

# Homework Set #1.

due April 20

1.

Consider the Harmonic Oscillator

$$L(x, \dot{x}) = \frac{1}{2} \dot{x}^2 - \frac{1}{2} x^2$$

under the following discretization procedure of the Feynman Path integral (Lecture 2):

$$T_0 = 2\pi \quad \text{classical period of oscillator}$$

$$\Delta t = \frac{T_0}{128}$$

$$N_D = 600 \quad x_0 = -4, \quad x_D = +4$$

$$x_{\text{start}} = 0.75$$

$$\psi_0 = \left(\frac{\alpha}{\pi}\right)^{\frac{1}{4}} e^{-\frac{\alpha}{2} (x - x_{\text{start}})^2} \quad \text{initial wavefunction}$$

$$\alpha = 2$$

1. Calculate the propagator  $K$  from the elementary  $K_\epsilon$  matrix  $(N_0+1) \times (N_0+1)$  dimensional,  
 $\epsilon = \frac{T_0}{128} = \Delta t$  for time period  $\frac{T_0}{16}$

$$K = (\Delta x)^{N-1} \cdot K_\epsilon^N(\Delta t)$$

2. Evolve the wavefunction in time with  $\frac{T_0}{16}$  stepsize and measure  $\langle x \rangle$  as a function of time. Make a plot
3. Calculate  $\langle E \rangle$ ,  $\langle K \rangle$ ,  $\langle V \rangle$  as a function of time. Make a plot.
4. Calculate the evolution of the wavefunction as a function of time. Make plot.
5. Compare your plots with the first three plots of Lecture 2
6. 142 and 242 : Animation of the wavefunction