# Forces On Moving Objects

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In concert with a companion paper,[1] inertial mass is explained and predicted *for any velocity* from electrodynamic forces based on physical processes occurring in electrons and protons with structure and finite size. By this result, a foundation is laid for Newton's laws of mechanics, without the need for assumptions of intrinsic mass or non-causal actions at a distance. The force on any material object depends upon an electrodynamic force law acting upon charged elements distributed within the object. Ambient electric and magnetic fields, including self-generated fields of the object acting in conjunction with the position and motion of the object's charge elements, determine the force on that charge element.

A point-particle assumption common in modern physics and embedded in Maxwell's law of magnetic induction is analyzed and discarded in favor of finite-sized elementary particles. The "curved space" geometries employed in Einstein's Theories of Relativity are rejected. A three-dimensional Cartesian coordinate system correctly models the isotropy of directions in space; the rectilinear properties of electrodynamic fields and the forces they exert on moving charged particles correspond to three dimensional physical space. From these fundamental concepts, inertial mass and the force of inertia are obtained from first principles and the law of cause and effect.

## INTRODUCTION

Common physical bodies are composed of positively charged protons and negatively charged electrons; yet, owing to an equal number of these oppositely-charged elementary particles, common bodies are electrically neutral. Otherwise, a large electrostatic force would be observed between objects, such as the sun and the earth, both of which contain huge numbers of charged particles. *The charged particles in a body account for the inertial mass of that body.* Observations indicate that an object with velocity ranging from zero to the speed of light has a non-zero "relativistic" momentum that approaches infinite momentum as the physical body gains a velocity approaching the speed of light.

Some important distinctions can be made between matter and energy. Matter always contains at least one charged particle and can be identified by the presence of charge; depending upon the volume and shape that charge is compressed into, matter also has potential energy. Alternatively, pure energy can exist where no charge resides, *e.g.* in a matterless region of space. The form of this energy may be an electric field, a magnetic field, or some electrodynamic combinations of these two fields, *e.g.* light waves propagating through space. While the concept of energy residing in space has been denied by otherwise competent physicists, the validity is easily demonstrated by stepping outside on a clear day to see the sunlight and feel its heat transported a great distance through space.

Potential theory, electric field theory, and Weber's electromagnetic theory (modified by Wesley[2] to include effects of finite propagation time) provide a supporting theoretical basis for these concepts of electrostatic charge, the fields they create, and the forces impressed upon charges in the presence of electromagnetic fields.

Light and fluctuations of electric fields always propagate at a high velocity termed "the speed of light," but matter must always move at a slower speed. (Three theories for specifying the speed have been proposed; see the section on *Electrodynamics and the Force of Inertia*.) Inertial mass, which resists acceleration in any physical object, increases "relativistically" while it is being accelerated; but light, which has no mass or charge, can propagate at the speed of light since it has no mass to carry along.

Barnes *et al.*[3] have shown that the inertial force of reaction is an effect on electrical charges produced in accordance with the primary laws of electricity and magnetism. In this way, inertial mass has been shown to be an electrical effect derived from first principles.

## ABSOLUTE AND RELATIVE SPACE

Adey suggests "there are only two ways in which the motions of bodies can enter into a theory of moving bodies electrodynamics," [4, p. 108] These two ways are labeled *relative* and *absolute*:

> **Relative.** Velocity and acceleration are specified in terms of the *relative* distance between two objects—one object that somehow exerts a force (the cause) and a second object that responds to the force (the effect). Einstein's Theory of Relativity (TR) is derived from the postulate that this specification will accurately predict the forces and motions of matter. In TR, frames of reference with relative velocity between them and mathematical coordinate transformations are employed to make calculations and predictions of an object's position and movements.
>
> **Absolute.** Location, velocity and acceleration of two objects are specified with respect to a point in space. Newton's famous equations of motion assumed that the forces and motions on an object can be determined by measuring from points in space that have constant velocity with respect to the unknown but important reference point of *absolute space*. Newton did not think we could ever locate this point in space, but he was not prevented from making calculations based on the notion that such a point existed. *Mach's Principle* postulates that the reference plane *defined by the special point in space* "should be taken [as] the whole physical content of the universe, so that the laws of nature would depend on the distribution of matter in the whole universe. In other words, Newton's absolute space has to be replaced by the stars and matter in the universe." [5, p. 103]

The absolute and relative methods assume point-like objects, and the equations of force and motion in these theories are written with respect to a single point at the centers of objects. It is common in the modern approach of Relativistic Quantum Theory to treat elementary particles as point-particles: [6, emphasis added]

> Physically, an elementary particle is regarded as a stable, *pointlike*, structureless entity (structureless except for having mass, spin and other possible quantum numbers), which in its free state, moves on a world line with momentum *k*"
>
> ...a particle is a *point* that moves on a world line (as [Eugene] Wigner emphatically told [Arthur] Broyles).

The approximation that all of an object's charge or mass is located at its center or an equivalent single position determined by the method of geometrical mean distance (the *gmd* method employed by Maxwell) usually produces inaccurate predictions of force, especially where high velocity is involved.

