

# Lorentz-Invariant System with Quantum Mechanical Properties

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## Abstract

In this work, we study potential fluids, within which eddies exist and have quantum mechanical properties because according to Helmholtz, they are made up of an integer number of lines and their displacement in a potential medium is a function of a frequency. However, this system is Lorentz-invariant since Maxwell's equations can be obtained from it, and this is what we demonstrate here. The considered hypothesis is that the electric charge arises naturally as the intensity of the eddy in the potential fluid, that is, the circulation of the velocity vector of the elements that constitute it, along that potential (it is not another parameter, whose experimental value must be added, as proposed by the standard model of elementary particles). Hence, the electric field appears as the rotational of the velocity field, at each point of the potential medium, and the magnetic field appears as the variation with respect to the velocity field of the potential medium, which is equivalent to the Biot and Savart law. From these considerations, Maxwell's equations are reached, in particular his second equation which is the non-existence of magnetic monopoles, and the fourth equation which is Ampere's law, both of which to date are obtained empirically demonstrated theoretically. The electromagnetic field propagation equation also arrives, thus this can be considered a demonstration that a potential medium in which eddies exists constitutes a Lorentz-invariant with quantum mechanical properties.

## Keywords

Quantum Mechanical Properties, Fluids, Lorentz-Invariant

## 1. Introduction

The equations for the movement of fluid were determined in the 17th century by

Navier-Stokes, and Euler customized them for potential flows, that is, without friction. From them, Bernoulli formulated the pressure equation of fluid at one point in the middle of its flow [1].

Helmholtz characterized some of the properties of eddies in the distribution of potential in media. Eddies are a phenomenon conserving energy, momentum and the amount of movement. Among the characterized features are [2].

- The particles that form the line of the swirl, are in rotation and the axis of the swirl is the tangent to the line at each point that closes on itself, and the set of lines constitute the swirl thread.
- In potential flow, the circulation around a swirling thread is invariable with respect to time and, in particular, no particle can acquire a rotation if it was previously free of the thread.
- A swirl always consists of the same number of particles, equal to the number of particles that constitutes the fluid, hence the mass is retained, even if the shape of the swirl thread is moved or modified, and at the same time, the particles can move across the lines.
- Circulation around a swirl thread is invariable along the entire length of the thread, hence the thread starts and ends at the limits of the fluid, or it recedes on itself.
- A velocity field that creates a potential swirl of intensity  $\Gamma$  in any environment can be expressed by an integral that covers the entire length of the swirl thread. The influence of a piece of thread of length  $d\mathbf{l}$ , on the velocity  $\mathbf{v}$  of a particle, at a point  $\mathbf{P}$ , is given by Equation (1):

$$d\mathbf{v} = \Gamma \frac{d\mathbf{l}}{4\pi r^2} \text{sen}\varphi \quad (1)$$

where  $d\mathbf{v}$  is perpendicular to the plane determined by  $\mathbf{P}$  and  $d\mathbf{l}$ , and  $r$  is the distance between  $\mathbf{P}$  and  $d\mathbf{l}$ , resulting in the Biot-Savart law. Hence, the variation with respect to time of the velocity field of a potential swirl is analogous to the magnetic field caused by an electric current in a conductor and is equal to that of the swirl thread.

The integral of the velocity field,  $\mathbf{v}$ , of the particles of the fluid by the differential element,  $d\mathbf{l}$ , of the perimeter of a curve within the fluid is called circulation and this is equal to the intensity of the eddy,  $\Gamma$ , if there is a tight curve around it [2]. Between the circulation and the rotational of the velocity field, there is the following relation using Stokes' theorem:

$$\Gamma = \oint_L \mathbf{v} \cdot d\mathbf{l} = \int_S \nabla \times \mathbf{v} \cdot d\mathbf{s} \quad (2)$$

where  $d\mathbf{s}$  represents a surface element and  $\nabla \times \mathbf{v}$  is the rotational of the velocity field of the potential medium around an axis perpendicular to  $d\mathbf{s}$ .

## 2. Development

### 2.1. Electric Field

Taking as a starting hypothesis that the electric charge,  $Q$ , is the intensity of the

eddy in the potential flow,  $\Gamma$ , which according to Helmholtz is constant,

$$\Gamma = Q \tag{3}$$

and applying Equation (2),

$$\Gamma = \oint_S \nabla \times \mathbf{v} \cdot d\mathbf{s} \tag{4}$$

and Gauss's law for the electric field displacement vector,  $\mathbf{D}$ , which indicates that the flow of the displacement vector across a closed surface is equal to the total charge it encloses,

$$Q = \oint_S \mathbf{D} \cdot d\mathbf{s} \tag{5}$$

then comparing and assuming that Equation (4) and Equation (5) are being integrated on the same surface, we obtain that:

$$\mathbf{D} = \nabla \times \mathbf{v} \tag{6}$$

That is, when we introduce a swirl in a potential medium, the displacement of the particles is altered and they occur in the same rotations which, in principle, in the ideal medium we did not have. The rotational velocity of the particles, which there is in each differential element of volume of the medium, produced by the various eddies, is known as the displacement of the electric field.

In finding the circulation, along a closed curve, of the rotational of the velocity field of the medium, which has angular velocity dimensions, it is obtained that the electric field effectively derives from the gradient of a potential function.

On the other hand, using Equations (3), (4) and (5), one can rapidly obtain the equivalent in fluid mechanics of the Coulomb equation regarding an electric field, of the Laplace equation regarding conductors, where the density of the volumetric load is null (the divergence of the rotational of the velocity field is always null) and of the Poisson equation regarding dielectrics with non-null volumetric charge density, for Equation (4) and Equation (5), and also considering that the electric field derives from the gradient of a potential function. Finally, obtaining the first Maxwell equation is immediate.

