Quantum Tunneling: A Short Overview

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1 Energy With Classical Physics

In classical physics, energy is always conserved. For any given scenario, a certain amount of energy is needed in order to complete a given task. Say there exists a potential barrier X; a potential barrier an simply be thought of as a region where energy is needed to pass. An object must have a certain energy E to pass this potential barrier.

Figure 1: Refer to this image to comprehend the analogy

1.1 Analogy

To understand this, think about a scenario with a skateboarder and a ramp. A basic understanding of energy shows that in order to get to the top of the ramp, the

skater must move with such a KE such that it can reach the top of the ramp; essentially, energy is converted from KE to GPE (Gravitational Potential Energy), assuming there is no friction on the ramp.

This constitutes what was said above; if the skater doesn't have some minimum KE (E), it will not be able to overcome the potential barrier (X) needed to get to the top of the ramp. This is just a fact of the classical world

2 Introduction To Quantum Tunneling

However, in the quantum world, things work very differently. A particle does not need to have a minimal energy E in order to cross some potential barrier X

If you could imagine a potential barrier as being a hill an object must go over, whereas in classical physics, an object would need energy to roll up the hill, in quantum physics, the particle could just travel through the barrier to the other side; this is what is called quantum tunneling.

3 Role of Wavefunctions

As stated before in the edition of quantum states, a particle in the quantum world can be represented through a wave function, which essentially gives a probability distribution of some characteristic of it.

Now imagine a quantum particle moving and approaching a barrier; we can re-imagine it as a wave (the wave function) moving towards the barrier. When the wave hits the barrier, not all of it reflects back. Some of it actually continued to move through the barrier

More specifically, the math can be properly displayed through the folowing expression: