FYS3520 - Bonus 1

Spring term 2017

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Problem 1

In problem set 1 we have been discussing the qualitative behavior of a plain wave with a rectangular potential barrier. During the group session the question came up, how the particle behaves inside the barrier. Can it be observed there? It was actually very interesting to dig a little deeper into this problem.

Given is this statement: In classical mechanics it is not possible for a particle to be in a place where its total energy is less then the its potential energy. In quantum mechanics this impossibility is changed into an improbability.

1. What effect are we talking about? Does that make sense? Argue with the general solution of the Schrödinger equation $\psi(x) = C\exp(-k_2 x) + D\exp(k_2 x)$, where $k_2 = \frac{\sqrt{2m(V_E)}}{\hbar}$. How do you calculate the total energy?
2. In the introduction the question is risen whether the particle can be observed in the barrier. To what extend is this covered by the question of the particle having a certain probability to be there?

Think deeply about this question for a while. Once you have done some math and formed your own ideas, you may get further inspiration. Then it is time to look at following references:

a) Aharonov et al., PhysRev. A **48** 4084. (1993). `http://link.aps.org/doi/10.1103/PhysRevA.48.4084`

b) Another paper by him has a very nice introduction (and then gets, as usual, increasingly more difficult to read): Aharonov et al., New J. Phys. **15** 113015 (2003). `http://dx.doi.org/10.1088/1367-2630/15/11/113015`

c) Yakir Aharonov is reknown for the Aharonov-Bohm effect. I can also recommend reading a little into, say for a start, the wikipedia article on David Bohm.