Project report : Quantum tunneling, a numerical study

Aim: I have basically reproduced the results of the paper **"Simulation in Quantum tunneling"** by Kevin Smith and Guy Blaylock. Here we study how barrier width and barrier height effects the tunneling of guassian wave packet hrough applying Crank Nicolson method on one dimensional time dependent Schroedinger equation. The Crank Nicelson method is unconditionally stable and computionally cheap. Only the high frequecncy components most probablly transmits through the barrier.

Method:

- set up simulation parameters
- convert the parameters into natural unit
- Initialized a guassian wave function (ψ)
- define the potential barrier either varying height or width as required(in natural unit)
- calculate the Crank Nicolson matrix C (C =A^{-1}B)
- Time evolve the initial wave packet by runnig a loop over ψ=Cψ
- Calculate Transmission probability $||\psi(x)||^2$
- convert back it into SI unit
- Plot it with appropriate units.

Key Results: I have sucessfully generated the fig1, fig3, fig4, fig5 of that paper qualitatively. And described the basic phenomenas as theoretical expectations.

In [2]:

```
from IPython.display import Image, HTML, display
from glob import glob
imagesList=''.join( ["<img style='width: 120px; margin: 5px; float: left; border: 1px solid
                     for s in sorted(glob('ss*.png')) ])
display(HTML(imagesList))
```

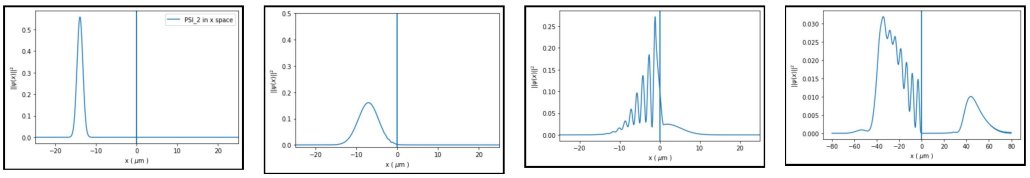

Fig:1

Fig1: represents the transformation of the wavepacket at different instances (far from barrier, just hit the barrier, just transmitts, fully transmitts and interference between incident and reflected wave respectively)

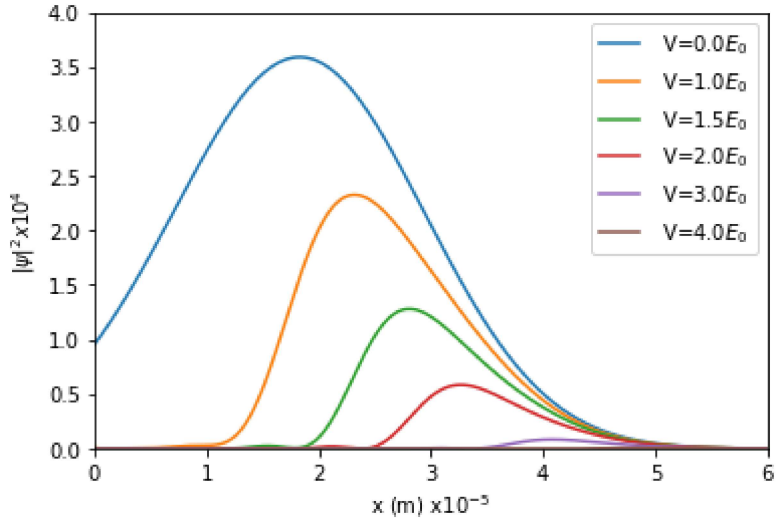

Fig:3

Fig 3: represents the how the wave with higher wave no transmitts with increasing barrier height

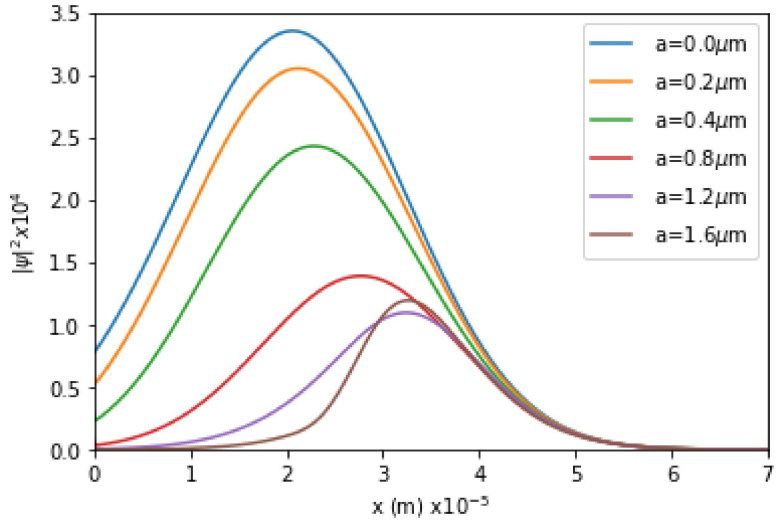

Fig:4

Fig 4: represents the how the wave with higher wave no transmitts with increasing barrier width

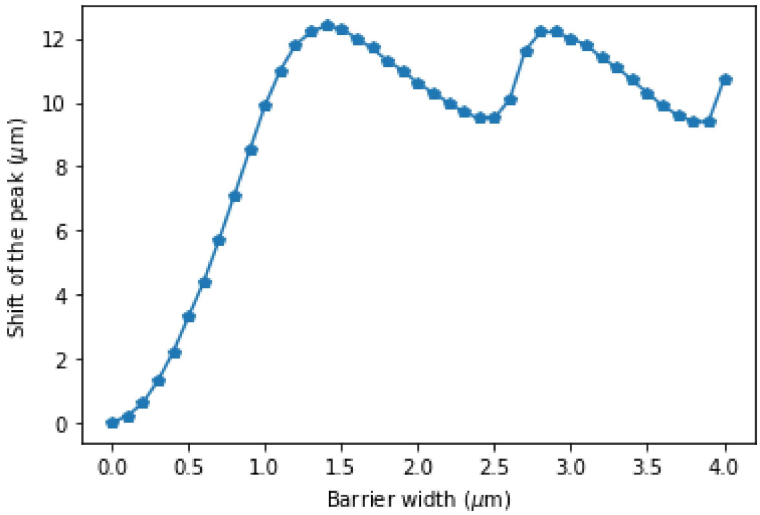

Fig:5

Fig 5: represents the how the peak of transmitted wave with higher wave no shifts w.r.t free particle with increasing barrier width