Previous works[7,8] provide successful models of finite-sized elementary particles in a theory of matter. In contrast, some of the deficiencies of physics based on point-like objects are:

- Errors of relative distance are used in the calculations based on force laws using the inverse square of the distance.
- The four so-called "intrinsic" properties of the stable elementary particles (the electron, proton, positron and antiproton)—charge, spin, magnetic moment, and inertial mass as electromagnetic energy divided by $c^2$ are all incompatible with concentration at an infinitesimal point. For this reason, the properties of elementary particles are *assumed* by many modern physicists because these properties cannot be derived from first principles and the law of cause and effect.
- A point-like object cannot contain a mechanism for physical process to occur. "There is no doubt substances are endowed with the power of mutually influencing each other. This causes changes in the rearrangement of matter."[9, p. 14] But, no rearrangement of matter is possible with a point-like object.
- A point-particle is unable to intercept incoming field energy. In contrast, a charged ring particle of finite size can absorb incoming magnetic field energy in proportion to the flux intercepted by the ring's cross sectional area. An electromotive force will be induced in the ring in accordance with Faraday's law of magnetic induction. But a point-particle lacks sufficient area to intercept and absorb any form of incoming energy.
- Without a finite size of an object, it is impossible for one part of an object to act upon the other parts of that same object; the force laws of physics cannot be applied between parts of an object. And the forces between the closest charge elements are neglected, although these forces from close charge elements are often the strongest.
- When point-like objects are employed, the physics of objects is reduced to a belief system without causal explanations for such fundamental properties as stability and the self-binding force; *e.g.,* the magnetic pinch effect in the spinning charged ring. Nor is any causal explanation possible to explain

> momentum or the cause of the force of inertia which, unlike all other forces that act between two bodies, is a self-induced force on a single body.[9]

THE THEORY OF DISTRIBUTION

A fundamentally new and third way to calculate the motion of bodies was introduced in 1977 by Thomas G. Barnes *et al.,*[3] called here the *method of distribution*. The method of distribution is accurate and more general than either the absolute or relative methods although it incorporates some aspects of both prior methods.

The previous methods, *relative* and *absolute*, mathematically consider only two points where all the mass, charge or current of a body is concentrated. No distribution of the causal element, *i.e.* charge, is considered in these methods. There can be no contribution to the effect, *i.e.* force, by any part of a body acting upon another part of the same body. Hence, self-charge effects, *etc.,* are excluded; and any force arising within a body, *e.g.,* inertial force, cannot be calculated.

Approximation to a point-like object is prohibited. The new Theory of Distribution takes account of the *distributed* locations and velocities of all objects in space:

> **Distributed.** With this method, the point-charge approximations of the relative and absolute methods are abandoned. Velocity and acceleration are specified between all charged elements that make up material bodies. The velocity and acceleration of charged elements *distributed* in space with various positions and velocities are taken with respect to the position and velocity of *all* bodies in the universe, *including those in itself.* Thus, the force on a body includes the self-effects of any forces it causes on itself by means of fields emanating from all charge elements of itself. Forces on an object are based on fields from every particle in the universe, though the effect of distant objects will often be insignificant due to the inverse square law or delays of field propagation time. Although no object may occupy some particular point in space, every location in space is occupied by energy fields that have an effect on all objects. The mathematics method of superposition can be used to calculate the potential energy and the vector sum of force fields at that location in space.

The method of distribution has more general application than the prior methods and more accurately predicts the motions of objects. Some advantages and features of the method of distribution are:

- It leads to a causal explanation of inertia; established laws of electrodynamics can be applied to explain the self-induced reaction force of inertia.
- The accepted equation for "relativistic" electrodynamics is obtained without the objectionable non-causal postulates of absolute space or Einstein's Special Theory of Relativity (STR).[10]
- An explanation is provided for the inertial force of reaction upon a *single* body.
- The method of distribution recognizes a mechanism for the exchange of energy based upon physical processes.

The point-particle approximation is widely applied in modern physics for objects that range from the smallest elementary particles to large objects such as planets and stars. This approximation is fundamentally embedded into both Quantum Theory and the Theory of Relativity. And the point-particle approximation has led to the "crisis of theoretical physics."

The method of distribution has been applied to an accelerated charged object to resolve one of the must puzzling controversies of modern physics—namely, the origin and cause of the inertial force. But before the origin of inertial force is explained, we will consider two significant approximations made in the applications of force laws: (1) errors in logic embedded in Maxwell's equation for inductance and (2) the use of coordinate systems that impose "curved space" on force laws.

ERRORS IN LOGIC FOUND IN MAXWELL'S FIRST EQUATION

Maxwell's First Equation is intended to express Faraday's Law of Magnetic Induction. However, two errors in logic were made in order to obtain the differential form expressed by equation (III).

