Mathematics Today Vol.28(June-Dec-2012)63-75
ISSN 0976-3228

Union of Space and Matter

Ramesh L Joshi, Ph.D., P.E.
48900 Crown Ridge Common, Fremont, CA 94539
Email: ramesh.joshi@sbcglobal.net

Abstract

The union of space and matter emerges from the steady-state motions of electrons (as presented in Maxwell electrodynamics with absolute time) and it is observable in an open conductor as electromagnetic field, and in a closed conductor or in a closed orbit with the unpaired electrons as magnetic field. The electromagnetic and magnetic fields *H* at a distance R in the neighborhood of steady-state motion of electrons, respectively, have six-point and eight-point spatial-connections that unite the matter with the space. A constant *J*, the product of *H* and R, upholds the union of space and matter.

Key words: Matter, particles, spatial-connection of particles
AMS Classification: 70F07 and 70F99

1. Introduction

There are fundamental differences in theoretical representations of Newtonian mechanic and Maxwell electrodynamics. In Newtonian mechanics, a state of motion of particles described by their gravitational fields depends on their relative positions and not on their velocities; the forces among these particles act at a distance without any express consideration of its surrounding. In Maxwell electrodynamics, a state of motion of particles described by electric, magnetic and electromagnetic fields depend on the relative positions and their velocities; the forces among these particles and their fields depend on their surrounding neighborhood. In both the studies, the spatial-connections of matter, defined as "a functional relation of matter with a number of geometrical points in the space that participate in describing its motion," connects the matter with other particles in the neighborhood, or with the space, or both in which it is residing; the time facilitates to study and remains absolute in the study of their motions. So, we will focus on the union of matter with the space, and not with space-time.

The gravitational particles have two, three or four-points of spatial-connections depending on the influence from the other particles in the space. These gravitational particles connect with themselves, but they do neither unite with the space nor with the time.

The charged particles, referred here as electrons, have minimum of four- point spatial-connections, and have macroscopic structure in space. By space, we meant that it contains other charges, and currents in the neighborhood of the particles. The electrons in motion demand to have a union of their matter with the space, as each - the space and the matter- has minimum of four-points of spatial-connections. In the study of two electrons the four-point spatial-connection appears as a special case and reduces to three-point spatial-connection when they are at rest. For this reason, only in the static case, the Coulomb's law of attraction and repulsion apply.

In the static or the time independent electrons motions producing the electric, magnetic or electromagnetic fields' cases, the electric and magnetic fields act independent of each other. Their interdependency appears when there are time dependent changes in the currents due to motions of electrons or magnets in a conductor are present.

In addition to the above basic differences and limitations, there are formal and profound variations in the motions of these particles in space. In the Newtonian mechanics, the action and reaction between two particles are equal and opposite and act along a straight line joining the particles and we can at the most discuss the motion of three particles. In general, this is not the case for electrons as they (mostly) follow the law of linear superposition.

In the case of electrodynamics there are apparent asymmetries that are not necessarily intrinsic to the phenomena. For example, moving a magnet through a closed conductor at rest produces a current in the conductor and an electric field in the neighborhood of the conductor. But, moving a closed conductor through a magnet at rest, there is neither a current in the magnet nor an electric field in the neighborhood of the magnet; but there is electric filed in the conductor.

From the above noted observations two things follow: The steady-state motions of electrons produce electromagnetic and magnetic fields depending on how the electrons motion is connected with themselves and its neighboring space. These fields represent the spatial-connections associated with the matter and establish a union of space and matter. The time does neither directly participate in the motions of electrons, nor unite with the space, nor with the matter nor with the electrostatic and magnetostatic fields. The time remains absolute (Newtonian).

Second, under certain specific spatial (geometrical) constrains on the motions of electrons, the electromagnetic fields turn into magnetic fields which are independent of time. And there are certain materials that have these magnetic field properties. Experimentally, an introduction of the material with magnetic field (magnetic pole) in a closed conductor induces the free electrons in the conductor to move, but its reverse is not true. So empirically, the electrons producing the magnetic field are in stable state of motions, and have higher number of points of spatial-connection compared to that of the electromagnetic field and free electrons in a conductor.

