Quantum Theory (PHYS 450): Week 8

Spring 2008 v1.0

We will finish the harmonic oscillator and study the ideas and conceptual structure of the path integral formulation.

Enjoy!

Reading:

Townsend Chapter 7
Townsend Chapter 8

Notes on text:

- page 203: It is amazing how the solutions in position space "fall out" of the operator formalism. Compare this to the amount of work required when simply solving the Schrodinger equation in section 7.9
- pages 205-7: This is a interesting section both the calculations of the expectation value of energy and in the discussion of melting of helium

Problems:

Problems are due at the beginning of seminar. Please make a copy of your solutions before you arrive.

(1) Select one question topic you would like to discuss during seminar.
(2) Derive 7.36 (or 7.37) by first writing out the upper left block (make it block of 3×3) of an arbitrary matrix in terms of Kroneker δ's then specializing to the raising or lower operators using 7.34 (or 7.35).
(3) Derive the classical probability in 7.60.
(4) 7.5
(5) 7.7
(6) 7.10
(7) 7.12
(8) Explain how by "inserting 1" repeatedly one can express the evolution to first order in Δt as 8.18.

Seminar Presentations:

Come to seminar with your presentation notes complete. If you have any doubt about your presentations, please ask questions **before** seminar.

- Wex.: Discuss the Heisenberg uncertainty principle and section 6.7 including the double slit experiement. Look up the Nature article in footnote 11 and present a summary of the paper (from last week).
- Nguyen: Use the discussion of tunneling and arbitrary potentials (pages 182-184) as a jumping off point to discuss the WKB method. Most of the slightly more advanced texts discuss the method (from last week).
- Emily: Let's pause for a moment in the development of quantum mechanics and get the Big Picture. Read Davies and Betts Chapter 6 and give us the one page summary of (the postulates of) quantum mechanics.
- Ruth: Find the Hermite polynominals (and the Rodrigues' formula) in the position space wavefunctions 7.45. Tells us about Hermite polys, relate them to the position representation wavefunctions. Include the generating function and some plots of the first four Hermite polynominals. See Boas and Davies and Betts section 4.1 and problems 4.4-4.8 in Appendix F.
- Mike: Guide us through section 7.9. Start with 7.66, the Schrödinder equation; explain the change of variables and 7.69; show why $e^{y^2/2}$ is a reasonable solution; show how we get a

recursion relation; and explain why the series must terminate, thus deriving 7.84 and 7.85. Find $h(y)$ for $n = 2$ checking your result with 7.47.

- Jordan: The path integral - the idea. Expand on the double a triple slot examples. Write out the required terms. How do I find the probability? See Feynman Lectures Vol III chapter 3.
- Walter: The path integral - the definition. Where does 8.28 come from?
- Dan T: Guide us through the discussion of the "which paths count" in section 8.6.
- Dan C.: Digest the argument on pages 229-231 for us. Refer to Feynman's book QED.