## 2.2. Magnetic Field

By partially deriving Equation (1) with respect to time,  $t$ , and taking once again as a starting hypothesis that the electric charge,  $Q$ , is the intensity of the eddy in the potential flow,  $\Gamma$ , we obtain:

$$\frac{\partial \mathbf{v}}{\partial t} = Q \frac{\partial l / \partial t}{4\pi r^2} \text{sen } \varphi = \frac{1}{4\pi} Q \frac{\mathbf{v}' \times \mathbf{r}}{r^3} \tag{7}$$

where  $\mathbf{v}$  is the velocity field of the medium and  $\mathbf{v}'$  is the variation of the element of differential length of the swirling thread. This expression is the Biot-Savart equation for the magnetic field strength,  $\mathbf{H}$ , of electromagnetism in a vacuum. Therefore, we have obtained that,

$$\mathbf{H} = \frac{\partial \mathbf{v}}{\partial t} \tag{8}$$

that is, the intensity of the magnetic field is the variation of the velocity field of the potential of the medium with respect to time.

Maxwell's second equation can be obtained from this expression, that is, the divergence of the magnetic field is zero. It is noteworthy that this equation is equivalent to stating that there are no magnetic monopoles. Thus, taking the flux of the magnetic field intensity through a closed surface,

$$\oint_S \mathbf{H} \cdot d\mathbf{s} = \oint_S \frac{\partial \mathbf{v}}{\partial t} \cdot d\mathbf{s} = \frac{\partial}{\partial t} \oint_S \mathbf{v} \cdot d\mathbf{s} = 0 \quad (9)$$

which is annulled since the flow of the velocity field of a potential flow is null, and since its divergence is null in a medium with invariable fluid density, due to the continuity equation [2], whether or not there are eddies, that is charges, and whether or not they are moving. Thus, using the Ostrogradsky-Gauss Theorem we obtain that,

$$\nabla \cdot \mathbf{H} = 0 \Rightarrow \nabla \cdot \mathbf{B} = 0 \quad (10)$$

as we aimed to demonstrate.

### 2.3. Permittivity and Permeability

If we match the propagation velocity of the electromagnetic field in a vacuum,  $c$ , with the propagation velocity of a wave in a potential flow with agitated medium of density,  $\rho$ , and compressibility module  $C$ , we obtain,

$$c = \frac{1}{\sqrt{\varepsilon_0 \cdot \mu_0}} = \sqrt{\frac{C}{\rho}} \quad (11)$$

where  $\varepsilon_0$  and  $\mu_0$  are the permittivity and the permeability, respectively, of the vacuum. Thus, it is inferred that the permittivity is the inverse of the compressibility module of the potential flow, and that the permeability is equal to the density of the potential flow [3].

### 2.4. Maxwell's Third and Fourth Equations. Propagation of the Disturbance

Maxwell's third equation, or Faraday's law, is reached via the mechanics of fluid potential in media by considering Equations (6) and (8) and the propagation wave equation with velocity  $c$  of the velocity field,

$$c^2 \nabla^2 \mathbf{v} = \frac{\partial^2 \mathbf{v}}{\partial t^2} \Rightarrow -c^2 \nabla \times \mathbf{D} = \frac{\partial \mathbf{H}}{\partial t} \Rightarrow \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (12)$$

where the fact that the rotational of the velocity field is equal to the gradient of the divergence has been used, which in this case is null by way of the continuity equation of the fluid with constant density, minus the Laplacian of the velocity field.

Maxwell's fourth equation, or Ampere's law, is reached by considering Equations (6) and (8), and taking the circulation of the velocity field of the potential flow,

$$\oint_L \frac{\partial \mathbf{v}}{\partial t} \cdot d\mathbf{l} = \int_S \nabla \times \mathbf{H} \cdot d\mathbf{s} = \frac{\partial}{\partial t} \oint_L \mathbf{v} \cdot d\mathbf{l} = \frac{\partial}{\partial t} \int_S \nabla \times \mathbf{v} \cdot d\mathbf{s} = \int_S \frac{\partial \mathbf{D}}{\partial t} \cdot d\mathbf{s} \quad (13)$$

where Stokes' theorem has been used twice. Comparing the second and fifth term of this equation, and in the case where we have stationary load currents that do not occur in a vacuum, it would remain, as we have shown using Maxwell's fourth equation, that

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} \quad (14)$$

where  $\mathbf{J}$  is the current density. Taking the rotational in Equation (12) or Equation (14) the propagation is reached.

### 3. Conclusions

If energy exists in the medium, as some field theory researchers advocate [3] then, due to the equivalence between mass and energy, it can be considered that in the medium we have a potential fluid, the mass differential of which we assume follows a "Theory of Everything" based on rational mechanics or classical mechanics. The mass and energy can produce eddies in the same medium. This system, as we have shown, constitutes a Lorentz-invariant since it gives rise to Maxwell's equations. It also explains how the electric charge (the intensity of the eddy) and the mass (when the eddies concentrate the particles in the medium) appear, which leads us to believe that these parameters can be obtained with this model, and not as with the standard model of elementary particles in which it is necessary to introduce the parameters from experimental data [1].

In this work, we return to the medium and give it a new interpretation, considering it a potential medium in agitation, in which eddies are immersed, these, in addition to being Lorentz invariants, have quantum mechanical properties, since they are made up of an integer number of lines and they move according to a frequency (matter wave, which we will publish in another work). Thus, a mathematical system can be established, which allows obtaining what has been shown here and solving all the implications that this may entail, among them and as we have highlighted the relationship between relativity and quantum mechanics [4] [5].

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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