For a simplification in derivation of the union, we will consider the electrons to be of macroscopic structure, moving in the steady-state motions that satisfy the Maxwell equations of electrodynamics.

The theory of union space and matter to be developed is based on - the electrostatic and magnetostatic, the fields produced by the steady-state motions of electrons – the kinematical association of matter of electrons with the space. It is the insufficient consideration of the union of space and matter lies at the root cause of difficulties in the study of electrodynamics to divide the space in to empty and occupied spaces.

2. Spatial-Connections of electrons at rest in space

Coulomb’s law states that the force between two charged particles at rest is directly proportional to the product of charges and inversely proportional to the square of the distance between them. The law is restricted. The time dependent motions of charges violate the law. Under the Coulomb’s law the force between the two charges is along the straight line from one charge to the other. In this restricted case, as discussed earlier in the paper[1] on the spatial-connection, the charges do not spin, and both the electrons’ and the Coulomb’s force have three-point spatial connection that lies on a plane.

There are more than two charges present in the space and the Coulomb’s law is (and the Maxwell equations are) supplemented with the “Principle of Superposition,” which states the empirical facts of electrons: “The force on any charge at rest is the vector sum of the Coulomb’s forces from the other charges, and the resultant force is not necessarily along the line joining to any one of the charges.”

The principle of superposition leads to two succeeding results. First: the resultant force field is not limited to be along a straight line, but is along a curve. Second: the charges in the neighborhood produce an electric field that is proportional to the charges contained in the space. These facts extend the Coulomb’s law of electrostatic force field into a vector field with zero curl and a given divergence which, for simplification of geometrical representation we associate them with the two electrostatic equations for the static case of the Maxwell electrodynamics. This leads to two cases for the spatial-connections of electrons.

Case 2.1 From the Stokes' theorem on vector algebra it follows that for a vector field with a zero curl everywhere has a zero circulation around any closed loop, as shown in the Figure 2.1A. In this case, if we choose any two points (1) and (2) on a closed curve in the space, the line integral of the tangential components of the vector field *E*, say electrical field satisfying the Coulomb's force field, from point (1) to point (2) is independent of a path taken. We will denote vector fields with Italic letterings. The electric field *E* depends only on its initial and final stages, and can be derived from a gradient of a potential function, say φ.