Faraday experimentally verified that the same current is induced in a probe circuit when the same relative motion is maintained whether (1) a magnet is fixed in space and a test probe is moved or (2) a magnet is moved while the test probe remains fixed. With this concept and application of the Galilean transformation, Faraday's law became expressed as

$$\oint \mathbf{E}'(r')\,dl = -k\frac{d}{dt}\int_S \mathbf{B}(r)\cdot\mathbf{n}\,da \qquad \text{(I)}$$

Equation (I) provides a relationship between the magnetic **B** field and the electromotive force it induces in a circuit loop. The electromotive force induced in a circuit depends upon any change of flux within the loop from two causes: (a) time variation of the flux, and (b) distance variation of the magnetic field strength. By a significant error, the latter cause (and its effect) was eliminated from Maxwell's differential equation for induction. As Jackson noted:

> It is important to note that **E′** is the electric field at *dl* in the coordinate system in which *dl* is at rest, since it is that field which causes current to flow if a circuit is actually present.[11]

Although Jackson recognized that the electric and magnetic fields have relative motion between them, he neglected this motion and did not apply the Galilean transformation or any other transformation of motion. (The relative motion and corresponding effects of induction also are excluded by other authors.)[12, p. 145] Instead, equation (1) was placed into differential form by the use of Stokes' theorem and arbitrarily placing the electric fields **E′**and **B** in the same frame of reference. Note how the field transformation information is excluded by this approximation that drops the prime notation from **E′**:

$$\int_S \left(\nabla\times\mathbf{E} + \frac{1}{c}\frac{\partial\mathbf{B}}{\partial t}\right)\cdot\mathbf{n}\,da = 0 \qquad \text{(II)}$$

A second error in logic was made in an attempt to solve equation II: the integral was assumed to vanish at all points in space in order to obtain the differential form of Maxwell's First Equation:

$$\nabla \times \mathbf{E} + \frac{1}{c}\frac{\partial \mathbf{B}}{\partial t} = 0 \qquad \text{(III)}$$

But as a consequence of the inverse square law, this integral vanishes only for two restrictive conditions:

*Condition 1*. A point-particle source and any arbitrary integral surface.

*Condition 2*. A spherical particle source and a spherical integral surface.

For the real world of finite-sized elementary particles, the surface must account for the induced fields and feedback effects. Induction fields exist in the space surrounding the particle, but the approximation omits the effects from induction that become most important at high velocities. *Thus, equation (III) often excludes induced fields and finite size effects.*

Maxwell's equations are not equivalent to the equations for the primary laws of electrodynamics, because the induced field effects relevant to real particles with finite size and structure are ignored when the laws are cast into differential equation form. Discarding finite size and structure effects leads to the point-particle approximation in electrodynamics. This causes Maxwell's equations to fail for high-speed phenomena where internal charge rearrangement and induced field effects are largest.

The Maxwell differential equation for inductance does *not* provide an equivalent equation of Faraday's Law, and physicists turned to Einstein's Special Theory of Relativity to obtain theoretical agreement with experiments on high-velocity objects. But recently, several physicists whose work is described below have actually performed the Galilean transformation to obtain the Galilean invariant form for the electric and magnetic fields of a moving particle. And other physicists are evaluating an approach to electrodynamics based on two criteria suggested by Gauss.

## REQUIREMENTS FOR A COORDINATE SYSTEM

Electrodynamic force laws are applied by means of a coordinate system to specify the geometrical relationships of objects. For applications in physics, a useful coordinate system must correspond with physical reality in terms of (1) the same number of degrees of freedom, (2) the isotropic nature of directions in space, and (3) orthogonality among the coordinate axes.

**Degrees of Freedom**. Common experience supports the axioms of Euclidean geometry. All builders and students of mechanics know that stationary physical bodies may be successfully modeled with a coordinate system of three mutually perpendicular axes. Even points in space where no object exists are commonly specified by three dimensions; space was universally characterized by three dimensions until 1905 when Einstein inserted time as a fourth dimension of space. In "The Meaning of Relativity," Einstein wrote:

> In the pre-relativity physics space and time were separate entities. Specifications of time were independent of the choice of the space of reference.... One spoke

> of points of space, as of instants of time, as if they were absolute realities.[13, p. 30]

Einstein did not accept this method of describing reality, and he inserted *time* into his coordinate systems under the guise of describing events:

> It was not observed that the true element of the space-time specification was the event specified by the four numbers $x_1$, $x_2$, $x_3$, $t$. [13, p. 30]

Of course, time is not a measure of length and is, therefore, an unsuitable parameter for specifying positions in space. In explanations to follow, we will analyze the geometry of TR and expand on the error in logic of using time as an independent coordinate of a physical system.

**Isotropy of Directions**. We make a distinction between *space*, which relates to the physical universe, and to a *coordinate system* that relates to mathematics. Space itself is anisotropic due to the non-uniform distribution of matter and fields in space. But the coordinate system of three axes used to specify positions in Euclidean space is isotropic because (1) we use unit length increments with equal magnitude; *i.e.* a linear scale and (2) we assume all directions are equivalent to each other. The latter axiom follows immediately from the first axiom and selection of three axes that are mutually perpendicular.

