Use the Distance Principle to explain the physical mechanism of Transistor

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Abstract

For beginners, the traditional explanation of a Transistor is not easy to understand. The traditional explanation can not explain why a slightly change of IB will create a significant change of IC clearly. This paper proposed the Distance Principle which can clearly and easily explain why a Transistor can work. Make beginners easier to understand the physical mechanism of a Transistor.

Key words: transistor, distance principle, physical mechanism of transistor

1. What is the Distance Principle

For a fixed position positive charge, it is obviously that the closer the distance of a negative charge the more significant that the negative charge will affect the electric field of the positive charge. So we can use less negative charges to create same effect when the distance is closer. This can create an amplification effect to make a Transistor work.

2. A sample of the Distance Principle

2.1 One negative charge with one positive charge

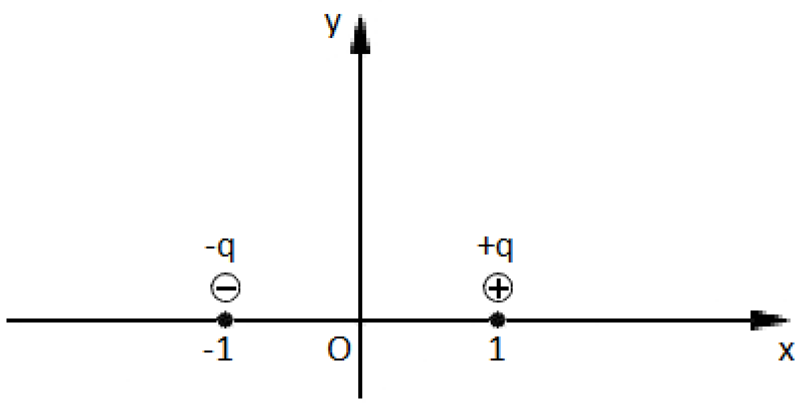

Figure 1: One negative charge with one positive charge

In this case, we put 1 positive charge at position (1, 0) and 1 negative charge at position (-1, 0). It is obviously that the electric intensity at position O is zero. And we have equation:

$$\frac{k \times q}{1^2} = \frac{k \times q}{1^2} \qquad (2\text{-}1)$$

2.2 Two negative charges with one positive charge

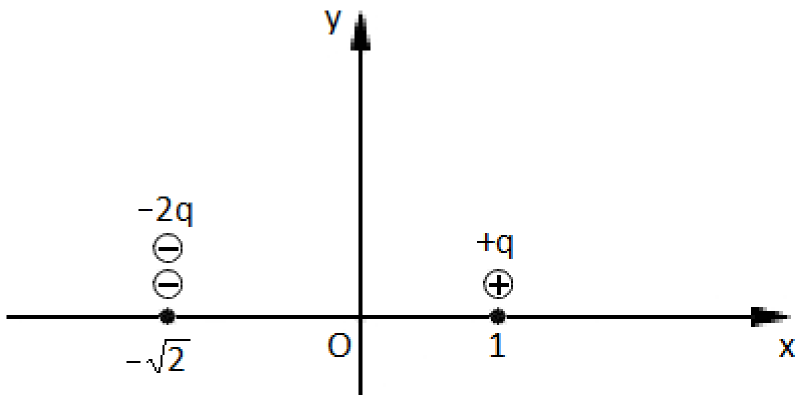

Figure 2: Two negative charges with one positive charge

In this case, we still put 1 positive charge at position (1, 0), but we will put 2 negative charges. To keep the electric intensity at position O zero, we need to put the 2 negative charges at position ($-\sqrt{2}$, 0). And we have equation:

$$\frac{k \times 2 \times q}{\sqrt{2}^2} = \frac{k \times q}{1^2} \qquad (2\text{-}2)$$