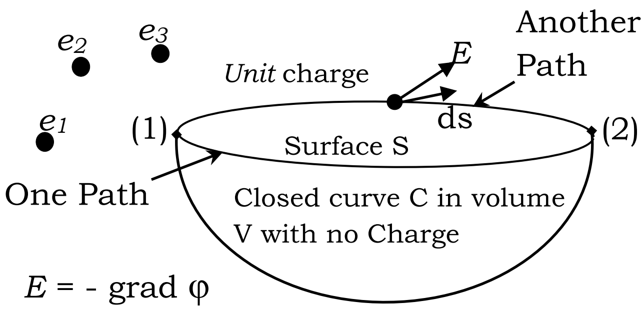

Fig 2.1A

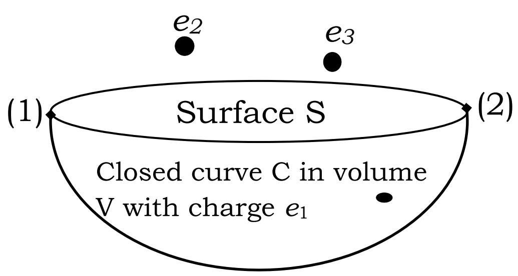

Fig 2.1B

From the above noted results it follows that for a vector field satisfying the Coulomb's law, the charges and its associated field lines at rest are not (necessarily) straight lines, but are curves. Let us consider charges on a surface and their Coulomb's force field expressed as a potential function φ. Since each charge produces a field on a surface expressed as a potential function φ, each charge has a spatial connection with minimum of three points of spatial-connections. Each point of connection lies in the neighborhood of the charge as the field depends upon its surrounding (neighboring) medium, and all of three points of connection lie on a surface. This is true and one can experimentally verify by charging a spherical conductor. In this case, charges lie on the spherical surface with three point spatial-connections, there is no electrical flux through the surface; electrical field inside the sphere is zero as there is no flux through the space enclosed by the sphere. Due to this reason, all charges lie on the surface not inside the surface. A forth point of connection associated with the electrical charges exist when a closed surface encloses the charges, which we will see in the following Case 2.2.

<u>Case 2.2</u> From the Gauss' theorem on vector algebra it follows that for a divergence of a vector field from a volume V with a closed surface S enclosing finite charges, say e_i (i = 1, 2, 3), the flux from the closed surface is proportional to the charges contained in the volume. This case turns into two subcases of having no-charges and charge contained in volume V. Figures 2.1A and 2.1B geometrically represent these two subcases, respectively.

The first subcase is a closed surface S that does not contains a charge, and then due to the Case 1 above, the curl of a gradient of the potential over the surface is zero. Let us take any closed curve C in surface S with volume V as shown in Figure 2.1A with no charge; the curve C can reduce to a point on the surface S. In this case the electrical field can be derived from the potential function φ. By application of the Gauss' theorem, the flux through the closed surface S is zero, so the divergence of the electrical field *E* is zero. Thus, the divergence of the potential function φ is zero. In this subcase, there is no charge enclosed by the surface S with volume V, and the added point of connection for field *E* lies at the charges. But each charge has its own geometrical point where it is located and three-points of spatial-connections are at the field *E* on surface S. Thus the charges e_1, e_2... have four-points of spatial-connections.

Let us consider a second subcase with closed surface S enclosing a charge with volume V, say q_1, as shown in the Figure 2.1B. The result discussed is true for any number of charges. We will limit our discussion to a single charge q_1. In this case we cannot shrink a closed curve C enclosing the charge q_1 to a point. From the application of the Gauss' theorem, the electric field *E*, produced by $q_{1,}$ has non-zero divergence for the volume V and non-zero flux through closed surface S with volume V. To maintain the non-zero properties for the volume V and divergence of the field *E* - a change in the electric field with respect the change in all direction of the space - the charge q_1 has to have in general a non-planer four-point spatial connection. The same way, for non-zero flux of the charge q_1 through a closed surface S with volume V has non-zero field *E*, a change in the electric field in all directions over the surface S, has to have non-planer fourth point of spatial-connection. In this subcase the four-point spatial-connection is necessary and sufficient respectively to have non-zero divergence and flux through a volume V enclosed by a closed surface S for a charge q_1.

3. Union of Space and matter of electrons

The motions of electrons produce electromagnetic and magnetic fields in space. The electromagnetic field is due to an induction of free electrons' motion in space. The magnetic field is a resultant representation of motions of two or more unpaired electrons moving in a closed atomic orbit of a material, or in a closed loop of a conductor. The magnetic field is independent of time and also of the electrical field.

The Faraday's concept of spatial continuity of magnetic field-lines leads to a local union of the matter of electrons with the neighboring space. The continuous magnetic field-lines are limited cases of three dimensional field curves on two dimensional surfaces in the neighborhood. The four-points connected electrons (to which Faraday, Maxwell and others considered as bodies, so let us consider them to be macroscopic) in motion unites with points in neighboring space each having a four-point connection and produce the electromagnetic and magnetic fields. To simplify our presentation, we focus a steady-state motion of electrons. In this limited case, the union of the matter of electrons and the space, both having four point connection at rest, appearing in the electromagnetic and magnetic fields has, in general, eight points spatial-connections in its neighborhood.

