PS-9

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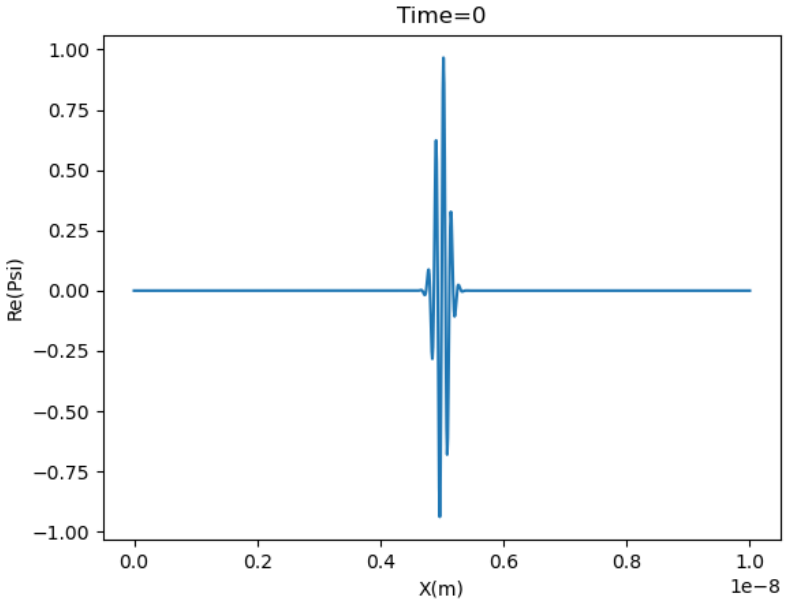
November 27, 2023

Abstract

In this problem set, we numerically solve the Schrodinger partial differential equation using the Crank-Nicolson method. Code is available at `https://github.com/Leen-Alrawas/phys-ga2000/tree/main/ps-9`.

1 Methods and Results

We use the Crank-Nicolson method to solve the full time-dependent Schrodinger equation and see how a wavefunction evolves over time. The problem considers an electron in a box with impenetrable walls so that we solve