as well.

The given presentations represented a balanced mixture of the different targeted fields of physics in which Bloch Oscillations and Landau-Zener Tunneling can be observed. For historical reasons semiconductor superlattices had been in the focus of many scientists (Aleksiev, Allen, Bastard, Beltram, Dignam, Domínguez-Adame, Fromhold, Hyart, Kosevich, Manevitch, Renk, Wacker), with presentations covering the development of this research since the pioneering work of Esaki and Tsu in early seventies and new approaches to the interpretation of complex experimental data including recent studies of ultrafast transient phenomena in ensembles of photoexcited carriers. However it became clear that experimental studies of ultracold atoms and Bose-Einstein condensates attract increasing interest with an impressive quality improvement of the experimental data (Biraben, Cirac, Díaz, Fromhold, Gat, Holthaus, Kasevich, Kolovsky, Korsch, Morsch, Nägerl, Oberthaler, Salomon, Stringari, Weitz, Wimberger). In addition there have been presentations devoted to newly emerging fields, like photonic systems (Desyatnikov, Dignam, Dreisow, Kavokin, Longhi, Malpuech, Peschel, Ruffo) and phononic systems (Cirac, Jusserand, Kosevich).

From the comments provided by many participants we can conclude the successful achievement of the goal of the conference, to provide a status of the interdisciplinary research field and to inspire future work which takes advantage of transferring and generalizing concepts among the different fields of physics. The meeting will facilitate further fruitful exchange of ideas between those fields. Owing to the success of the meeting, the organizers plan to publish selected lectures of the Workshop in a book.

We thank the mpipks for all the financial support to the Seminar and Workshop. Most importantly we would like to thank Claudia Poenisch and all the mpipks staff for the excellent organization of the event. The very friendly atmosphere was an important part of the overall success of the conference.