The Maxwell's concept of spatial continuity in the electromagnetic field due to the electrons' motions in electrodynamics extend the local union to a global union of space and matter through the equations of motion, in particular through the divergence of the magnetic and electromagnetic fields to be zero, representing their changes in three dimensional space. These facts unite the space and matter globally.

In the time independent case – in the steady-state motions of electrons - the Maxwell four equations turn into a pair of two equations representing electrostatic and magnetostatic equations. In this static case, the time does not participate in these equations, and electrostatic and magnetostatic phenomena appear independent of each other. For this reason, it is permissible and appropriate to consider the time to be absolute (Newtonian) in the study of static electromagnetism.

To observe the union of space and matter and to uphold it, we consider two well-known experiments of a steady direct current flowing through a closed (small circular) conductor and a straight wire. For the closed conductor, the magnetic field appears on the top and bottom neighborhoods. And for the straight wire, only the electromagnetic field appears in its neighborhood.

The first case is analogous to the motion of unpaired electrons moving in a closed orbit of some material, influencing each other to produce a magnetic field. For simplification of discussion, we will consider the case of two unpaired electrons. The discussion equally applies to more than two unpaired electrons.

The second case is the motion of electrons moving on a straight conductor (wire) producing an electromagnetic field in its neighborhood. In this case there are two types of electrons – the first one is the real electrons moving on the wire; the second type of electrons are fictitious, induced in the space, appearing with electromagnetic field produced by the motion of real electrons on the wire.

The four-point spatial-connected electrons in motion have velocity, electric and electromagnetic fields and each of them is at right angle to other two. In the steady-state motion of electrons, the electrical field has its curl zero and a given divergence - expressed in terms of charge density which is constant in time; electromagnetic field has its divergence zero, giving rise to derive it from a curl of a vector – expressed in terms of current density which is also constant in time. The electrons with four-point spatial-connections can move on a closed circuit, or in a closed conductor and also on an open conductor- like a long wire. In either case electrons have to meet and to maintain the forgoing required conditions for the electrostatic and magnetostatic fields to be independent of time, and satisfy the pair of equations. In both these cases, the time derivatives of the fields do not appear in the electrostatic and magnetostatic equations. In the following we will study these two cases.

Case 3.1 Let *O* be the origin of a suitable Cartesian coordinate system with three axes (OX, OY, OZ) as shown in Figure 3.1 and (*i*, *j*, *k*) unit vectors along these axes respectively. We will first study the case of magnetic field produced by the motion of two unpaired electrons, denoted as *e*, in a closed orbit, located on opposite side of an atom or can be manually performed by producing a motion of sets of unpaired electrons located on opposite sides in a small, closed, circular conductor of radius *a* as shown.

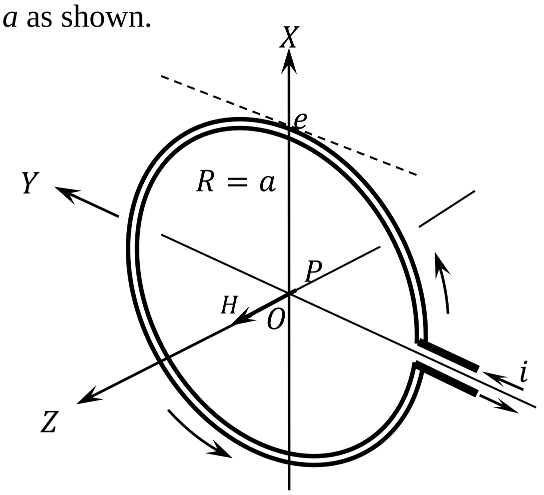

Fig 3.1

The electrons moving in a closed conductor with charge density ρ produce current i and a magnetic field H inside which is perpendicular to the surface of the closed conductor. The current i and magnetic field H are independent of time, are constant, and expressed in terms of the electrons. A simplification will result if two electrons, and not its time dependent motion- the current i - is chosen for the discussion related to the time independent magnetic field H. The final results presented here, without the loss of generality, remain the same whether we use e or i in our discussion.

