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The Theory of Statistical Comparison with Applications in Quantum Information Science

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Abstract: In mathematical statistics a central role is played by the notion of statistical experiment (or statistical model), namely, the mathematical object describing a possible state of knowledge about an unknown parameter. It is then natural to compare and order statistical experiments on the basis of their "information content." This kind of problems led in the 1950s to the formulation of a whole theory, so-called "theory of statistical comparison," which soon developed into a very deep field with many applications, ranging from mathematical statistics to physics and economics. In this tutorial I will first review the basic ideas of statistical comparison, stressing in particular their operational character. I will then present various possible generalizations of statistical comparison to the quantum setting. Finally, by means of explicit examples in quantum thermodynamics, entanglement theory, and the theory of open quantum systems, I will argue that quantum statistical comparison theory provides a powerful toolbox to study some among the most exciting recent developments in quantum information science. This tutorial is organised to be as self-contained as possible, and only basic notions in probability theory and quantum information theory are required. The slides will be made available for download at http://goo.gl/5toR7X

Introduction to measurement-based quantum computation

Tzu-Chieh Wei
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Abstract: Measurement-based quantum computation (MBQC) is an alternative approach to realizing quantum computation. In contrast to other approaches where unitary evolution is the key ingredient, the MBQC uses only local measurements on a suitable entangled state to achieve universal quantum computation. The cluster state on the square lattice is such a universal resource state on this one-way quantum computational scheme which consumes entanglement. The MBQC helps to greatly reduce the resource requirement in linear-optic quantum computation, and its fault-tolerant implementation using a 3D cluster state prompts the surface code quantum computation. Novel information processing schemes, such as blind quantum computation and its verifiable version, have been invented in the MBQC framework. Moreover, the connection to condensed matter physics has also been uncovered, such as short-ranged interacting Hamiltonians with the resource state as the ground state, phase transitions in quantum computational power, and more recently the symmetry-protected topological order. In this tutorial I will give an introduction to the measurement-based quantum computation and then select a few topics for discussions.

Engineering the quantum: probing atoms with light and light with atoms in a transmon circuit QED system

Nathan Langford
Delft University of Technology

Abstract: In this tutorial, I will give a practical overview of the measurements and techniques used to tune up and characterise a simple cavity QED superconducting quantum circuit for use in quantum information processing applications such as quantum computing and quantum simulations. Think of this as an introduction to the bits that enable the flash results in papers, but mostly don't make it into them. In the process, I will give an experimentalist's guided tour of the physics of a simple circuit QED system made up of transmon qubits and microwave resonators.

The device-independent outlook on quantum physics

Valerio Scarani
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Abstract: In this tutorial, I shall first explain the claim that the violation of Bell inequalities leads to "device-independent" certification of quantum devices. Then I shall present in some detail the task of self-testing.

Reference: Thttp://arxiv.org/abs/1303.3081; http://arxiv.org/abs/1401.4243