the general science journal

No Relativistic Mass Increase Required

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Abstract

A thought experiment to determine whether or not, by using the concept of length contraction and Einstein's equation for length contraction, we can predict the need for an increasingly stronger magnetic field as a charged particle's speed increases in relation to a ring shaped particle accelerator without need of a relativistic mass increase.

Statement 1
A charged particle q moving with constant velocity v in a uniform magnetic field B is deflected, by a magnetic force F acting perpendicular to the charged particle's velocity, from the straight line path it would travel were there no magnetic field.

Statement 2
In a ring shaped particle accelerator, magnetic fields are used to keep a charged particle parallel to the walls of the ring shaped accelerator, preventing the charged particle from traveling a straight line path and running into the wall. It is known that when the charged particle travels faster (with respect to the ring shaped accelerator) the magnetic fields have to be made stronger in order to keep the charged particle traveling parallel to the walls.

Statement 3
The flux density B at any point r in a magnetic field of a long straight conductor carrying a current I is directly proportional to the current I in the conductor and inversely proportional to the radial distance r of the point from the conductor. Allowing the constant of proportionality to be 2k we have

Equation 1
$B = 2k(I / r)$

Statement 4
Since 2k is constant, when we allow r to remain constant, the flux density B is increased by increasing the current I in the conductor.

Equation 2
$(2k / r)I = B$

Statement 5
In allowing the strength (magnitude) of a magnetic field to be represented by the flux density B, when r is allowed to remain constant, increasing the current I in the conductor, which increases the flux density B, increases the strength (magnitude) of the magnetic field.

Statement 6
The flux density B can be expressed in terms of the lines of flux per unit area A that permeates the magnetic field. The flux density B is equal to the magnetic flux Φ divided by the area A.

Equation 3
$B = \Phi / A$

Statement 7
We can equate equations 2 and 3 to get Equation 4

Equation 4

$(2k / r)I = \Phi / A$

Statement 8
In Equation 4, 2k is constant, and since r is allowed to remain constant, the quantity (2k / r) is constant, which means a change in the current I changes the ratio Φ / A.

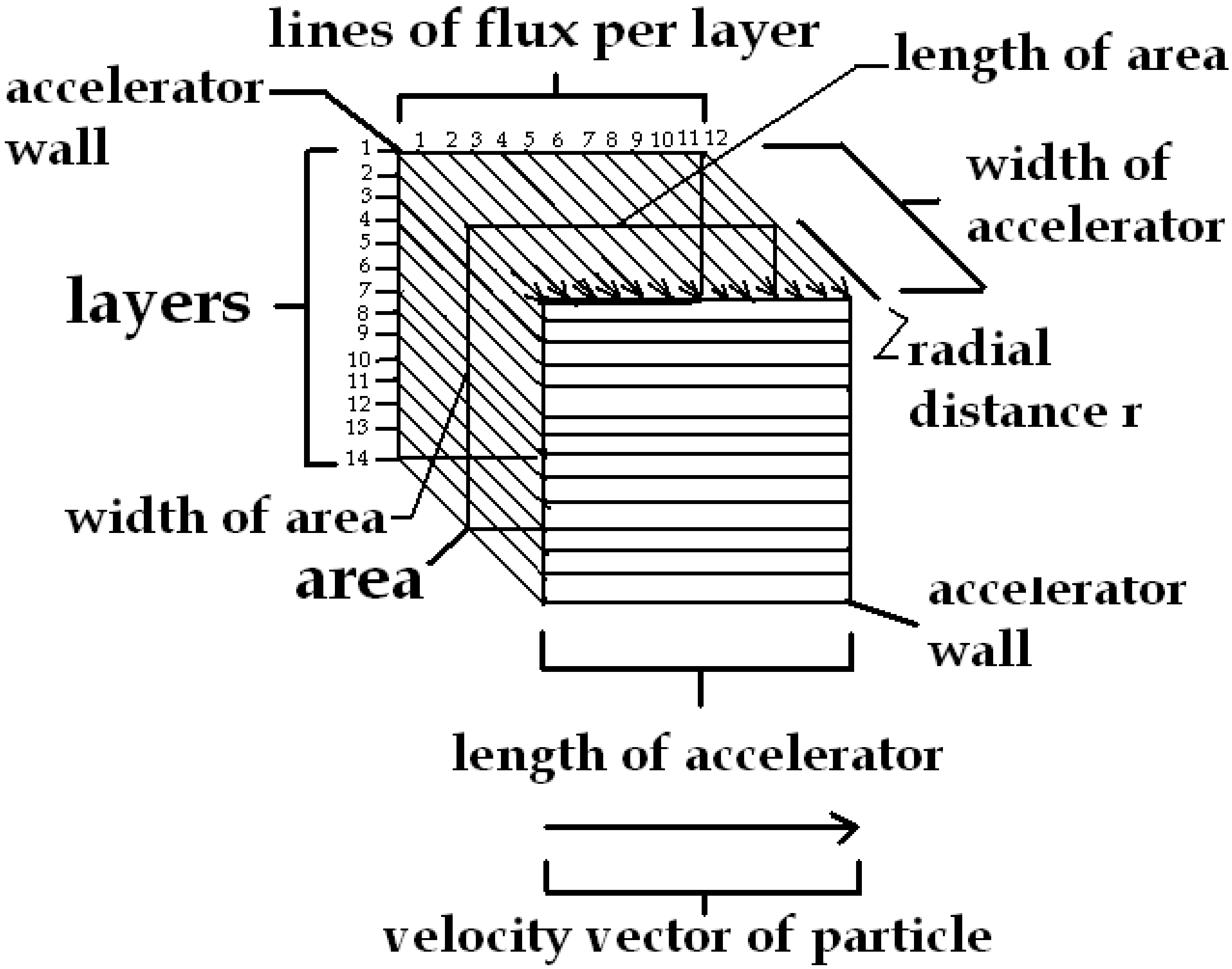
Statement 9
In Equation 4, 2k is constant, and since r is allowed to remain constant, the quantity (2k / r) is constant, which means a change in