**Anisotropy of Space**. The density of matter and charge in space vary widely over regions with an abundance of stars, planets or galaxies, and other regions that are largely void of matter. For every charged particle throughout space, a corresponding electric and magnetic field extends indefinitely and corresponds to the shape of that object. The ambient field strength at a point *p* in space is related to the location of all charges in the universe, the distance from point *p*, and the rate at which changes of field magnitudes are propagated. It follows that the distribution of energy in space varies with location and time. Stated briefly, space is anisotropic. We agree with Einstein that "all directions in space must be equivalent to each other,"[13, p. 35] provided that *directions* are meant to be isotropic rather than the characteristics of space itself.

**Isotropy of Coordinate Axes**. Fluctuations of electric and magnetic fields propagate outward from every charged particle at the speed of light. At a distance far from the source, the surface of the propagating fields is like an expanding sphere whose surface area increases by the square of distance from the original location of charge (or charge element). Because the energy carried by the field is transported ever outward and spread over a larger surface, so the field strength (Joules per square meter) is reduced in accordance with an inverse square law. The spherical nature of this effect has been measured and is the basis for concluding that *empty space* is isotropic.

The force laws—say Coulomb's law—must be written to reflect the isotropic nature of *directions*. For example, Coulomb's law for the force between an electron and a proton must be written so that the force between the objects is the same in all directions of space. The second requirement for a coordinate system is that its coordinates are scaled in units that are consistent with isotropy of direction.

**Orthogonality of Coordinates**. Coordinates to describe a physical system should be orthogonal so that the change in any coordinate has a corresponding change in one and only one degree of freedom in the physical system. This requirement is primarily a mathematical requirement to eliminate errors in calculations of the state of the physical system.

The force laws of electricity are identical in all direction when a Euclidean geometry is assumed. Where matter is distributed homogeneously in space or is entirely missing in some region of space, the Cartesian coordinate system most clearly displays the isotropy of spatial characteristics for this special case.

## FUNDAMENTAL DEFECTS IN THEORY OF RELATIVITY

Einstein's Theory of Relativity has significant defects and is not a valid scientific model of physical reality. The principal reasons for this assessment of TR are:

- An assumed interdependence of space and time (and the equivalence of "curved space").
- A non-causal assumption (regarding the velocity of light) that is unrelated to first principles.
- A point-particle assumption that eliminates self-charge effects in elementary particles.

**Interdependence of Space and Time.** Einstein claimed that space and time are related entities, and he added a fourth dimension in his "space-time continuum:"

> One spoke of points of space, as of instants of time, as if they were absolute realities. It was not observed that the true element of the space-time specification was the event specified by four numbers $x_1$, $x_2$, $x_3$, $t$.... Upon giving up the hypothesis of the absolute character of time, particularly that of simultaneity, the four-dimensionality of the time-space concept was immediately recognized.[13, p. 30]

The interdependence of space and time is equivalent to a "curvature of space" that defines the path where events occur in space and the time when events occur. The "curved space" concept of STR was developed by Minkowski (1908) in non-Euclidean geometry, but the "curved space" of Einstein's General Theory of Relativity (GTR) was developed in Riemann's non-Euclidean geometry. [14, p. 20] Later, Einstein acknowledged that Minkowski's space "is a four dimensional, quasieuclidian [sic] space, with the line element [$\Delta s^2$], (the distance between two neighboring events)" given as [13, pp. 32, 39]

$$\Delta s^2 = \Delta x_1^2 + \Delta x_2^2 + \Delta x_3^2 + \Delta x_4^2 \qquad (1)$$

where $x_1$, $x_2$, and $x_3$ are the three position coordinates of space and $x_4 = ict$ is the "imaginary time variable." When $\Delta s^2 > 0$, the Minkowski formulation of STR gives the displacement of a particle as [15 p. 286]

$$\frac{ds^2}{c^2} \equiv dt^2\left[1 - \frac{v^2}{c^2}\right], \quad \mathbf{v} = \frac{d\mathbf{x}}{dt} \qquad (2)$$

Einstein developed the implications of equation (2); he claimed that time slows down, length contracts, and mass increases with velocity in accordance with equation (2). The same results are obtained in the original formulation of STR by Einstein in 1905 [10] and the later formulation by Minkowski in 1908.[15]

The Minkowski formulation of STR in 1908 is based on equation (1) and “curved space.” Kanarev shows the correspondence of Einstein’s STR with Minkowski’s geometry by his analysis of the theorem of Pythagoras. [14, p. 10]

> Late in the last century, the theoretical mathematicians Riemann and Lobachevsky invented geometries different from Euclid’s. Such geometries are called “non-Euclidean” or “pseudo-Euclidean.” In Euclid’s geometry all sides of a right triangle are straight lines, and its included angles add up to 180 degrees. In the geometries of Riemann and Lobachevsky, all sides of triangles are curved, and their included angles add up to more or less than 180 degrees. In the observable world, such geometries exist only on curved surfaces; therefore they are associated with concept of “curved space.”