Each of the unpaired electrons is moving in a closed conductor with a four point spatial-connection as shown in Fig 3.1. Each of the electrons occupies a point on the conductor and produce electromagnetic field. We will see in the Case 3.2, discussed below, that the electrons in steady state motion have eight points of spatial-connections in its neighborhood, of which six are independent. The set of two unpaired of electrons together will have twelve independent points of spatial-connection. Let us focus on the magnetic field produced by two unpaired electrons of a material moving in a closed orbit, or its equivalent in the closed conductor. Both the cases give the same results. For the conductor case, however, there will be electromagnetic field outside of the conductor, but we will focus on the magnetic field inside of the closed conductor and along the cylinder with conductor as edge, similar to the one produced in front of a magnetic pole of a magnetic material.

For a magnet, the forces from the electrical fields associated with the moving electrons are in equilibrium and their resultant electric field is zero. This occurs as the electric fields of both the electrons lie in a local plane-surface enclosed inside the conductor. This requirement originates one constrain on both the electrons and their available independent points of spatial-connections. The constrain on the two electrons to move on a conductor and to maintain their associated electrical field in equilibrium, the electric field associated with each electron must be such that their resultant field lines joining them are along the radial-axis; the resultant of the electrical force fields is zero. This physical fact reduces two independent points of spatial-connections for the magnetic field.

Now, both the electrons to remain on the surface enclosed by the conductor (orbit) with two points of freedom of motion in producing a common magnetic field adds a second constrain reduces two additional independent points of spatial-connection. Thus, the two unpaired electrons producing the magnetic field have total of eight independent points of spatial-connection in its neighborhood.

For a case of material having more than two unpaired electrons in its orbit will have the same two constrains, but will have corresponding points of spatial- connections associated with constrains to reduce the total number of points of spatial-connection to eight points of spatial-connections. In either case, the magnetic field associated with the unpaired electrons have total of eight points of spatial-connection in its neighborhood.

The observed experimental facts are: Magnetic fields have north and south poles, without a monopole in the classical electrodynamics; and in quantum mechanics theoretically present a monopole to the magnetic fields, but never detected. So, for the present study we consider that there are two sets of poles associated with the magnetic field and separated by the magnetic material.

These two sets of magnetic fields located perpendicular to two magnetic poles (magnetic material) need to satisfy that their divergence is zero, and giving rise to a vector field derived from a curl of a vector. Thus, the magnetic vector field, a curl of a vector, has two equal and opposite forces, working at a finite distance from each other. The equal and opposite forces do not add any constraint on each of the magnetic field located on either side of the magnetic material, as the original eight-point spatial-connections have satisfied this requirement.

The eight-point spatially-connected magnetic field appears as a set of two separate fields, but physically that has never observed. The set of two magnetic fields always remain connected. The magnetic field on each side of the material satisfies that its local divergence be zero. A curl of a vector expresses the set of the magnetic fields. The curl of vector is a third vector. The curl vector field, in addition to curl property, has to satisfy the global divergence to be zero. This three dimensional global property connects the two sets of the magnetic fields, located on top and bottom (opposite sides) of the material, introduces a geometrical curvature (turn) and torsion (twist) in its three dimensional space of the magnetic field. The magnetic fields either on both sides of the magnetic material or that of the conductor have locally equal and opposite force fields at a finite distance of the plane separating these two fields create a curvature (turn), and its associated curl vector is not a straight as an arrow but has torsion (twist) to meet its local and a global properties of having divergence zero. Both the vectors are not independent, but are connected; the connection of the vector field produces eight points of spatial-connection for the magnetic field.

