Workshop
on
Quantum Information Science

January 7, 2010

Room 210, Run Run Shaw Building

The University of Hong Kong

Department of Mathematics

The University of Hong Kong

Morning Session Chaired by Chi-Kwong Li

09:00 – 09:05 Opening Remark

09:05 – 10:05 Mikio Nakahara (Kinki University)

Scalable neutral atom quantum computer with interaction on demand

10:05 – 11:05 Akira SaiToh (Kinki University)

Nonclassical correlations in quantum systems: detection and quantification

Tea Break

11:20 – 12:20 Yidun Wan (Kinki University)

Emergent matter of quantum geometry: a meeting point of quantuum gravity and quantum computing

Group Photo

Afternoon Session Chaired by Mikio Nakahara

14:00 – 15:00 Hoi Fung Chau (The University of Hong Kong)

Quantum cryptography with higher dimensional quantum information carriers

15:00 – 16:00 Yiu-Tung Poon (Iowa State University)

Quantum operations and completely positive maps

Tea Break

16:15 – 17:15 Raymond Nung-Sing Sze (The Hong Kong Polytechnic University)

Quantum error correction and generalized numerical range

Titles and Abstracts

Scalable neutral atom quantum computer with interaction on demand

Speaker: Professor Mikio Nakahara
Department of Physics, Kinki University
nakahara@math.kindai.ac.jp

Abstract

As an example of physical realizations of a quantum computer I reported in the introductory talk, I outline a neutral atom QC, which is one of the most promising candidates of a working QC. I will summarize advantages and disadvantages of the current proposal of a neutral atom QC and report possible way out of the difficulties.

Nonclassical correlations in quantum systems: detection and quantification

Speaker: Dr. Akira SaiToh

Interdisciplinary Graduate School of Science and Engineering, Kinki University

saitoh@alice.math.kindai.ac.jp

Co-authors

Robabeh Rahimi, Interdisciplinary Graduate School of Science and Engineering, Kinki University

Mikio Nakahara, Department of Physics & Research Center for Quantum Computing, Kinki University

Abstract

Nonclassical correlations other than entanglement have been of growing interest in quantum information science. This talk will consist of a review of the entanglement detection theory and entanglement measures, a review of nonclassical correlations other than entanglement, and our recent results on detection and quantification of nonclassical correlations.

Emergent matter of quantum geometry: a meeting point of quantum gravity and quantum computing

Speaker: Dr. Yidun Wan

Interdisciplinary Graduate School of Science and Engineering, Kinki University

ywan@alice.math.kindai.ac.jp

Abstract

We show that there exist emergent matter degrees of freedom of spin networks, the basis states of Loop Quantum Gravity, which is a model of non-perturbative canonical quantum gravity. These emergent degrees of freedom are 3-strand braids with 4-valent vertices, which can interact with each other in two ways. In one way, two neighboring braids can merge to form a new braid. In the other way, two adjacent braids can interact and become two different adjacent braids. There are conserved quantities associated with braid interactions. Since braids, in particular 3-strand braids, are important topological structures that topological quantum computing concerns, the above results may implicate a connection between Quantum Gravity and Topological Quantum Computing. Some implications will be discussed.

Quantum cryptography with higher dimensional quantum information carriers

Speaker: Dr. Hoi Fung Chau
Department of Physics, The University of Hong Kong
hfchau@hkusua.hku.hk

Abstract

Qubits (i.e., two-level quantum particles) are used as information carriers in many standard quantum cryptographic protocols. I shall report an extension that uses higher dimensional quantum particles as information carriers and analyze the advantages and disadvantages in doing so. The unconditional security proof of this extension is also outlined.

Quantum operations and completely positive maps

Speaker: Professor Yiu-Tung Poon

Department of Mathematics, Iowa State University

ytpoon@iastate.edu

Co-author

Chi-Kwong Li, Department of Mathematics, College of William and Mary

Abstract

In quantum information, quantum operations are represented by completely positive maps. In this talk, we study some basic interpolation problems of completely positive maps.

Quantum error correction and generalized numerical range

Speaker: Dr. Raymond Nung-Sing Sze

Department of Applied Mathematics, The Hong Kong Polytechnic University

raymond.sze@inet.polyu.edu.hk

Co-authors

Chi-Kwong Li, Department of Mathematics, The College of William and Mary

Yiu-Tung Poon, Department of Mathematics, Iowa State University

Abstract

The idea of quantum error correction is developed in quantum computing to protect quantum information from errors due to decoherence and other quantum noise during transmitting information in quantum channel. In connection to quantum error correction, some generalized numerical ranges were introduced and studied by researchers. In this talk, a brief introduction, basic properties, and some recent results on this topic will be discussed.