Lecture 34

Quantum Algorithms I
The Pieces of the Course

- Wave particle duality
- Bound states of quantum mechanical potentials
- Quantum mechanical states of optical radiation field
- Interaction of quantized light and matter
Last quarter in Schleich

- Review of QM and introduction to QM written in terms of the density matrix (C2)
- The thermal (blackbody) state of light (C2)
- Wigner functions (C3)
- Wigner representations of the states of light (C4)
- Quantization of the electromagnetic field (C10)
This quarter in Schleich

- More states of the EM field including the states of Schrödinger’s cat (C11)
- Q and P functions to go with Wigner functions (C12)
- Beam splitters and interferometers (C13)
- Atom-field interactions (C14)
- The JCP model and its solution (C15)
- Preparing entangled states (C16)
Last Monday’s Topics on Quantum Computing with actual Gate Realizations

- Single qubit logic gates
- Two qubit logic gates
- An archetypical Q computer
- An implementation of a circuit which performs classical addition on pure states
- Realizations of the simplest gates of the simplest adder
Single Qubit Quantum Logic
Two Qubit Quantum Logic

CNOT

$|x,x \text{ (XOR) } y>^>$

$|x,y \text{ (XOR) } f(x)>^>$
A Model for a Q computer

Unitarily Evolve

Feedback
Another Model for a Q computer

- Create Data Registers
- Unitarily Evolve
- Target Registers
- Control Interference
- Read-Out
Examples using polarization as well as quadratures (CVQC)

- A modulo two adder (w/wo interference)
- A modulo 4 adder (w/wo interference)
- An adder (w/wo interference)
- A Q FFT on three bits
- A Q FFT
- Shor’s algorithm
Today’s Topics

• The $U_f$ gate for 1+1 and n+1 inputs
• Quantum parallelism and quantum interference
• Deutsch’s algorithm
• The Deutsch Jozsa algorithm
• The quantum FFT
• Quantum phase estimation