Mathematical Control Theory and Quantum Applications

joint students meeting by the ENB PhD Programmes
QCCC, TopMath, and "Identification, Optimisation,
& Control for Technical Applications"
hosted by QCCC

Wed., June 4th 2008 on the TUM Campus Garching,
Mathematics Building Room MI 00.13.009A, Boltzmannstr., 85748 Garching
http://www.ma.tum.de/twiki/bin/view/Mathematik/AnfahrtCampusGarching

---

10.30h —coffee in MI cafeteria—
11.00h Welcome
11.10h Christina Kraus:
Quantum Simulations under Translational Symmetry
12.00h —lunch at MATH-MI or MPG-IPP—
13.10h Tobias Wichtrey:
Controllability for Systems with almost Periodic Excitation
14.00h Volkher Scholz:
Challenges Concerning the Control of Many-Body Quantum Systems
14.50h —coffee break—
15.20h Indra Kurniawan:
Controllability Aspects of Open Quantum Systems
16.10h Thomas Schulte-Herbrüggen:
Quantum Control at QCCC: Topics and Appetizers of Current Projects
Transfer via tube U6 to beergarden for get-together
17.00h —drinks and snacks at Poseidon Garching—

---

abstracts overleaf

Abstracts

Christina Kraus, QCCC, MPQ Garching, Group Prof. Cirac, (Christina.Kraus@mpq.mpg.de)
Title: *Quantum Simulations under Translational Symmetry*
Abstract: We investigate the power of quantum systems for the simulation of Hamiltonian time evolutions on a cubic lattice under the constraint of translational invariance. Given a set of translationally invariant local Hamiltonians and short range interactions we determine time evolutions which can and those that can not be simulated. Whereas for general spin systems no finite universal set of generating interactions is shown to exist, universality turns out to be generic for quadratic bosonic and fermionic nearest-neighbor interactions when supplemented by all translationally invariant on-site Hamiltonians.

Tobias Wichtrey, TopMath, Math. Inst. Uni Augsburg, Group Prof. Colonius, (tobias@tarphos.de)
Title: *Controllability for Systems with Almost Periodic Excitation*
Abstract: For control systems described by ordinary differential equations subject to almost periodic excitations the controllability properties depend on the specific excitation. In this talk, these properties and, in particular, control sets and chain control sets are discussed for all excitations in the closure of all time shifts of a given almost periodic function. Then relations between heteroclinic orbits of an uncontrolled and unperturbed system and controllability for small control ranges and small perturbations are studied using Melnikov's method. Finally, a system with two-well potential is studied in detail.

Volkher Scholz, Guest from Group Prof. Reinhard Werner, Math. Phys. Inst., Uni Braunschweig
Title: *Challenges Concerning the Control of Many-Body Quantum Systems*
Abstract: The idea of quantum simulators, going back to Feynman, is to use "controllable" quantum systems in order to simulate other interesting systems of interacting particles. Or, to pose it in a more drastic way, to beat the complexity of exponentially growing Hilbert space dimension by other quantum systems. However, at the same time, the realization of quantum simulators requires new techniques to optimize the control of quantum many body systems. In this talk, we will give an overview of possible experimental realizations as well as theoretical challenges.

Indra Kurniawan, ENB-PhD Programme: "Identification, Optimisation, and Control for Technical Applications", Math. Inst. Uni Würzburg, Group Prof. Helmke, (kurniawan@mathematik.uni-wuerzburg.de)
Title: *Controllability Aspects of Open Quantum Systems*
Abstract: This talk addresses control-theoretical issues of finite dimensional (N-level) open quantum systems described by Lindblad-Kossakowski master equations (LKME). Specifically, in the case of negative controllability results, we provide a new necessary and sufficient condition for accessibility of the unital LKME by exploiting a well-known result on the classification of transitive Lie groups actions on $\mathbb{R}^m \setminus \{0\}$. For the special case of n coupled spin-1/2 systems, we particularly obtain a remarkably simple characterization. We will also discuss whether accessibility is a generic property.

Dr Thomas Schulte-Herbrüggen, QCCC, Coordinator, Dept. Chemistry TUM Garching, (tosh@ch.tum.de)
Title: *Quantum Control at QCCC: Topics and Appetizers of Current Research Projects*
Abstract: We sketch the mathematical structure of gradient flow methods for abstract optimisation tasks on Lie groups and Riemannian manifolds on the one hand side and dynamic optimal control tasks on the other. Within the framework of optimal control, current topics range from implications of optimal control on the design of quantum hardware via controllability analysis of quantum systems under symmetry constraints to optimal control of closed and open quantum systems in Markovian and non-Markovian settings. They give a perspective on relaxation-protected quantum compilation and scalable assembly.