Lecture 9

Commutators

and

Part I of the Project

Revisited
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
Topics from Last time

- Expectations for operators
- Energy eigenstates
- Representation theory
- Commutation of operators
Topics for Today

• Commutation of operators
• Some things about the project that weren’t covered the last time around
Commutators of operators

- Fourier transforms and uncertainty
- Canonically conjugate quantities
- Measurements of position and momentum
- \([x,p] = \frac{i}{2\pi} h\)
- How arbitrary is \(\psi\) when calculating a commutator
Some things about the project

- Polarization of electromagnetic waves
- A polarized propagating wave as a qubit
- A review of linear algebra but this time in Dirac notation
- The four postulates of quantum mechanics
Waves and polarization

- An expression for the electric field
- Polarization vectors and abstract vectors
- Polarizers and operators
- Detectors and photon counting
- Weak fields and quantization
- Strong fields and shot noise
Linear algebra

- Complex n-tuples and their bases
- Inner product (Hilbert) spaces
- Vector outer products
- Hermitian operators and measurement
- Unitary propagation
- Composite vector spaces
Quantum mechanical postulates 2x2 part I

- A quantum mechanical system is represented by a vector in a Hilbert space.
- A closed quantum mechanical system evolves by a unitary transformation where that unitary transformation is generated by the system Hamiltonian.
Quantum mechanical postulates 2x2 part II

- Quantum mechanical measurements can only yield values that are eigenvalues of Hermitian operators that model the measurement system.
- A composite quantum mechanical system is represented by vectors in a Hilbert space that is an outer product space of its composite parts.