Does a magnetic interaction really exist between two parallel moving charged particle beams?

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Abstract

Concerning the paradox of magnetic interaction between two parallel moving charged particle beams, there are a lot of discussions. Here in this paper, an experimental design is proposed, by which we can verify if there is really a magnetic interaction between the two charged particle beams.

Introduction

In a previously paper [1] of the author's, two scenarios where the Lorentz force law clash with the theory of special relativity were proposed and analyzed. It involves the question that if there is really a magnetic interaction between two parallel moving charged particle beams or two charged particles moving in the same direction at the same speed. The original paradox is: in the reference frame co-moving with the charged particles there is only electric interaction, while in a reference frame where the charged particles are moving, we observe both the electric interaction and the magnetic interaction. This paradox was claimed to be resolved by the notion that the Magnetism is a relativistic side effect of Electro Statics. [2, 3, 4] However, when the charged particle beams are placed within conductor tubes (as shown in figure1), the electric interaction between them is eliminated. And now, the paradox comes again.

In this article, an experimental design is proposed, by which, we can verify if there is really a magnetic interaction between the two parallel moving charged particle beams.

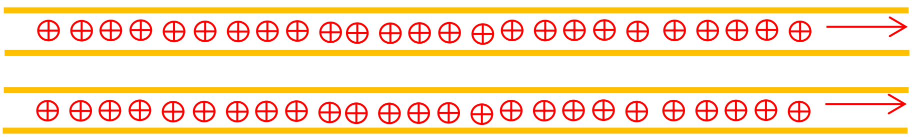

Figure1. Two parallel moving charged particle beams which are covered within copper tubes.

Experimental design and discussions

In figure2, we have two identical cathode-ray tubes arranged in parallel rows. The two electron beams will repel each other because of the Coulomb force. Even if there would be any magnetic attraction, it will be much smaller than Coulomb force. So, we will always see the two electron beams going away from each other.

In order to measure the magnetic interaction, we need to screen the electric force between the two beams. For this purpose, one of the cathode-ray tubes is placed within a good conductor cavity, such as copper, as seen in figure3. So the electric interaction between the two electron beams will be eliminated. Now, if a magnetic attraction force exists between the two beams, it would be observed that the two moving electron tracks will go towards each other, as shown in figure3. If no such a magnetic force exists between the two electron beams, the two moving electron tracks will go straight line, as shown in figure 4.

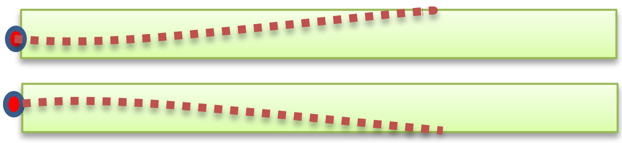

Figure2. Two cathode-ray tubes arranged in parallel rows

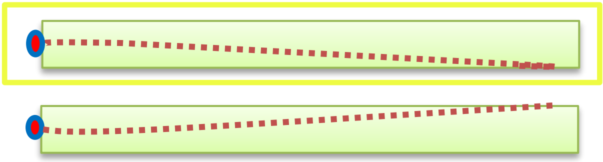

Figure3. One of the cathode-ray tubes is placed within a good conductor cavity, such as copper. The two moving electron tracks will go towards each other if there is a magnetic interaction between them.

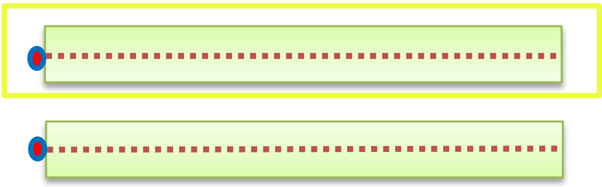

Figure4. One of the cathode-ray tubes is placed within a good conductor cavity, such as copper. The cathode-ray track will go straight lines if no magnetic force between them

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