Andrew Daley

Department of Physics and Astronomy
University of Pittsburgh
214 Allen Hall, 3941 O'Hara St.
Pittsburgh, PA 15260, United States of America

Lectures 1-2: Quantum Simulators

- Introduction to the concepts of digital and analogue quantum simulation
- Introduction to the microscopic models for atoms in optical lattices and the well-controlled approximations behind their derivation
- Outline derivation of Bose-Hubbard and Hubbard models with as an example
- Summary of basic properties of these models, and interest in quantum simulation

Lecture 2-3: Dynamics, state-of-the-art, and perspectives

- Time-dependent dynamics in optical lattices: Fundamental relevance of quenches/thermalisation
- Examples including global and local quenches / thermalisation
- Entanglement in quantum simulators
- Comparison of classical vs. quantum simulation
- Verification of quantum simulation. Importance of producing pure states; controlling heating
- Experimental state-of-the art and perspectives

Lecture 4: Atoms in optical lattices for clocks and precision measurements

- Strontium Optical lattice clocks
- Related atomic physics
- Applications of these systems for interferometry - standard quantum limit / Heisenberg limit
- Applications to quantum computing

Lecture 5: Imperfections: Introduction to decoherence and open systems

- Introduction to open quantum systems
- Decoherence in quantum optics, what this means in either measurement or many-body quantum simulators
- Forms of system-reservoir coupling. Quantum Optics approximations, and the master equation

Lecture 6 (if time): Introduction to quantum trajectories methods to interpret and solve master equations

- Combination with t-DMRG to solve many-body master equations
- Examples including light scattering in optical lattices, and dissipative driving to many-body states
- Examples of using losses to achieve Heisenberg-limited interferometry.