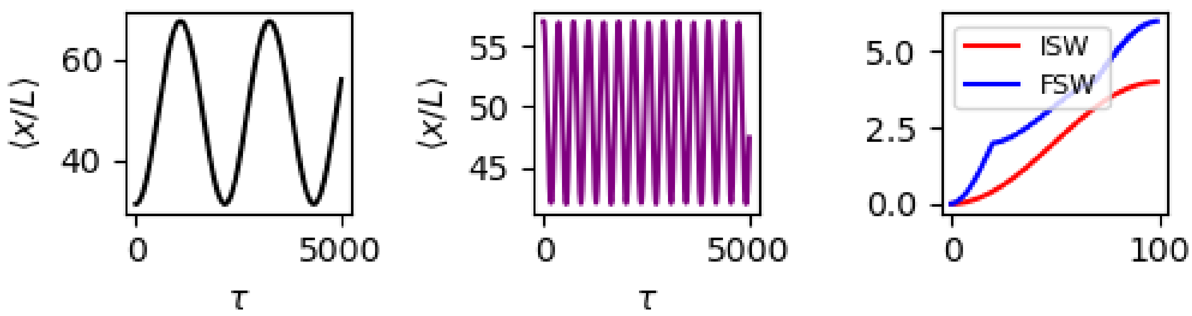


Figure 1: Expectation values of position as a function of time for the infinite (left) and finite (right) square well

# Project 2

**Quantum Mechanics**

*December 6, 2022* C Seitz

## Part 1

We can work in a coordinate system centered on zero, and write

$$\begin{aligned}
\langle x\rangle &= \sum_{a'}\sum_{a''} c^*_{a'}c_{a''}\langle a'|\, x\,|a''\rangle \exp\left(\frac{-i(E_{a''}-E_{a'})t}{\hbar}\right)\\
&= \frac{1}{2}\left(\langle 0|\, x\,|1\rangle \exp\left(\frac{-i(E_1-E_0)t}{\hbar}\right) + \langle 1|\, x\,|0\rangle \exp\left(\frac{-i(E_0-E_1)t}{\hbar}\right)\right)\\
&= \beta\cos(\omega t)
\end{aligned}$$

where $\beta = \langle 0|\, x\,|1\rangle = \langle 1|\, x\,|0\rangle$ (because $x$ is Hermitian) and $\omega = (E_1 - E_0)/\hbar$. The angular frequency is higher for the finite square well because there is a large energy gap between the first excited state and the ground state (see the differential in the eigenvalue spectrum in Figure 1c).