When Einstein and Minkowski chose $\Delta s^2 \neq 0$ in equation (1), the result was a violation of Pythagoras’ Theorem with correspondence to all of the following:

- Interdependence of space and time
- Curvature of space
- Physics based on four dimensions instead of three
- “Relativistic effects” of mass, length, and time varying in accordance with velocity

Figure 1 illustrates a case of “curved space” with a longer path when $\Delta s^2 > 0$

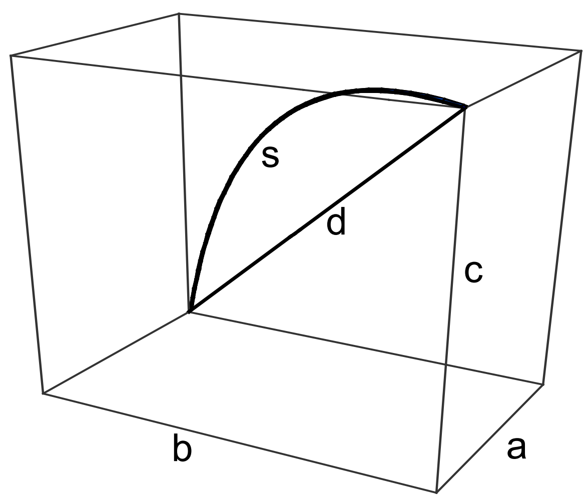


**Figure 1.** Illustration of a path in “curved space” that is longer than a straight line in Euclidean space. Einstein disregarded the Theorem of Pythagoras. His STR attempts to make $s^2$ equivalent to $d^2 = a^2 + b^2 + c^2$.

**Non-causal assumption.** Minkowski’s “curved space” coordinate system is equivalent to non-causal premises of the Special Theory of Relativity concerning (1) postulated constant velocity of light relative to all observers and (2) interdependence of time and length dimensions. In the General Theory of Relativity, the geometry of another "curved space" coordinate system (Riemann's) is equivalent to a non-causal postulate concerning equivalence of inertial mass and gravitation. But equivalence of mass and gravitation is denied by experiments on the inertial force:

> ...inertial mass can be measured independently of gravitation by impact experiments....[16, p. 246]

And Newton rejected equivalence of mass and gravitation:

> In Newton's mind the force of inertia was very different from the force of gravity. Gravity was called forth by the presence of another body.... Inertia was quite different. It was not an interaction between two particles or extended bodies.[9, p. 60]

**Point-Particle Assumption.** The dominant theories of modern science are Quantum Theory and the Theory of Relativity. Both theories assume the existence of point-particles for the purpose of simplifying mathematical calculations on material objects. [17, p. 148] This seemingly minor approximation is, in fact sufficient to discredit modern physics and make additional progress in science impossible.[7] The results of assuming point-like objects include:

- Missing induction effects in Maxwell's equation for inductance and failure to predict the so-called "relativistic" effects observed in high speed objects—necessitating the use of the Special Theory of Relativity.
- Inability of Quantum Theory to predict fundamental phenomena—*e.g.,* spin, magnetic moment, finite rest mass, and stability of elementary particles—which must have finite size according to the fundamental laws.[7]
- Inherent properties for objects are assumed because no relationship between characteristics and first principles is possible.
- Point-like objects are inconsistent with any physical mechanism for the exchange of energy between objects, rendering impossible any description of fundamental physical process.
- Inability of STR to predict inertial force.

Scientific methods and principles, especially Potential Theory, require a finite-sized, extended object to explain the force of inertia. The point-particle assumption has prevented a rational and causal explanation of the force of inertia.

## ELECTRODYNAMICS AND THE FORCE OF INERTIA

Peter and Neal Graneau [9, pp. 59-60] describe the force of inertia as "one of the deepest riddles of science:"

> In addition to gravity, Newton claimed, there existed another fundamental force of nature. He called it "vis insita" or innate force of matter. In Definition III of the *Principia*,...he defined it as: "The vis insita, or innate force of matter, is a power of resisting, by which every body, as much as in it lies, continues in the present state, whether it be of rest, or moving uniformly forward in a right line." Inertia manifests itself as follows. When the driver or a car slams on the brakes,

> his body is flung forward on the steering wheel. Some force must be pushing the body. This is the force of inertia. Where does it come from? ...The Creator seemed to have built inertia permanently into every particle.

Most forces observed in nature follow an inverse square law of the distance between *two* objects, *e.g.* the force between charged particles, magnets, currents or planets. But the force of inertia depends upon a *single* object's momentum $p = mv$ and its rate of acceleration $f = ma = dp/dt$. The distance between two objects is not a factor in the magnitude of inertial force. As Newton recognized, inertial force seems to rise up within an object. The force of inertia is different from all other forces.

The most important application of the *method of distribution* is to predict and explain inertial forces and the related characteristic of momentum. By the use of this method, the complaint that Newton's laws of mechanics are non-causal "actions at a distance" has been removed—an achievement that Newton would have welcomed.

