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Quantum Fields in Curved Spacetime

Examples XII

To hand in Monday 19th January in the examples class

Path Integral

1. Consider the Hamiltonian

$$\hat{H}(\hat{p},\hat{q}) = f(\hat{q})\hat{p}^2 f(\hat{q}) + V(\hat{q})\,. \tag{1}$$

Derive the Hamiltonian path integral formulation for this quantum Hamiltonian, ordering such that the $\hat{p}$'s are to the left of the $\hat{q}$'s. Use the commutation relation $[f(\hat{q}),\hat{p}] = i\hbar f'(\hat{q})$.

(5 pts)

2. Using the Lagrangian path integral formalism, calculate the propagator $K(q_f,t_f;q_0,t_0)$

a) for a free particle in in one dimension, $L = \dot{q}^2/(2m)$.

b) for the one-dimensional harmonic oscillator potential, $L = \dot{q}^2/(2m) - m\omega^2 q^2/2$.

(5 pts)