Popular Abstract

Imagine that someone handed you a quantum tennis ball to play with. You were instructed to throw it against a wall. In the beginning it would seem like a normal tennis ball: regardless how hard you threw it against the wall, it would bounce back. Surprisingly the ball would go through the wall all the sudden, unlike a normal tennis ball would. This is the moment when you would encounter the quantum mechanical properties of the quantum tennis ball.

If you kept throwing the ball against a wall for a longer period of time, you would notice that after a certain number of tries the quantum tennis ball would usually make it to the other side. In other words, there is a certain probability that the ball goes through the wall. This is something that is typical of the quantum particles and is called the quantum tunneling.

Of course, in the real world there are no quantum tennis balls, as the quantum particles are very small and invisible to the eye. However, quantum mechanics plays nowadays a role in many technological applications and devices that have become an everyday commodities, even when the quantum mechanical properties of the particles are not noticeable in our surroundings.

In this thesis, a double-quantum dot system connected to the heat baths is studied and the electric current and the noise are calculated. A quantum dot is like an artificial atom, and in this case, it can have one electron inside per dot. The heat baths are the source of the electrons. If things are simplified quite a bit, this system is actually not too far away from playing with the quantum mechanical tennis balls. In this system, the quantum dots can be understood as the walls that the quantum tennis balls bounce against. For the electronic current to flow through the system, the electron should tunnel through all the walls and end up on the other side of the system. This can be calculated by using a suitable mathematical model. Also, the noise in this system is calculated, which basically tells how much the current changes. After the noise and the current are calculated, the behaviour of this system is compared to the systems which do not have quantum mechanical properties.

In the recent years, nano-technology has become an increasingly important field. Nano systems are so small that the quantum mechanical properties of the electrons start to play an important role and cannot be neglected. In fact, the quantum mechanical properties of the particles can be a source of new inventions. This has happened already as the quantum computing, for example, has become more and more relevant. To this end, it is important to investigate the nano scale systems theoretically to see how the quantum mechanics could be benefited in the form of future's devices and in general, to provide a fascinating outlook to the world of the tiny particles, which seems so counter-intuitive based on what we experience in our daily lives.