

# Inertial Mass and Gravitational Mass - What They Are and the Fundamental Reason Why They Are Equal

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## Abstract

Why do objects possess inertia at all ? *What* is gravity ? Why are inertial and gravitational masses equal ? These are some of the greatest puzzles and mysteries in physics that have not been solved to date. This paper reveals these mysteries. Inertia and electrical inductance are not only analogous, but they are the same phenomena: electromagnetism ! Electrostatic force and gravitational force are not only analogous, but they are the same phenomena: electrostatics ! Both inertial mass and gravitational mass depend on the same quantity: the total number of electrons, protons and neutrons in an object, i.e. the *total* (NOT net ) charge in the object. This is the fundamental reason why inertial mass and gravitational mass are equal. Universal speed limit is due to non-linear law of electrical self inductance.

## Introduction

Inertial mass is a measure of the resistance of a body to acceleration, and is defined in Newton's second law of motion. It is the constant of proportionality in Newton's second law.

$$F = m a$$

The larger the inertial mass of an object, the less it responds to an applied force, i.e. the less its acceleration will be for the same force.

But *why* do objects possess inertia at all ? No explanation exists in physics so far.

Gravitational mass is defined by Newton's law of gravitation.

$$F = G \frac{M m}{r^2}$$

The more the gravitational mass (m) of an object, the more the gravitational force of another body ( with mass M ) acting on it.

But *what* is gravity ? Newton's law of gravitation provides only a model for the behavior of gravity and does not explain *what* gravity is ?

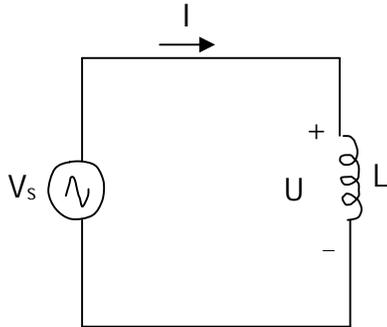
The inertial mass and gravitational mass have been confirmed experimentally to be equal to a high level of precision. If two objects have the same gravitational mass, for example as measured by the amount by which each extends a spring from which it is suspending, they will also undergo the same acceleration if subjected to equal forces in space, for example.

There is no theoretical explanation so far as to *why* these two masses should be equal. This paper solves these long standing puzzles.

### **Inertial mass**

Why do objects possess inertia ?

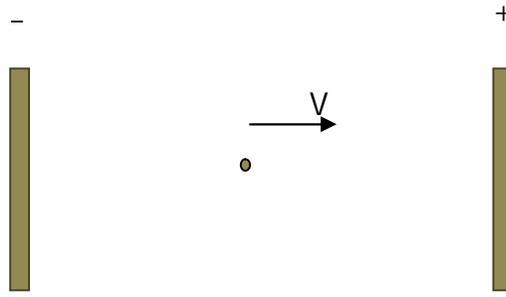
Let us consider the familiar electrical inductance. Consider the following circuit.



$$U = L \frac{dI}{dt}$$

From electrical circuit theory, we know the property of the inductor that it resists any change in the current  $I$  passing through it. If the voltage  $V_s$  is DC and if the circuit is in steady state condition, there will be no induced voltage across the inductor and the electrons move inside the conductor at some constant average velocity. If the voltage changes, say increased, the increased electric field tends to accelerate the electrons. However, the property of the inductance ( self inductance,  $L$  ) resists instantaneous change in current, hence instantaneous change in the velocity of the electrons. The magnetic field of the inductor cannot change instantaneously.

The same principle applies to an isolated electron. Consider an electron moving between two parallel plates connected to a high voltage source.