Unlike the preceding methods dealing with the forces between two bodies, the new method includes the effects of self-charge within a single body acting upon itself. An additional feature of the method concerns the propagation of radiation and field fluctuations *which proceed outward from the source object* at the speed of light. In this approach, movement or redistribution of charge within a charged body causes (1) the outward propagation of energy, and (2) the speed of the propagation (as measured from the source). The latter proposition, that energy propagates at velocity *c with respect to its source,* reflects an implicit assumption of the Galilean transformation, and evidently applies in the near vicinity of the source object. Light velocity must enter into any proposed theory of electrodynamics; an example is given by Moon *et al.*[18] who proposed a new Gaussian equation of electrodynamics[**] that incorporates the causal proposition:

**Postulate III*:** In a coordinate system that is not moving with respect to the source and which is not in rotation, the velocity of light in free space is a constant *c*.

It is unclear to me if the original velocity of radiant energy relative to its source is maintained as the energy proceeds into regions of space where the fields of other charged particles become relatively greater than the fields of the source object. Others have proposed three theories for the *one-way velocity of energy propagation of light in free space.*[19, p. 197] These are:

> 1) the Ritz, or ballistic, theory of light, where the velocity of light is supposed to be *c* relative to the moving source,
>
> 2) the "special relativity" theory, where the velocity of light is supposed to be *c* relative to the moving observer, and
>
> 3) the...classical theory, where the velocity of light is found to be *c* with respect to the fixed all-pervading luminiferous ether, or absolute space.

In 1977, Barnes, Pemper, and Armstrong proceeding in accordance with the principle of Postulate III* and derived the total electric field of a charged spherical body using the method of distribution.[3] They used

[**] Two noted physicists recently and independently analyzed Gaussian electrodynamics and claim to have found fundamental defects in Moon's implementation.

the idea of feedback, in which changing electrical fields cause magnetic effects and vice versa.... The results agree with those from previous theory; but they are obtained in a way which seems physically more meaningful, and which does not require one to assume effects for which there is no experimental evidence.

The result they obtained, equation (IV),

is the same solution one would obtain using the special theory of relativity for the electric field seen in the fixed frame of reference for the case of a charge *q* traveling by with uniform velocity. The remarkable thing about this new theory is that the assumptions of length contraction, time dilation, and constancy for the speed of light *c* were not necessary.[3]

$$\mathbf{E} = \frac{q}{4\pi\varepsilon r^2}\left[\frac{1-\beta^2}{(1-\beta^2\sin^2\theta)^{3/2}}\right]\mathbf{u}_r \qquad \text{(IV)}$$

where $r$ and $\theta$ are spherical coordinates and $\beta = v/c$ is the usual expression for velocity normalized to the speed of light.

Equation (IV) predicts the electric field intensity found in the space surrounding a charged sphere. This E-field depends upon the velocity of the moving charge $\beta$ relative to the location of fields the charge created and is moving through. (Movement of a charge through its own self-generated fields is possible only because the charge has a finite size distribution.) The electric field intensity becomes very large as the velocity of moving charge approaches the speed of light. In this case, the charged sphere itself is moving forward almost as fast as the E-field propagating forward through space with velocity *c*; at the same time, the relative velocity between the forward moving charge and backward propagation of E-field is nearly twice the speed of light.

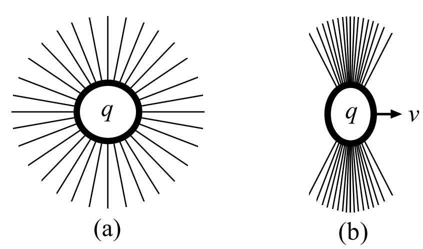


**Figure 2.** Electric Field Intensity of Charged Sphere, from equation (IV). Part (a) shows the field lines for the charge at rest. Part (b) shows the field lines for the same charge moving at a velocity $0.94c$, so that $\beta = 0.94$.

The electromagnetic energy of the charged sphere resides in the electric and magnetic fields surrounding the sphere, *i.e.* in space. The shape of these fields change with the velocity of the sphere (Figure 2), and their energy approaches infinite energy as the sphere's velocity approaches the speed of light. A corresponding increase in inertial mass occurs with the increase of field energy.

The field energy associated with a moving charged particle and the inertial force of reaction depends upon the velocity in equation (IV). Barnes *et al.* describe the force of reaction that opposes any attempt to accelerate the charge:[3]

> There is a physical reason to expect an interaction from the S frame to the S′ frame. When a charge is accelerated by a force there must be, according to Newton's Third Law, a reaction force exerted by the field back on the charge—a feedback phenomenon. Thus an altered electric field must develop during the acceleration which acts back on the charge like an inertial force opposing the acceleration.
>
> In addition to the production of a radiation field by the acceleration of the charge, an induction field is also developed. This induction field is associated with the velocity of the charge and stays with the charge as long as it is in uniform motion with respect to the ambient field of the fixed frame. One would expect this electric field feedback to persist during uniform motion, only in a balanced state such that the net feedback force on the charge is zero.

