# Information Theory and Computation
# Exercise 7

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## Theory

### Split operator method

Suppose we want to propagate the wavefunction according to some (possibily time dependent) Hamiltonian $H(t)$. For a small time interval the propagator is:

$$U(t+\tau,t) \approx e^{-\frac{i}{\hbar}H(t)\tau} \tag{1}$$

Since the Hamiltonian is $H = \frac{p^2}{2m} + V(x,t)$ we can use use the BCH formula and split the evolution operator as:

$$e^{-\frac{i}{\hbar}\hat{H}(t)\tau} = e^{-\frac{i}{\hbar}\frac{\hat{V}(x,t)}{2}\tau} e^{-\frac{i}{\hbar}\frac{\hat{p}^2}{2m}\tau} e^{-\frac{i}{\hbar}\frac{\hat{V}(x,t)}{2}\tau} + o(\tau^2) \tag{2}$$

Now if we have the wavefunction at time $t$, $|\psi(x,t)\rangle$ and we want to apply the evolution operator we may proceed in the following way: we apply first, in space representation, the operator $e^{-\frac{i}{\hbar}\frac{\hat{V}(x,t)}{2}\tau}$; then, by means of Fourier Transform, we represent the result in momentum space, which makes $e^{-\frac{i}{\hbar}\frac{\hat{p}^2}{2m}\tau}$ diagonal. After applying it, we go back to space representation and we apply the last operator.

## Code Development

## Results

## Self Evaluation