the equation in a finite-sized space. The boundary conditions require the wavefunction to be zero at the walls at all times. Following the steps given in the problem we arrive to a wavefunction that evolves as shown in the figures below.
The particle starts in the middle of the box with the highest probability of finding the particle there, over time, the wave function hits one wall then reflects and spreads across the box increasing the uncertainty in the electron's position.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0.25
0.00
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−0.50
−0.75
−1.00
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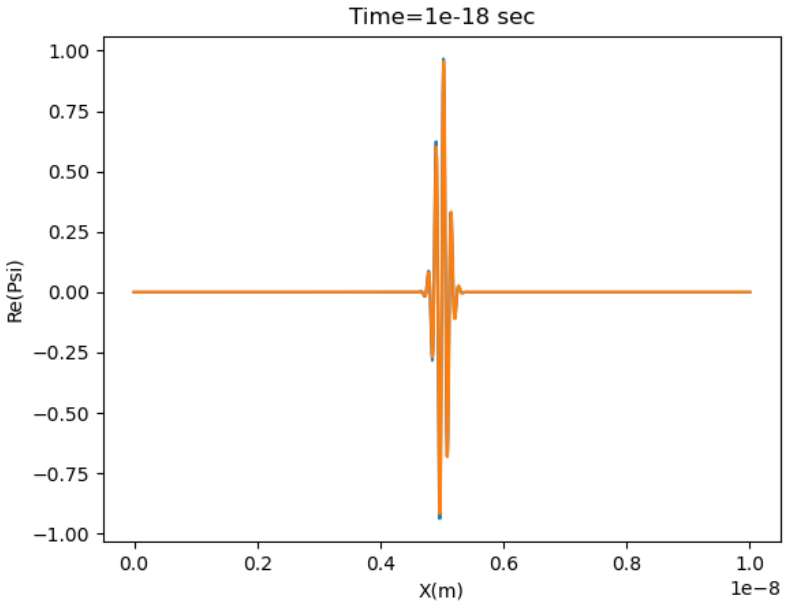
0.2
0.4
0.6
0.8
1.0
1e−8
X(m)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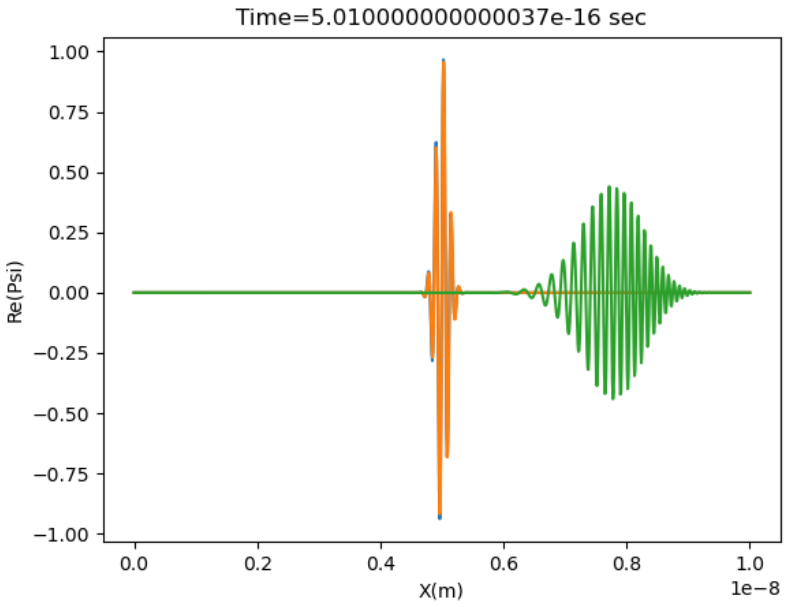
0.6
0.8
1.0
1e−8
X(m)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X(m)
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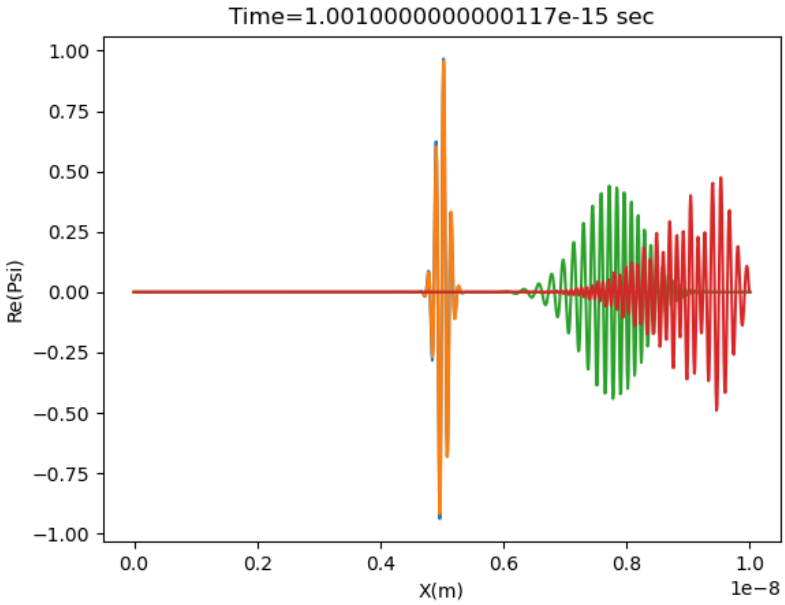
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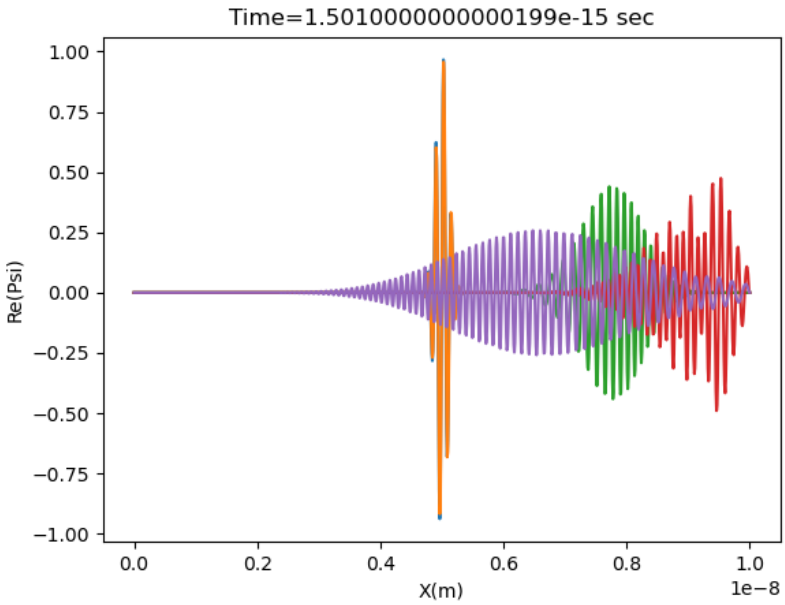
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Re(Psi)