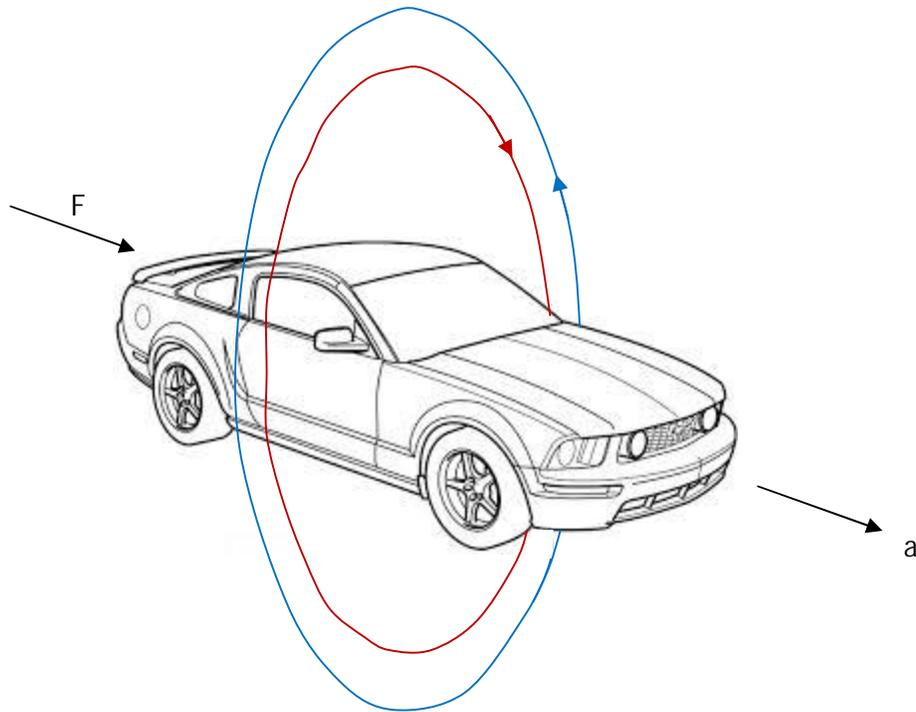
Suppose that the electron is initially moving with some constant velocity  $V$ . This can be done by initially switching on the voltage across the plates briefly and switching it off, discharging the plates so that there will be no electric field. With zero electric field, the electron will continue moving with constant velocity as shown.

Now suppose that the voltage across the plates is suddenly increased, increasing the magnitude of the electric field between the plates. The electron will accelerate with a finite value of acceleration. The electron will not accelerate infinitely. From conventional physics, this is due to the inertial mass of the electron. According to the new theory, however, the electron resists infinite acceleration due to its self inductance: the magnetic field of the moving electron cannot change instantaneously, for the same reason that the magnetic field of the inductor cannot change instantaneously.

An expected question is: what about electrically neutral objects? The same law applies to neutral objects. A neutral object is one which contains equal amounts of negative charges and positive charges. Each electron and proton in the neutral object behaves as the isolated electron discussed above[1]. The only difference is that, whereas the magnetic field of the isolated electron can be detected, the magnetic field of an electron in the neutral object is 'cancelled' by the magnetic field of a proton and cannot be detected. That the magnetic field cannot be detected doesn't mean that it doesn't exist. This is a strange, unique nature of electromagnetism.

A neutron has inertia because of the self inductance of its charges. A neutron has a zero *net* charge but NOT a zero total charge. The total charge of a proton is not equal to its known net charge if the proton is not an elementary particle. The total charge of an electron is equal to its known net charge if the electron is an elementary particle.

Therefore, the inertia of a car is due to electrical self inductance of the electrons, protons and neutrons it contains. The velocity of the car cannot change instantaneously ( zero inertial mass ) because the magnetic fields created by the electrons, protons and neutrons cannot change instantaneously, for the *same* reason that the magnetic field of an inductor cannot change instantaneously. That a neutron has inertia shows that it contains positive and negative charges.



- magnetic field created by a negative charge (an electron ) of the car
- magnetic field created by a positive charge of the car

The electrons, protons and neutrons in the car create magnetic fields around themselves and around the car. As force  $F$  is applied to the car, the car will resist change in velocity because of the self inductance of the protons, electrons and neutrons in the materials from which the car is made. The car will change its speed with some finite acceleration and will not change its speed instantaneously. This is because the magnetic field of the car particles ( electrons, protons, neutrons ) cannot change instantaneously for the *same* reason that the magnetic field of an inductor cannot change instantaneously.

