

Quantum Mechanics C (Physics 130C) – Winter 2014

TENTATIVE COURSE OUTLINE

Disclaimers: The ordering and content indicated below is approximate and may shift. Sub-headings are not in one-to-one correspondence with lectures.

1. Quantum is not classical (aka Quantum Mechanics in Your Face).

- 1.1 Basic facts about quantum mechanics.
Dirac notation, linear algebra review
- 1.2 Symmetries and conservation laws.
- 1.3 Two-state systems (Pauli matrix boot camp).
- 1.4 Putting things on top of other things. QM of not the whole universe: density matrices, mixed states and pure states.
- 1.5 Entanglement: entanglement and locality, Bell inequalities, GHZM states.
- 1.6 Uses of entanglement.
- 1.7 Quantum bomb testing. This is an example of something that you simply cannot do without quantum mechanics.
- 1.8 Quantum computing. Perhaps quantum error correction.
- 1.9 Interpretations of QM.

2. The emergence of classical mechanics from quantum mechanics

- 2.1 Ehrenfest's theorem.
- 2.2 First pass at a theory of measurement.
- 2.3 Decoherence and the interpretation of QM.
- 2.4 Path integrals as the logical conclusion of superposition.
- 2.5 ? Berry phases
- 2.6 WKB.

3. Applications to condensed matter and to particle physics

- 3.1 Review of the harmonic oscillator.
- 3.2 Towards quantized field theory of sound and light (in which we discover quantum field theory under the mattress).

- 3.3 Casimir effect (vacuum energy is real).
- 3.4 Identical particles.
- 3.5 Band structure: metals and insulators
- 3.6 Particles in electromagnetic fields: Landau levels and quantum Hall effects (topology from dirt), Aharonov-Bohm effect (the vector potential is real).