Barnes *et al.* established equation (IV) and a classical foundation for electrodynamics by means of a Galilean transformation and the use of Maxwell's equations. The two errors in Maxwell's equation for induction do not affect the result because: (1) the Galilean transformation was performed to obtain the electric and magnetic fields in the same reference plane *before* Maxwell's equation was used and (2) the spherical symmetry (Condition 2) permitted the surface integral in equation II) to be correctly performed without loss of energy in the induction fields.

From Maxwell's field theory and equation (IV), one could, in theory, predict the inertial force required to accelerate the charged sphere. (The valid use of equation (IV) is not restricted to a sphere. Lucas[20] and Smulsky[21, eq. (6)] have independently produced equivalent forms of equation (IV) for general applications.) However, stable elementary particles cannot have the shape of a sphere. Furthermore, the inertial mass defined in Newton's law as the ratio of force to acceleration has already been derived as the equivalent rest mass energy for a spinning charged ring by the use of Weber electrodynamics.[22]

## INERTIAL MASS OF SPINNING CHARGED RING

Modern science considers inertial mass to be an inherent property of matter; thus, mass is *not* seen as a property derived from a fundamental natural entity and primary laws, but as a fundamental relationship between force and acceleration, *i.e.* a definition or an assumption. But good science minimizes the number of assumptions and intrinsic properties, so here we *derive* inertial mass from more fundamental electrical laws and a model of elementary particles that corresponds to the actual physical structure of electrons and protons.

Electrodynamics analysis of a charged sphere is important for insight into physical processes. But electrons and protons have the shape of a thin ring;[22,23] and, for correspondence to the real physical world, an object of finite size and actual shape must be used for calculations to predict the inertial mass.

Ring particles, *e.g.* electrons and protons, consist of charge rotating in a loop at the speed of light *c*. The moving charge creates a standing wave of two fields surrounding the ring: an electrostatic field and a magnetostatic field store almost equal amounts of energy. A boundary condition theorem in electromagnetic field theory specifies that the electric and magnetic fields surrounding an object are completely determined (for static conditions) by the shape of an object and its surface voltage.

For charge rotating with tangential velocity *c* along the circumference, a balance of force is achieved at the surface of the toroid by the magnetic pinch force that confines charge in spite of the strong outward force from electrostatic charge repulsion.[22]

In a separate paper[1] inertial mass and its property of momentum are derived from electrodynamic effects on the spinning charged ring. There, the charge distribution and internal structure of the rotating ring is deduced, providing insight into the physical processes that are involved in the reaction force of inertia that resists acceleration. Current and electrostatic charge contribute equally to the inertial mass of an elementary particle. Approximations made in [1] limit the accuracy for prediction of inertia to low velocity objects. But, next we derive an accurate expression for the inertial mass of an object at any velocity.

Inertial mass can be *explained* (not assumed) on the basis of fundamental concepts already presented; these concepts for explanation include self-charge effects, propagation of field changes outward from the charge at velocity *c*, and isotropy of directions in space. From these principles, the inertial mass of a spinning charged ring is obtained in a manner similar to that of Hughes.[24]

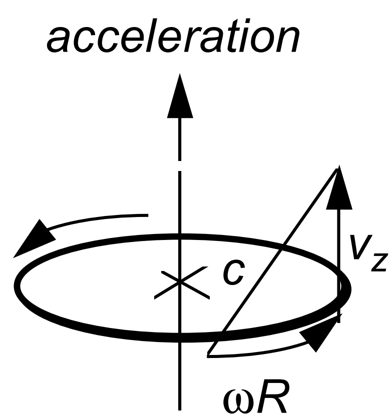


**Figure 3.** Geometry for calculating the increase of inertial mass with velocity when an electron (or proton) acquires kinetic energy as a result of acceleration. The rim velocity of charge in the ring's own electric fields is maintained at *c,* the speed of light.

An external force of acceleration on a ring particle (shown in Figure 3) will increase its velocity and kinetic energy. For acceleration of a spinning charged ring in the direction of its axis, the axial velocity and the tangential velocity of charge in the ring must be equal to the speed that gives a balance of forces, *c*.

$$c = \sqrt{v_z + (\omega R)^2} \qquad \text{(V)}$$

where $\omega$ is the angular velocity of charge rotation.