Both the electrons in the closed orbit or its equivalent in a closed conductor are under the action of the Coulomb's force field giving rise to two equal and opposite forces F. The force F is given by:

$$F = \frac{1}{4\pi\epsilon_o} \cdot \frac{e.e}{4a^2} j \tag{3.1}$$

The forces are under equilibrium under the centripetal forces due to the motion of electrons, either moving in the orbit or moving in the conductor and, is given by mv^2/a, where v is the velocity of the electron with mass m and a distance from the center for the two forces. Please note that $e.e$ in equation (3.1) denotes a simple multiplication of e with another e giving rise to e^2. From the equilibrium conditions, then we have

$$F = \frac{mv^2}{a} j \tag{3.2}$$

From which we get the following equations for two electrons:

$$\frac{1}{4\pi\epsilon_o} \cdot \frac{e^2}{4a^2} j = \frac{mv^2}{a} j \tag{3.3}$$

These two equal and opposite forces give rise to a fourth point of spatial-connection along the magnetic field H. The magnetic field H is a cross product of two equal and opposite forces along j, $2a$ distance apart along the radius vector and perpendicular to the plane enclosed by the conductor. The magnetic field H produces a local couple of two equal and opposite forces, and is given by

$$H = \frac{1}{4\pi\epsilon_o} \cdot \frac{e^2}{4a^2} j \times 2ai$$

$$= \frac{1}{2\pi\epsilon_o} \cdot \frac{e^2}{4a} k \tag{3.4}$$

$$= \frac{\mu_o}{2\pi} \cdot \frac{e^2}{a} k$$

The magnetic field is at the center, directed perpendicular to the plane, located on both sides of the plane. The magnetic field H produced by two electrons is given by

$$H = \frac{1}{2\pi\epsilon_o} \cdot \frac{e^2}{4a} k = \frac{\mu_o}{2\pi} \cdot \frac{e^2}{a} k \tag{3.5}$$

On the right hand side of the equation (3.5), the quantities e, μ_0 and π are magnetic field constants and do not change. So, from (3.5) it follows that the magnitude of the magnetic couple H increases its value inversely as the value of a decreases, the radius of the conductor or the radius of the orbit decreases without limit. In a limiting case, the magnitude of H will go to infinity as the value of *a* goes to zero, which makes no physical sense and it is not feasible. Similarly, the distance between two electrons cannot be reduced to zero to produce the magnetic field *H*. From these comments follows the postulate:

Postulate

> **For unpaired electrons in motion in a closed conductor, or in a closed orbit of a material with radius R, producing magnetic and electromagnetic fields *H* in its neighborhood is such that the product of *H* and R is constant. The constant *J*, defined as *H*R = *J*, upholds the union of space and matter.**

From equation (3.3) and the kinetic energy of two electrons 2*(½mv^2), we see that the constant *J* has dimensions of ML^3/T^2, where M, L and T, respectively, are the mass of electron, L the distance (Length) and T the absolute (Newtonian) time, and unites the matter and space.

Case 3.2: Let *O* be the origin of a suitable coordinate system with three perpendicular Cartesian coordinates (OX, OY, OZ) axes, and (*i*, *j*, *k*) the unit vectors along the axes respectively. A steady electron flow with charge density *ρ* (rho) flowing through a straight conductor along the axis OX is shown in the Figures 3.2.

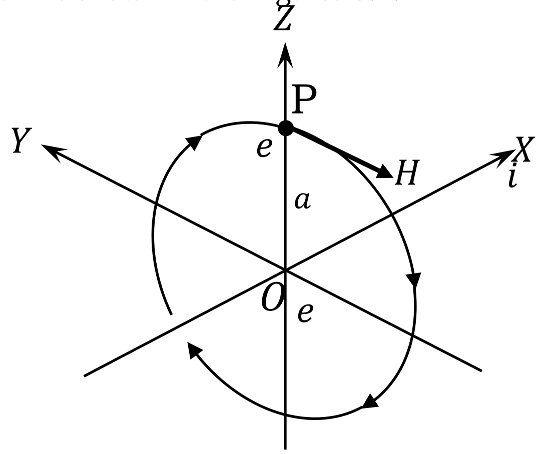

Fig 3.2

We focus our discussion on a single electron *e* located at point O moving with a constant velocity *v* on a conductor. The steady-state motion of the electron(s) in the long wire produces electric field *E* and electromagnetic field *H* in its neighborhood. We will focus on the static electromagnetic field *H*. The electron *e* at O has constant mass m, velocity *v* and $\frac{1}{2}\,mv^2$ kinetic energy. As discussed in the Section 2, for the electron on the wire, the electric field *E* has its curl zero giving rise to an electrical potential φ (Phi). The electric field lines starts and ends on point

