*SECTION 11*

# *A Model for the Universe (1)*
# *Electric Field and Charge*

In the process of pursuing the convergence from three directions, Origin, field and matter, on the central underlying reality, the Origin direction has been investigated a fair distance. It is now necessary to pursue the field direction.

"Field" is a term used to explain "action-at-a-distance". In order to explain the effect that a mass or charge at one location exerts a force on another, distant or near, mass or charge, it is hypothesized that the mass or charge generates or has associated with it a "field of force" throughout surrounding space, and that the field does the acting, that is, the field exerts the force. It is apparent that this is not an explanation of how or why the effect occurs but only an elaboration of describing the "action-at-a-distance" by giving another name to it, field.

The fundamentals of what is known about the effect called electrostatic field can be summarized as follows.

- Two electric charges attract or repel each other for charges of opposite or like sign, respectively ("positive" or "negative" charge).

- The force is inversely proportional to the square of the distance of separation of the charges and directly proportional to the product of the amounts of the two charges involved.

- The effect appears to extend throughout space, becoming reduced but still present no matter how great the distance of separation.

The details of this behavior have been thoroughly worked out in terms of mathematics which describe the location, amount, and direction of the effect. The physical constants needed to give correct quantitative results have been well determined.

But, there is no explanation of how or why these effects occur. In the early days of scientific investigation of the electrostatic effect and its "action-at-a-distance" there were attempts to explain it in Newtonian mechanical terms involving particles propagated by the charges. These attempts failed for a number of reasons that made the concept unworkable, and reliance on the field concept followed.

## *ELECTRIC FIELD*

Considering the "action-at-a-distance" problem, if the separately located charges are to affect one another they must be "present" in some sense to each other. Since the effect operates over any distance no matter how large, only decreasing in magnitude with increase in separation distance, then the "presence" of each charge to the other must extend outward from each in all directions for as far as the universe extends. On the other hand, this "presence" cannot be the charge itself nor a particle of matter with which it is associated, because the attraction / repulsion is a local effect demonstrably present only on the charge at its location.

That this "presence", the electric field effect, occurs by virtue of a tension or compression type of action over the intervening space can readily be rejected. Such a model demands too much of the intervening space, is incompatible with multiple body interactions and is incompatible with the free movement of particles, those involved in the field interaction and any others, through the same intervening space.

Two characteristics of electric field indicate the nature of the solution to the question of what this mechanism is.

- When the location of an electric charge is changed the "field" pattern relative to its old location must disappear and a new "field" must appear relative to the new location.
- The strength of the effect is inversely proportional to (decreases as) the square of the distance from the charge, which is also in proportion to the surface of the sphere centered at the charge and of radius the distance from the charge.

These are the same characteristics as of something continuously propagated from the charge. Something propagated outward from the charge uniformly in all directions into the surrounding volume would:

- travel outward throughout the universe (at least until interrupted by running into something),
- decrease in magnitude as the square of the distance from the source of propagation (the charge) because as it propagates farther outward it is spread over a spherical surface increasing in area as the square of the distance from the charge,
- generate the new field of a charge at its new location because of new propagation continuously leaving the charge, and
- account for the disappearance of the old field that was relative to the old location of the charge because of the old propagation moving continuously farther outward into space.

<u>Electric charge</u>, then, since it must involve the propagation of something and not propagation of particles, <u>must be a spherical oscillation</u> which propagates spherical wave outward from the charge. As will be presented as this overall discussion develops, the oscillation is an oscillation of the <u>medium density</u> encountered in the previous section *10 - The Probable Beginning*, and it is of the `[1 - Cosine]` form derived there. The source of the propagated oscillation will be referred to as a <u>center-of-oscillation</u>.

In the case of positive charge the oscillation is (arbitrarily) a *+U* oscillation and the wave is a wave in *+U* (*U* for Universe and $^{+}/-$ all as presented in the preceding section.) Negative charge is correspondingly *-U*. The result of a *+U* wave front, propagating outward from a *+U* charge / center-of-oscillation encountering another *+U* charge / center-of-oscillation is the tendency to impart motion to the encountered charge, motion in the direction of the wave front, away from the source charge. Of course, the wave front propagated from the second charge likewise encounters and affects the first charge. In the intervening space the waves essentially simply pass through each other. These Universal Waves, U-waves, propagate at *c*, the speed of light, in the absence of other U-waves but are slightly slowed if they encounter other U-waves. This effect is explained in detail in a later section.

This is repulsion of like positive charges. Each successive wave encountering a like sign center-of-oscillation has the effect of imparting an impulse, a momentum change, to it in the repulsive direction. The effect is of a force acting on the encountered charge / center-of-oscillation, a force proportional to the rate of the impulses and to their magnitude. Since the time rate of the impulses is constant, being the source center-of-oscillation frequency, which is constant (at least for charges at rest which is the subject of electrostatic field), then the force is proportional solely to the wave front magnitude. The wave front magnitude is proportional to the source center-of-oscillation's oscillation amplitude (which is here defined as the amount of charge) as reduced according to the square of the distance to the encountered charge per the inverse square law of spherical surface.

The same effect occurs when a negative charge interacts with another negative charge, a *-U* oscillation propagating outward and encountering a *-U* enter-of-oscillation.