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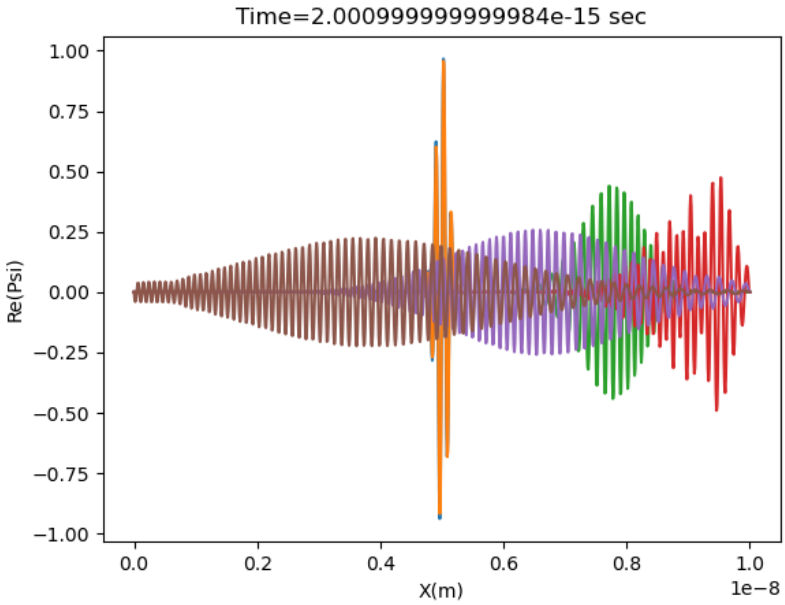
0.2
0.4
0.6
0.8
1.0
1e−8
X(m)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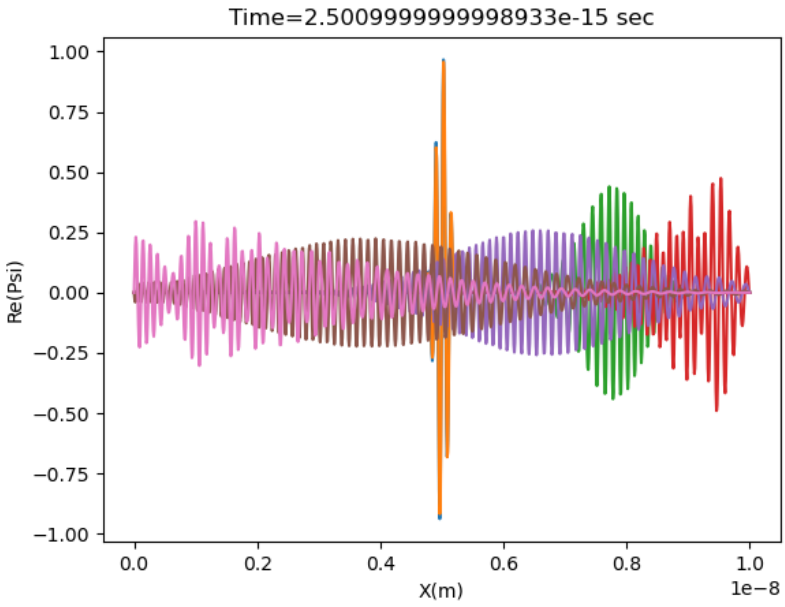
0.8
1.0
1e−8
X(m)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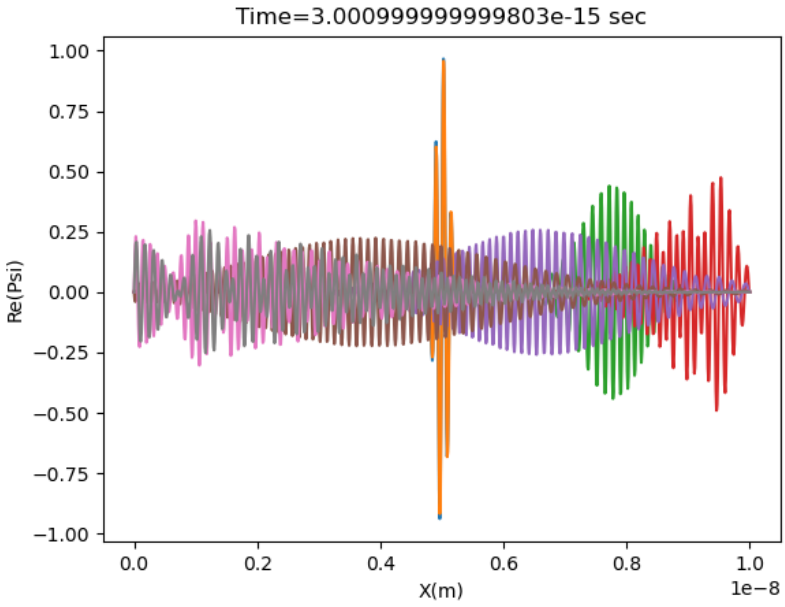
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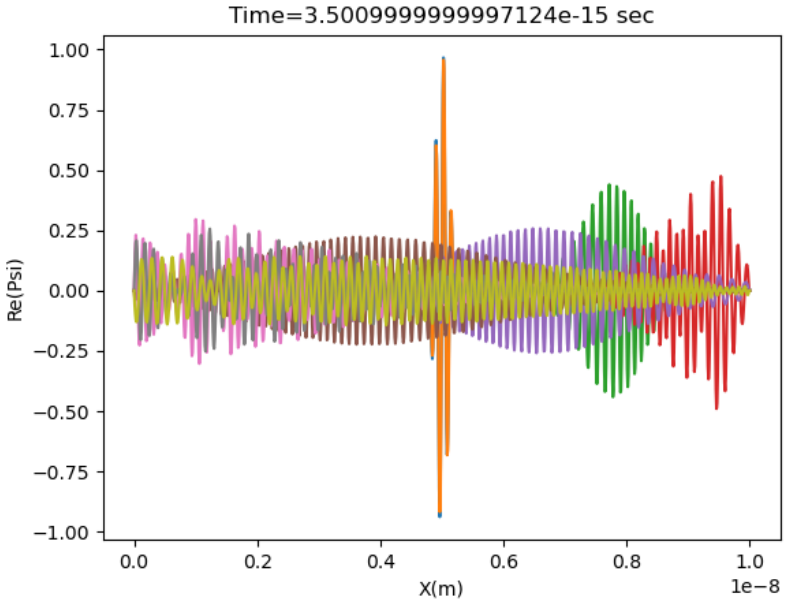
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0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.0
0.2
0.4
0.6
0.8
1.0
1e−8
X(m)