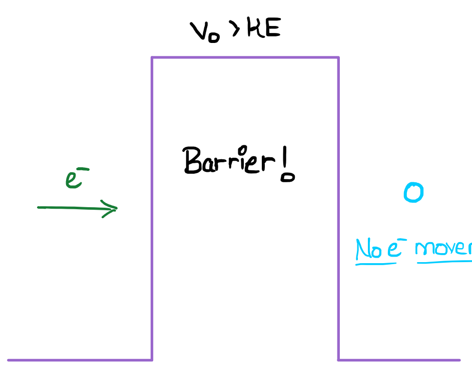
A Short Take on the Significance of Quantum Tunneling in Quantum Computing

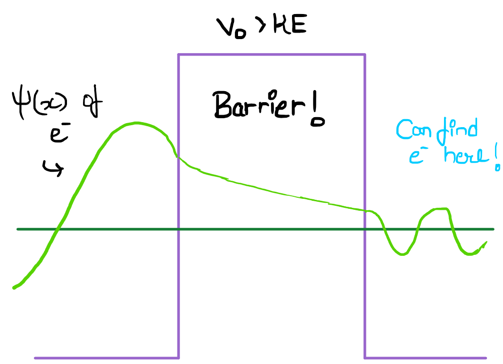
One of the improvements that can happen to an electronic device include its size. That is, the size of devices and circuits are expected to become smaller as time progresses. According to Moore's Law, the number of transistors on an integrated circuit nearly doubles about every two years.

That is, the size of transistors keeps decreasing as time progresses. The current size is ~5nm, and for comparision the size of an RBC is ~8 μm. As it keeps getting smaller, quantum effects come into play. Essentially, a transistor is a "switch", and it being ON/OFF would correspond to 1/0. The problem arises when the switch is opened to break the circuit.

This is done (usually) by applying a potential that is larger than the KE of e^-, so they stop. However, as the size decreases, quantum tunneling comes into play!



Classical



Quantum

Therefore, one of the most fundamental foundations of electrical circuits is broken! If my switches don't work, that would cause the device to fail. This is one of the reasons why quantum computers are a necessity. In them, qubits can be defined using, say, the polarity of a photon or the such.

Also, by the Copenhagen interpretation, each qubit would be in a superposition of both the states. Quantum Entanglement can be exploited to perform calculations in logarithmic time.* This is very powerful, and is the reason why research in this area is very exciting.

* Don't quote me on this, I'm not quite sure about my source. Quantum computers will be faster than traditional computers, I'm not sure about the factor.