O giving rise to a closed curve (surface) connection for the electron at O, establishing a minimum of three point surface, say S, for the electron in the space. The velocity vector originates from O is perpendicular to the surface S, establishing the fourth point of spatial-connection for electron at O.

Since the motion of the electron *e* produces an electromagnetic field *H* in its neighborhood, say at point P with a fictitious electron. The zero value of divergence of electromagnetic field gives rise to circulation around the curve enclosing the surface S which, according to the magnetostatic equation is equal to the flux of electric current density. From these facts, the electromagnetic field *H* is given by:

$$H = \frac{1}{2\pi\in_o} . \frac{e^2}{4a} k = \frac{\mu_o}{2\pi} . \frac{e^2}{a} k \qquad (3.6)$$

The surface S encloses the electromagnetic field and its direction is given by the right hand screw rule. It has three points of connection with a fictitious electron *e* at point P. At the point P, there is also an electrical field *E* at right angle to the electromagnetic field which starts from and terminates at point O giving rise to a fourth point of connection with the fictitious electron at P. The point P is an arbitrary point at distance *R* from O. Thus motion of *e* at O gives rise to electromagnetic field *H* with eight-point spatial-connection. The electrostatic energy due to the charge *e* at point O and the fictitious charge at P with the electromagnetic field *H* at a distance *R* is given by:

Electromagnetic energy $= \frac{1}{4\pi\in_o} . \frac{e^2}{4R}$

The electron is in motion and its electromagnetic energy and kinetic are equal and can be expressed at a distance R as

$$\frac{1}{4\pi\in_o} . \frac{e^2}{4R} = \frac{1}{2} mv^2 \qquad (3.7)$$

The electromagnetic field *H* in the neighborhood of the real electron at O and an induced electron at P has to satisfy that its divergence to be zero. The divergence constrain reduces two independent points from the spatial-connections. Thus, the electrons and the electromagnetic field *H* have six-point spatial-connections in its neighborhood.

For the electromagnetic field *H* at distance *R*, by following the same reasoning of Case 1, the above noted postulate follows and we have the result as *H*R = *J*, where *J* is a constant that upholds the union of space and matter.

4. Conclusion

1. Electrons at rest have up to four points of spatial-connections.
2. The steady-state motion of electron produces electromagnetic field *H* in its neighborhood. The electron and its electromagnetic field *H* have six-points of spatial-connections.
3. The steady-state motion of unpaired electrons in a closed conductor or in a closed material orbit produces magnetic field *H* in its neighborhood which is perpendicular to the conductor or to the orbit. These unpaired electrons and the magnetic field *H* have eight-points of spatial-connection.
4. The steady-state motion of electrons unites the space and matter through the magnetic and electromagnetic fields. The union of space and matter is represented as magnetic and electromagnetic fields *H*, produced at a distance R from the moving electron, and in its neighborhood satisfies the equality $H\mathrm{R} = J$, where J is a constant.
5. Thus, electrons at rest have up to four-points, and in steady-state motion their matter unites with space with six-points or eight-points of spatial-connections depending on its motion in the neighborhood.

5. Acknowledgments

I am thankful to Professor George Leitmann, Emeritus professor at the University of California, Berkeley for valuable comments, and to Mr. Vatsal H. Trivedi in preparing the figures of this paper.

Reference

1. Spatial Connection of Matter and Explanation: Why earth spins and not its moon, Mathematics Today, Vol. 27, P.93-99.