LTCC Proposed Course

Title: Mathematical Aspects of Quantum Computing

Basic Details:

- Core Audience: 1st yr and 2nd year in pure, also accessible to others with linear algebra and
- Course Format: **Extended**: 5 x 2hr lectures.

Course Description:

- Keywords: Quantum computing, ZX calculus, Kitaev model
- Syllabus (tentative):

  We provide an introduction to the mathematics of quantum computing. The course starts off with elementary notions from computer science before turning to the central algebraic and categorical structures of interest. These will include Frobenius algebras, ZX-calculus based on interacting pairs of Hopf algebras, monoidal and braided monoidal categories. The course ends with an introduction to Kitaev surface code models for topologically fault-tolerant quantum computing, including some illustrative examples.

  1) Elementary notions: qubits, entanglement, quantum gates and quantum teleportation. Quantum circuits and ZX calculus.
  2) Special Frobenius algebras and the `spider theorem'.
  3) Interacting pairs of Hopf algebras and their construction.
  4) Quantum double, monoidal and braided tensor categories.
  5) Kitaev surface code models. Ribbon operators and illustrative examples.

- Recommended reading: Quantum Computing, by E. Rieffel and W. Polak (MIT press, 2014). (An optional first introduction to the computer science.)
- Additional optional reading: R. Duncan and B. Coeke, Interacting quantum observables: categorical algebra and diagrammatics, New J. Phys. 13 (2011) 80pp. (A classic paper in the field.)
- Prerequisites: Basic linear algebra should be sufficient for the most part.

Format:

- No of discussion/problem sheets: 4.
- Electronic lecture notes

Lecturer Details:

- Lecturer: Professor Shahn Majid
- Lecturer home institution: Queen Mary University of London
- Lecturer e-mail: s.majid@qmul.ac.uk