the ratio Φ / A is the result of a change in the current I, which by Statement 5, is a change in the strength (magnitude) of the magnetic field.

Statement 10
Length contraction occurs because the charged particle q is in motion, not because of a change in the current I.

Statement 11
Length contraction occurs only in the charged particle’s direction of motion. Within the accelerator, the length of area A is orientated to the length of the accelerator, and the width of area A is <u>not</u> orientated to the width of the accelerator, but the width of area A and the width of the accelerator are both perpendicular to the charged particle's direction of motion, which is orientated to the length of area A and the length of the accelerator. Since the length contraction that is due to the charged particle being in motion (not because of a change in the current I) is in the charged particle's direction of motion, it is the length of area A, not the width of area A, that is contracted.

Diagram 1



Statement 12
Since the length contraction occurs only because the charged particle q is in motion and not because of a change in the current I, the current I is considered as constant in terms of the length contraction, which means the quantity (2k / r)I is constant in terms of the length contraction.

Statement 13
As a result of the length contraction the area A becomes smaller while the magnetic flux Φ does not change, which means there is a change in the ratio Φ / A but this occurred without a change in the current I (see Statement 12), which means the strength of the magnetic field is to week to keep the moving charged particle q traveling parallel to the walls of a ring shaped accelerator, which

means it will run into the wall unless the strength of the magnetic field is made stronger.

Statement 14

Statement 13 predicts the need for an increasingly stronger magnetic field as a charged particle’s speed increases in relation to a ring shaped particle accelerator without need of a relativistic mass increase, and gives Equation 5 where the magnetic field strength is expressed in terms of the magnet flux density B, and the length contraction is expressed in terms of the length l of the area --- recall that the width w of the area was not contracted.

Equation 5

$$B = \frac{\Phi}{\left(l\sqrt{1-(v/c)^2}\right)w}$$

Note 1

Instead of the relativistic view of the force increasing in strength as the relativistic mass of the charged particle increases, which means the charged particle can not be accelerate to the speed of light because an infinite force would be trying to move an infinite mass, we have the view of the force increasing in strength as space (distance, in this case, in one direction in relation to the charged particle being accelerated) decreases toward zero, which means there would be no place into which the charged particle can farther accelerate into. Were the decrease in distance to reach zero, the result would be a collapse of space in all directions in relation to the charged particle being accelerated, which would be achieving zero dimension. Rather reminiscent of the Big Bang ….. all that energy squeezed into zero dimension waiting to burst forth.