This kinetic energy is absorbed in the ring (and fields surrounding the ring) by compressing the ring to a smaller diameter. Any additional kinetic energy is acquired during the period of acceleration. As energy is absorbed, however, the product of the ring's size *R* and its energy *E* remain constant.[23, equation (7)]

$$ER = \frac{e^2}{4\pi^2 \varepsilon_o}\left[1 - 3\ln 2 + \frac{2\pi\phi_o}{\mu_o ce}\right] = mc^2 R = K \qquad \text{(VI)}$$

where $e$ is the charge of an electron or proton, $\phi_o = 4.13 \times 10^{-15}$ Weber is the magnetic flux of an electron or proton,[22] and $K$ is a constant equal to the product of energy and radius. At rest, a particle's energy is $E_o = mc^2$. The rest mass $m_o$ and the ring radius are obtained from equation (VI):

$$m_o R_o = \frac{e^2}{4\pi^2 \varepsilon_o}\left[1 - 3\ln 2 + \frac{2\pi\phi_o}{\mu_o ce}\right] \qquad \text{(VII)}$$

So a moving ring acquires kinetic energy and becomes smaller while it undergoes acceleration. Whatever radius a ring may have, the tangential velocity of moving charge can change no more than infinitesimally, keeping the tangential charge velocity equal to *c*. No increase in charge velocity is possible, because then the magnetic pinch force would exceed the electrostatic force, causing the charge to collapse to a filament of zero thickness (which would correspond to infinite energy and a violation of the conservation of energy law).

Instead of changing the tangential velocity of the rotating charge, acquired kinetic energy changes the radius of the ring. By combining equations (V), (VI), and (VII), we obtain the change of mass in the spinning charged ring.

$$m = \frac{m_o}{\sqrt{1 - \frac{v_z^2}{c^2}}} \qquad \text{(VIII)}$$

Equation (VIII) predicts an increase of inertial mass with higher velocity. The derivation of equation (VIII) shows that inertial mass is not an inherent property of matter but an electrical property that depends upon velocity achieved during a sustained period of acceleration.

From equation (VII) and equation (VIII), the size of an elementary particle is obtained:

$$R = R_o \sqrt{1 - \frac{vz^2}{c^2}} \qquad \text{(IX)}$$

where $R_o$ is the radius of the ring particle when it does not reside in an induction field produced by acceleration. (If an ether exists, then $R_o$ is the radius of the ring particle when its velocity with respect to the ether is zero.) Equation (IX) shows that the spinning ring becomes smaller when an elementary particle is accelerated to higher velocities. The kinetic energy acquired by a moving ring is stored in the fields surrounding the ring as it is compressed to a smaller size. This explains why highly accelerated electrons could be used in scattering experiments that determined the charge distribution in small objects, *i.e.* protons and neutrons.[25]

## SUMMARY

The theories used by modern science to predict force employ postulates that deny causality and seem irrational to careful observers of natural phenomena. Contradictions with experimental observations and the requirement for logical consistency provided the motivation for analyzing the current theories and proposing the *method of distribution as a new scientific method for calculating forces.*

Compelling evidence for electromagnetic fields and the fact that matter interacts with fields have prompted several attempts at formulating a theory of moving body electrodynamics consistent with the primary force laws. Several systems of electrodynamics have been proposed and are in use today, with varying results, particularly when high velocities are involved.

The *method of distribution* specifies the way moving body electrodynamics enter into calculations. A particular theory of electrodynamics may be selected as sufficiently accurate depending upon the situation—provided that suitability is established on a causal, physical basis.

The *method of distribution* imposes those factors of geometry most consistent with the physical world. The significant features of the new method are:

- Use of the primary laws of electricity and magnetism to calculate forces, or use of an electrodynamics discipline that was logically derived from those primary laws.
- Inclusion of all electric fields. The velocity and acceleration of charged elements distributed in space with various positions and velocities are taken with respect to the position and velocity of *all* charge elements in the universe, *including charge elements contained in the object under consideration*.
- Use of "flat space" or Euclidean geometry. The mathematics of "curved space" is unsuitable for describing the physical universe.

## CONCLUSIONS

Other critiques of STR have listed errors in logic found in the theory with respect to a definition of time, non-causal postulates, mathematical rigor, a preference for invariance among moving frames of reference, *etc.* A long debate on these issues has not resolved the status of STR or even produced a consensus for its use. The impasse has come about because (1) objections to the theory are usually expressed in mathematical terms and (2) a suitable replacement for STR has not appeared.

By applying the principles of the *method of distribution*, we have shown the proper basis for a theory of electrodynamics, predicted and explained the origin of inertial mass, and presented a causal explanation for the so-called "relativistic" effects of objects moving at high speed. The explanation for effects of inertial mass demonstrates the electrical character of natural phenomena and shows that fields and charged particles are more fundamental than previous assumptions of intrinsic mass of material bodies in point-like objects.

Many years after they were formulated, Newton's laws of mechanics finally have been established on the scientific principles of reality, causality and unity. The primary laws of physics reflecting the electrical character underlying all natural phenomena are adequate to explain the mechanical features associated with mass, motion, and forces. An explanation for inertial mass and its property of momentum has removed the mystical idea of forces reaching across great distances to conserve momentum. Einstein's criticism of "spooky actions at a distance" has been justified.

Modern science is dominated by a belief in random events instead of causality, postulates denied by experiment and logic, and a plethora of force laws. The current expression of fundamental science is an unsatisfactory deviation from the approach of true science and amounts to little more than a system of belief concerning natural phenomena and its perception.

Our criticism of modern science has been restrained until we could offer replacement theories consistent with the scientific method. This paper and others in the list of References are reestablishing physics and the methods of science.

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