Physics 8880 Quantum Optics and Quantum Information

Instructor: Olivier Pfister (135 Physics. 4-7956. opfister@virginia.edu)

Prerequisite: Phys 751 (Quantum Mechanics I) or instructor permission

Grading:
- Homework (∼ one problem set per week) 3/8
- Pledged homework 1/4
- Bibliography, study and presentation of a research paper 3/8

I Nonclassical light: quantization of the electromagnetic field

B. Photodetection and photon statistics
C. Linear quantum optics: beam splitting and vacuum fluctuations
D. Nonlinear quantum optics: photon correlations, squeezed light, and quantum interference
E. Nonlinearizable nonlinear quantum optics: negative Wigner functions†

II Quantum entanglement

A. What is entanglement? Qubits, qumodes, and statistical mixtures
B. Bipartite entanglement
   1/ The Einstein-Podolsky-Rosen paradox. Quantum optical realization
   2/ The Bell theorem.† Quantum optical realization
   3/ The Schmidt representation, entanglement measures, and criteria
C. Multipartite entanglement
   1/ Greenberger-Horne-Zeilinger theorem and states; W states
   2/ Cluster states and stabilizers
   3/ Discrete variables vs. continuous variables (CV)†?

III Quantum information

A. Quantum communication
   1/ Quantum key distribution
   2/ Quantum teleportation & dense coding
   3/ Quantum secret sharing
B. CV dense coding and precision measurements
C. Quantum error correction
D. Quantum computing
   1/ Circuit-based quantum computing
   2/ Measurement-based quantum computing
   3/ Quantum algorithms: from database search (Grover) to factoring (Shor)†

IV Quantum computing over the rainbow @ UVa

A. CV graph states
B. One-way quantum computing over CV toroid states†
C. Practical implementation. Road to the Nobel Prize?

† From nonclassical to quantum only