Report on ECOQAS11

Christiane Koch[1] and Giovanna Morigi[2]

[1] *Universität Kassel, Institut für Physik, Kassel*
[2] *Universität des Saarlandes, Theoretische Physik, Saarbrücken*

(Dated: November 29, 2011)

Main focus of the conference A prerequisite for quantum technologies is the creation of robust quantum mechanical coherence and entanglement. A major challenge that any implementation of quantum technologies has to face is that coupling to the environment leads to loss of coherence: This problem represents a serious obstacle for realizing scalable protocols. Therefore the search for strategies to combat the detrimental effects of dissipation and decoherence is at the center stage of current theoretical and experimental research and requires the development of novel concepts.

The workshop ECOQAS was devoted to the discussion of the challenges and perspectives for scaling control strategies up to the mesoscopic regime. For this purpose, we brought together world-leading scientists from the fields of physical chemistry, atomic, molecular and optical physics, and quantum information science.

Most of the speakers addressed the characterization and control of specific physical systems providing the common ground. The subjects ranged from applications of control to atomic and molecular systems, cavity quantum electrodynamics, optomechanics, and NMR systems, to novel concepts and ideas in quantum thermodynamics, quantum communications, and quantum effects in biology.

In order to provide a flavour of the conference, we highlight a few presentations: The theoretical underpinnings of quantum control were discussed in detail in the lectures by Tommaso Calarco (Ulm) and Rosario Fazio (Pisa), and in the colloquium by Herschel Rabitz (Princeton), setting the stage for the new challenges, namely, optimal control of quantum many-body systems. Newly developed concepts such as quantum reservoir engineering and noise-assisted transport were introduced by Barbara Kraus (Innsbruck), Birgitta Whaley (Berkeley), Thomas Wellens (Freiburg), and Susana Huelga (Ulm). Ideas and techniques for quantum state estimation and tomography were discussed in the talks by Antonio Acin (Barcelona) and Juan Pablo Paz (Buenos Aires). On the experimental side, in his the femtosecond laser pulse control experiments Kenji Ohmori (Okazaki) applied basic concepts in physical chemistry to quantum information science. Serge Haroche (Paris) presented the first successful demonstration of quantum measurements combined with feedback control in cavity quantum electrodynamics. Ennio Arimondo (Pisa) discussed the experimental application of optimal control protocols to ultracold atomic gases forming Bose-Einstein condensates. Tobias Kippenberg (Basel) presented a review of control achieved in state-of-the-art experiments in optomechanics. A major breakthrough was reported by Immanuel Bloch (Garching), who showed the realization of in-situ measurements of atoms in optical lattices, revealing the microscopic details of these many-body systems.

The variety of physical systems provided in first place a diversity of approaches. Moreover, it also contributed to delivering a more complete picture of the limitations and challenges which the issue of scaling up quantum control carries with itself. In passing, we would like to point out that 7 out of 41 talks were presented by women scientists and a number of talks beyond the joint colloquium with the institute were attended by institute members.

Most important participants Due to the diversity of the attendants' background, it is difficult to single out a few major protagonists: Indeed, the conference was characterised by excellent talks and intense discussions, which involved most participants. Discussions took place after the talks, during the various breaks, and at the poster sessions. It is noteworthy that these discussions involved both senior and junior scientists from different fields who exchanged knowledge and identified common questions.

How did scientific newcomers present themselves Young scientists took actively part in the conference program, they were involved in several discussions and, as far as we can say, established new connections. Two young postdocs (Cecilia Cormick and Giulia Gualdi) were session leaders. Young postdocs were also selected for some of the contributed talks, to mention some: C. Cormick, A. Gorschov, M. Khasin. All student participants presented their own work in the poster sessions that were attended by most attendees. Discussions in front of the posters continued even outside the assigned slots of the program.

Scientific results of the conference in a broader sense The objective of the conference was to highlight new theoretical ideas and experimental methods tackling the current challenges and to identify limitations to and future perspectives for scalable control at the quantum level. Considering the excellent talks and the extensive discussions, which saw the active participations of most attendees, the conference has successfully met this objective. We furthermore believe that the conference has also served as an opportunity

for scientific networking where collaborations have been both refreshed and newly established and future joint proposals have been discussed. The ECOQAS11 conference has thus significantly contributed to the ongoing effort of identifying perspectives to scalable control of quantum systems.