From this theory it follows that the greater the *total* ( NOT *net* ) positive and negative charge an object has, the larger will be its inertia. So objects with large inertia have large *total* charge .

Therefore, the law of motion of an object or a particle is given by:

$$F = K \frac{dV}{dt}$$

where K is the proportionality constant. The constant K is directly proportional to the *total* (not *net*) amount of charge (positive and negative). The constant K is what is conventionally known as mass, m. Therefore, the mass of an object is a measure of the *total* amount of charge inside the object.

For example, a neutron is said to be made of one up quark and two down quarks. Up quarks have a charge of  $+2/3e$ , and down quarks have a charge of  $-1/3e$ . Now, the *net* charge of the proton will be zero. But the *total* charge of the neutron will be :

$$\frac{2}{3}e + \frac{1}{3}e + \frac{1}{3}e = \frac{4}{3}e$$

The above law is the law of electrical self-induction.

### Universal speed limit

I propose in this paper that the mass of particles increases with velocity because of a non-linear law of self-induction. We know that the universal light speed limit has been confirmed by many experiments.

The accurate formula for self induction is:

$$F = \frac{1}{\sqrt{1 - \frac{V^2}{c^2}}} K \frac{dV}{dt}$$

The inductance of an inductor will also increase as the current increases, for the same reason that the mass (self induction) of the electron increases with increasing velocity. Just as there is light speed limit to the velocity of particles, there will also be a maximum limiting current  $I_C$  for the inductor circuit. Of course, the limiting current is because of the light speed limit to the velocity of the electrons in the inductor coil conductor. Therefore, for the inductor circuit, the accurate formula will be:

$$u = \frac{1}{\sqrt{1 - \frac{I^2}{I_C^2}}} L \frac{dI}{dt}$$

## Gravitational mass

What is gravity ? I have already proposed in [1] that gravity is a result of slight difference between electrostatic attraction and repulsion forces. The electrostatic attraction force is slightly greater than the electrostatic repulsion force.

There is an attractive gravitational force between two neutral objects A and B because the sum of electrostatic attractive forces ( assume the object contains only protons and electrons and no neutrons, for simplicity )

between protons in A and electrons in B and

between electrons in A and protons in B

is slightly greater than the sum of electrostatic repulsive forces

between protons in A and protons in B and

between electrons in A and electrons in B

Since neutrons also contain (equal ) amount of positive and negative charges, they will also contribute to the gravitational force between the two objects.

I have proposed in [2] the laws for electrostatic attraction and repulsion forces as follows:

$$F_{att} = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{r^2} K_{att1} \quad (K_{att1} \cong 1)$$

$$F_{rep} = \frac{1}{4\pi\epsilon_0} \frac{Q_1 Q_2}{r^2} K_{rep1} \quad (K_{rep1} \cong 1)$$

$K_{att1}$  and  $K_{rep1}$  are numbers very close to 1. It is the extremely small difference between  $K_{att1}$  and  $K_{rep1}$  that will give rise to gravitational force. Since gravitational force is attractive,  $K_{att1}$  should be greater than  $K_{rep1}$ .

## Equality of inertial mass and gravitational mass

From the above theories, *both* inertial mass and gravitational mass depend on the *total* amount of charges in an object. Therefore, two objects with equal gravitational masses will have equal *total* amounts of charge, from which follows equal inertial masses.

## **Discussion**

According to the above theory that gravitational force is a difference between electrostatic attractive and repulsive forces, there can be no gravitational force between two electrons, assuming that electrons are elementary particles. However, there will be gravitational force between an electron and proton, between an electron and a neutron.

It has been proposed in this paper that inertia is electrical self-inductance. Does mutual inductance also exist ? Yes it should exist because it exists in electrical circuits.

## **Conclusion**

This paper has solved some of the great puzzles and mysteries in physics. Inertia of an object has been shown to be due to electrical self inductance of the charges in the object. Gravitational force is the difference between electrostatic attraction forces and electrostatic repulsion forces. Inertial mass and gravitational mass are equal because both depend on the *total* ( NOT *net* ) amount of positive and negative charges in objects.

Thanks to God and His Mother Our Lady Saint Virgin Mary

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