Problem Set 9

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1 Schrodinger Equation

1.1 Writing the code

I follow the steps in Exercise 9.8 in Newman. First, I create the grid and initialize the wave function value. Then I create the banded matrix A and B to update the wavefunction value at the next moment. I noticed that the banded.py function causes some problems so I use np.linalg.solve to get the new wavefunction value. It is worth noting that to satisfy the boundary condition we change the first and last values of matrix A and B to make the wavefunction vanish at $x = 0$ and $x = L$. Finally, I use FuncAnimation to create the animation of the real part of the wavefunction for 2000 timesteps. 'animation.gif' is available on my GitHub: phys-ga2000/ps-9.

1.2 Physical Meaning

As we can see from the formula of the initial wavefunction, this is a Gaussian wave packet. From the animation, we can see that the wave packet's spatial width gradually increases with time, which means the position uncertainty increases. Besides, we can also see that as the wave packet reaches the wall, it reflects.

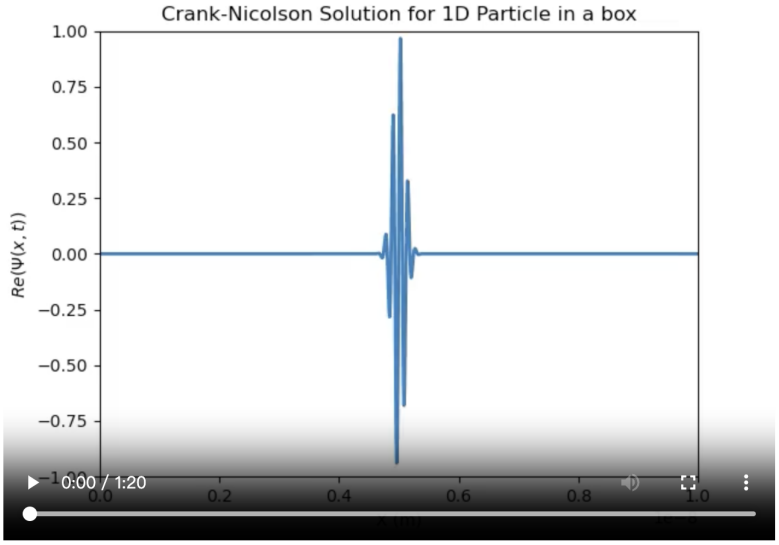

Figure 1: The initial wavefunction has a small position uncertainty.

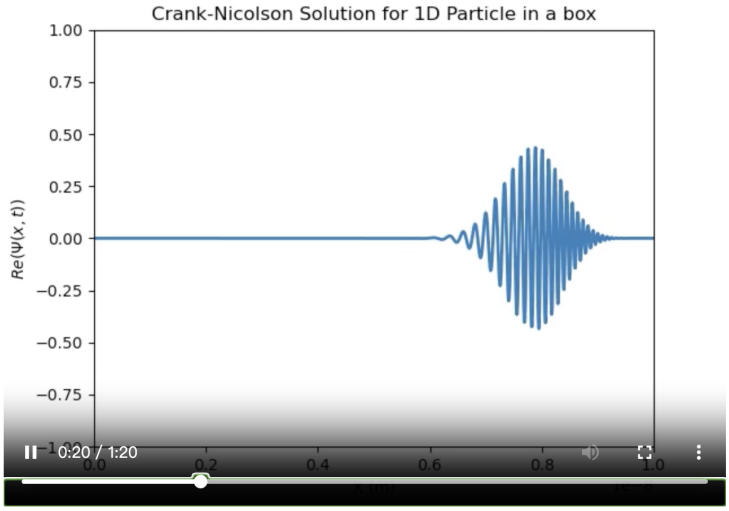

Figure 2: The wavefunction after a amount of time. The packet spreads compared to the initial wavefunction.