Physics 401

One Dimensional Nuclear Fusion

Consider a case of one dimensional nuclear 'fusion'. A neutron is in the potential well of a nucleus that we will approximate with an infinite square well with walls at $x = 0$ and $x = L$. The eigenfunctions and eigenvalues are

$$E_n = \frac{n^2\hbar^2\pi^2}{2mL^2} \qquad \begin{aligned} \phi_n &= \sqrt{\frac{2}{L}} sin\left(\frac{n\pi x}{L}\right) \qquad && 0 \le x \le L \\ &= 0 && x < 0 \text{ and } x > L \end{aligned} \quad .$$

The neutron is in the $n = 4$ state when it fuses with another nucleus that is the same size, instantly putting the neutron in a new infinite square well with walls at $x = 0$ and $x = 2L$. Be sure to include a Purpose, a Conclusion, and a Discussion.

1. What are the new eigenfunctions and eigenvalues of the fused system?
2. Which state in the fused system will have the same energy as the original state?
3. Calculate the probabilities for finding the neutron in the three lowest energy states of the fused system.
4. What is the probability for the energy state in Part 2.
5. Use *Mathematica* to plot the integrands you used in part 3. What features distinguish the three functions? How are those features associated with the results of part 3?
6. What is the full, time-dependent wave function $\Psi(x, t)$?
7. Use the *Mathematica* notebook here to make a movie to see the time evolution of the probability density. You may get a warning about dynamic content. If you click the 'Enable Dynamics' button, you should be ok. Describe how the initial wave packet evolves.