2.3 Three negative charges with one positive charge

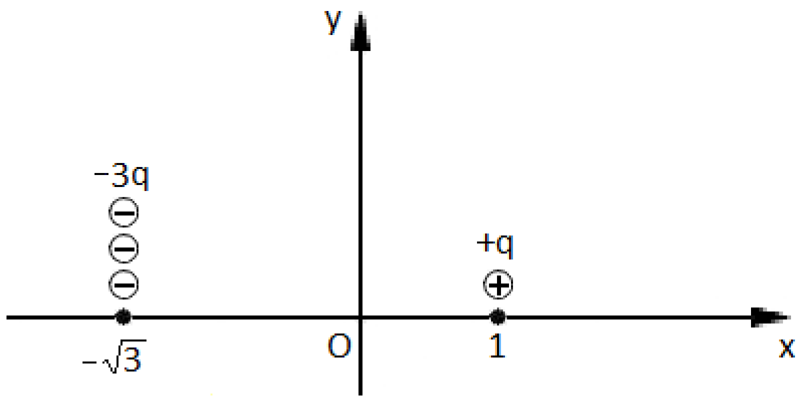

Figure 3: Three negative charges with one positive charge

In this case, we still put 1 positive charge at position (1, 0), but we will put 3 negative charges. To keep the electric intensity at position O zero, we need to put the

3 negative charges at position ($-\sqrt{3}$, 0). And we have equation:

$$\frac{k \times 3 \times q}{\sqrt{3}^2} = \frac{k \times q}{1^2} \qquad (2\text{-}3)$$

2.4 One negative charge is equal to three negative charges

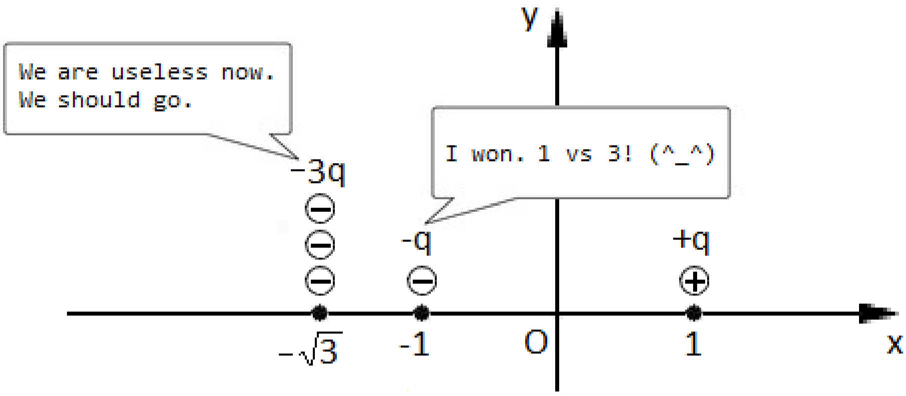

Figure 4: One negative charge is equal to three negative charges

Base on the case 3, we put 1 negative charge back to position (-1, 0). We can see that just 1 negative charge at position (-1, 0) can make the electric intensity at position O zero. So the other 3 negative charges will be useless, and the can be released. Just 1 negative charge released 3 negative charges, this is 3 times of the current amplification.

The amplification factor can be higher if the other negative charges are at a farther position. And this is the Distance Principle which is easy to understand: The closer the distance of a negative charge the more significant that the negative charge will affect the electric field of the positive charge.

3. Explain the mechanism of Transistor with Distance Principle

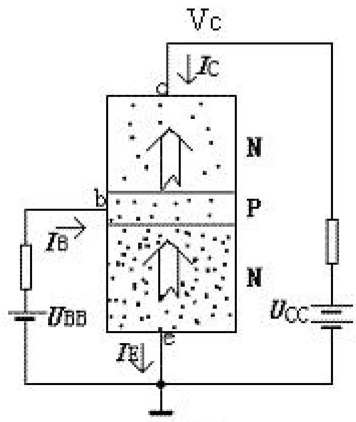

Figure 5: Transistor

When the current I_B is zero, the high voltage V_C will pull the electrons into the PN junction region of the collector, and they will be just pulled but can not be released. Because the voltage of V_C is very high, the electrons will be pulled a long distance.

When the current I_B is not zero, the electrons which are drived by U_{BB} move into the base, and these electrons are much closer to the holes in the base than the electrons which are pulled by V_C. So base on the Distance Principle, just 1 of these electrons will make multiple electrons which are pulled by V_C be released, and this is the amplification mechanism of a Transistor.

5. Conclusion

The Distance Principle clearly explained the physical mechanism of a Transistor. And it is much easier to understand than the traditional explanation. We can use this explanation to make the beginners to understand a Transistor easier.