Lecture 25

Discussion of Project and Review of Proposals
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
Summary of the quantum postulates

- There is a (normalized) state vector
- Unitary evolution of the state vector is generated by a Hamiltonian
- Measurements are represented by Hermitian operators that place the system in a measurement eigenstate
- A composite state vector is represented in a basis that is an outer product of the basis sets of its component state vectors
Week after the Midterm

- A project discussion on 10/20
- The hydrogen atom
- Transition from Robinett to Schleich and chapter 1 of Schleich
- A project proposal due date 10/24 (10/31)
- Problem set on chapters 16-18 due on 10/27 (11/3)
Some Project Details

• Project write up should include both some review and some *original* work be they calculations or revelations

• Psets from here on out will be taken from topics in Schleich and will be somewhat open ended

• Project topic should be a Q info topic related to an area in Schleich

• Project is *25%* of the course grade
Some Possible Project Topics

• Teleportation and 8 port interferometers
• Schrodinger cat states as qubits
• Bell state decoherence and density matrices
• Quantum measurements via quantum tomography
• Zero point fluctuations and the Casimir effect
Some Proposed Topics

- Photon pressure sensing with Casimir effect sensors
- Disproving possibility of quantum cryptography
- Implementations of Q gates
- Possible Q computing architectures
- The SU(1,1) interferometer
Book References for Project

- George Johnson
- John Gribbon
- John Bell
- Nielson and Chuang

complexity
Articles for Project

• Gisin
• Bennett
• Nielson (Scientific American)
• Centre for Q computing tutorials
• Schleich
• Recent Physics Todays and Sciences
Previous Project Discussion

- Polarization and polarizers
- Quantum cryptography (non cloning theorem)
- Qubits, Poincare spheres and decoherence
- Entangled Qubits and Bell States
- Teleportation and Dense Coding
The Cast of Characters

Alice

Charles

Bob

Eve

Victor

Information
Quantum Cryptography

Generally need to distribute key first
Why Q Cryptography?

• Non cloning theorem allows one to know when a bit is lost allowing for secure, but slow communication

• Data encoded in non orthogonal basis can only be read with knowledge of the basis

• Teleportation can be used to develop random keys
Teleportation

Alice —> Q Info —> Victor

Charles

Bob
Eve’s Transmitter

8 Port

From Charles

Info

Joint Bell State Measurement

E L E C T R A L

X M I T

Two Bit Classical Code
Superdense Coding

Alice

Charles

Bob

Classical Information

Victor
Eve’s Transmitter

From Charles

Two Bit Code

Set Filter Control box

Filter

Q Info to Bob
Bob’s Receiver

8 Port

Joint Bell State Measurement

From Charles

Info

E L E C T R I C A L

Two Classical Bits

X M I T
Last Monday’s Topics

- Qubits, Poincare (Bloch) spheres and decoherence
- The Pauli matrices as rotations
- A possible set of primitives
- Other sets of primitives
- Quantum parallelism
Quantum Logic

X

Z

H

CNOT
Quantum parallelism

Unitarily Evolve