HW #8 Problems
Quantum 521

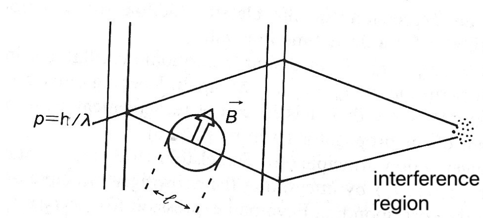
1. A sketch of a neutron interferometer is shown in the figure. Prove that difference in the magnetic field to produce two successive maxima in the counting rate is

$$\Delta B = \frac{16\pi^2\hbar c}{e g_n \lambda \ell}$$

where the neutron magnetic moment is

$$\mu_n = \left(\frac{g}{2}\right)\frac{e\hbar}{2mc}$$

$g = 2(-1.9)$ is the neutron magnetic moment g-factor.



2. The pre-factor A in the Feynman Path integral can be obtained from (L. S. Schulman, "Techniques and Application of Path Integrals")

$$A(t) = \sqrt{\frac{m}{2\pi i\hbar f(t)}}$$

where the function f satisfies the differential equation

$$m\frac{d^2 f}{dt^2} + cf = 0$$

Here $c/2$ is the coefficent of the quadratic term in the potential (as in lecture). The boundary conditions for f are $f(0) = 0$ and $\frac{df}{dt}|_{t=0} = 1$

Derive the free particle propagator.

3. On homework we found the action for the simple harmanonic oscillator along the classical path. Find the propagator $\langle x_b|\,\hat{U}(t)\,|x_a\rangle$ for the harmonic oscillator including the pre-factor $A(t)$. You can also write the same propagator in terms of the harmonic oscillator energy eigenstates using completeness. Equating the two expressions for the propagator you can optain the ground state wavefunction using the Feynman-Kac method: analytic continue to imaginary time $t \to -i\tau$ and take the limit $\tau \to \infty$ to pick out the ground state wave function and the ground state energy. This is pretty amazing!