Practical Numerical Simulation Homework 2

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1 Schrodinger Equation for a particle in a potential well

Below are the energies for the lowest three states correct to 5 significant figures using $n = 10^7$ steps. This gives accuracy to five signifcant figures. This was determined by running the code for 10^8 steps and taking the difference between the values for $n = 10^7$ and $n = 10^8$.

Table 1: Energies)

i	E_i
0	0.16017
1	28.579
2	76.989

The corresponding wavefunctions can be seen in figure 1.

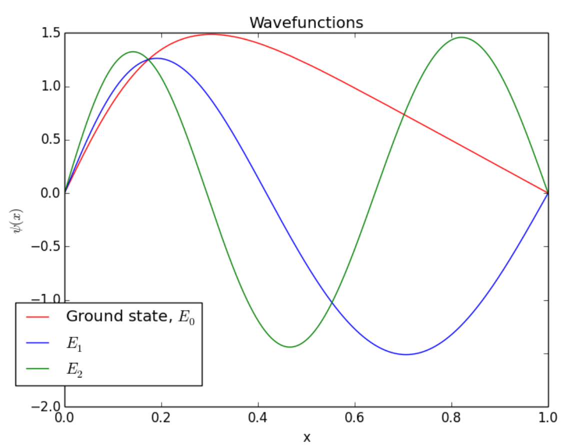

Figure 1: Wavefunctions

These wavefunctions have been normalised by integrating the probability distribution (ψ^2) between 0 and 1. We expect that a probability distribution should obey:

$$\int_0^1 \psi^2_{normalised} dx = 1 \tag{1}$$

ie. we are certain to find the 'particle' between x = 1 and x = 0.
Instead for a non-normalised wavefunction we got:

$$\int_0^1 \psi^2 dx = \alpha \tag{2}$$

$$\int_0^1 \frac{\psi^2}{\alpha} dx = 1 \tag{3}$$

$$\implies \psi_{normalised} = \frac{\psi}{\sqrt{\alpha}} \tag{4}$$

The normalised probability distributions is shown in figure 2.

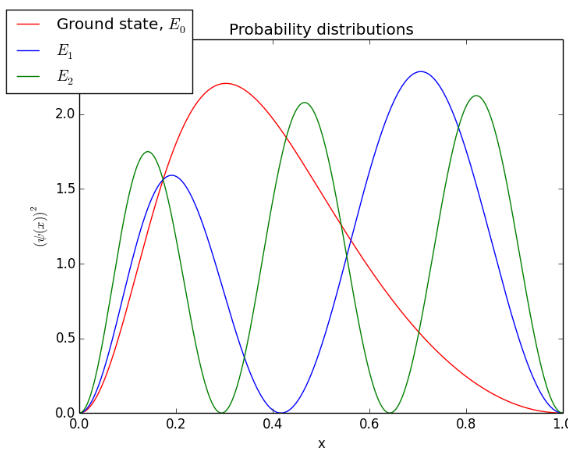

Figure 2: Probability distributions

2 Planetary motion

The final positions of the planets at t = 3 correct to three significant figures are shown in table 2. We used $n = 10^6$ number of steps. We confirmed this by comparing 10^6 and 10^7 step numbers.

Table 2: Positions)

Planet	x	y
0	-0.309	-0.352
1	-0.318	-0.525
2	0.036	0.906
3	0.103	0.859

In figure 3 we can see the path of the four planets over t = 3.

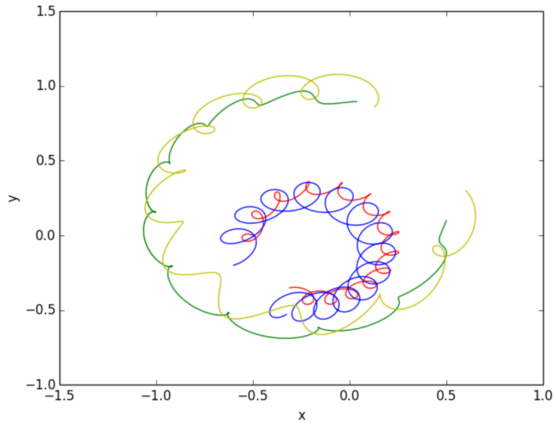

Figure 3: Path that four planets take over the time period t=3.