The discussion here is of a single elementary charge, that of a proton or an electron. Any other charge is an integral multiple of this elementary charge and is and acts like a group or bunch of elementary charges. The waves propagated from such a group of charges are the effective sum of the individual waves, already described, propagated by each individual charge. This results in the actual repulsive force being directly proportional to the total charge.

The center-of-oscillation is a participation in, a minute element of, the primal oscillation from the start of the universe. (How the primal oscillation came to be "diversified" into the myriad individual charges in the universe will be taken up in a later section.) As with the primal oscillation, the oscillation is not a vibration on both sides of a zero level, but rather an oscillation from zero to maximum to zero in a smooth continuing sinusoid, identical for *+U* and *-U* except that one is the "anti-", the "negative", of the other as already presented.

The spherical wave propagated outward in all directions by the center-of-oscillation is the propagation of density variations of "medium" in a *[1-Cosine]* form dispersing into ever decreasing average density as the radial distance from its source increases. It produces, is, the "electric field". The general situation is crudely analogous to a ball oscillating in radius and generating a pressure or sound wave traveling outward radially through the surrounding air; however, in the case of the U-waves we have the medium, which is not particulate as air is but rather is continuous, uniform, simple and of minimum "tangibility" as presented in the prior section. The "density" variation is not of density in the macroscopic world sense, but rather is of the "amount" or "degree" or "maturity" of the medium. (Again, it is difficult to give terms to that which is so far from the world our language was invented to describe. All such terms should be treated only as vague attempted indications.)

Since an incoming wave impulses the encountered center, then the propagating of the wave outward from its source center should involve equal-but-opposite reaction impulsing of the source center. This in itself produces no net effect on the source center, however, because the center is impulsed equally and simultaneously in all directions by the departing spherical wave. The center can be loosely visualized as if it were under compression from all directions, due to its own propagation, to no net effect.

But, when a $-U$ wave encounters a $+U$ center the effect of the incoming negative wave is to cancel "part" of the positive outgoing wave's positive reaction effect back on its source center. The "part" cancelled is the same magnitude as the incoming negative wave with which it cancels. The $+U$ enter in this case no longer receives equal "compressive" reaction on itself from all directions. The reaction from the direction of the source of the $-U$ waves is reduced by the magnitude of the $-U$ waves arriving. The reaction on the opposite side of the $+U$ center is still the full value. The net effect is an impulse on the $+U$ center toward the $-U$ center, an attracting impulse.

This is attraction of opposite charges, the effect of a $-U$ wave on a $+U$ center and vice versa. Just as with like charges repelling, the force is proportional to the time rate of the net impulses and their magnitudes and yields the electrostatic law behavior just as already presented for interactions between like polarity centers-of-oscillation.

The entire area of the details of how departing and arriving waves interact with centers-of-oscillation requires elaboration; however, the means by which these effects, stated here in Newtonian terms, actually result from the action of the U-waves on U-centers must await the discussion of Mass, Matter, Motion, Relativity and Newton's Laws in the next several sections. The description as presented so far is sufficient for the discussion at present, giving the broad concept of charge, its electric field and how the electrostatic behavior occurs. Only two further points of elaboration are appropriate at this stage in the development.

> When a number of waves occur in the same location the "appearance" is as of the sum of all the waves (in a linear medium, which must be the case since the medium is uniform and simple). This "appearance" is valid and the resulting behavior is that of the "appearance", but it is also valid that all of the individual waves are present. The resulting behavior is also that of the sum of the behaviors for the individual waves adding up to the overall "appearance". This is the essence of the *Fourier Transform*, that any finite (and smooth and continuous) periodic (regularly repetitive) function can be expressed as the sum of a set of *sinusoids* of appropriate phases, amplitudes, and frequencies. It is valid both in "hard" reality and mathematically.

> The phase (relative timing) of the U-waves arriving and interacting with a U-center relative to the phase of the U-center is not relevant to the direction (whether attractive or repulsive) of the forces as described because the U-waves and the U-center's oscillations are all zero-to-maximum-to-zero, not oscillations equally above and below a zero value. A specific propagated wave and the oscillation of any specific center are either all $+U$ or all $-U$. The only directional effect is when the wave and center are of opposite sign as already presented. The relative phase of arriving U-wave and encountered U-center could be relevant to the magnitude of the interaction. This will be addressed in the next section where these concepts are all quantified.

It is interesting to note that the "mutual" attraction or repulsion between charges is not necessarily really "mutual". The effect of each on the other is due to the arriving wave, which arrival occurs some time after the wave departed its source center-of-oscillation. If during that time the location of the source center changed, the force effect produced by the wave on the encountered center is directed toward / away-from where the source center was when the arriving wave left it, not where it is at the time the encounter occurs. In many cases this effect is quite small since the U-waves propagate at the "speed of light" so that the time difference is quite small. (Actually, as will be seen, the "speed of light" is defined or set by the propagation speed of the U-waves in the medium and that speed is another characteristic of the medium, all of which is why the speed of light is the fastest possible speed.) There can be cases, however, where the difference between the field force acting with regard to where the field source was rather that where it is can be important.

Before leaving the subject of electrostatic field it should be pointed out that the model described is not merely plausible, it is essential; it is not merely proposed, it is demonstrated in every day physics. Traditional physics, whether modern or classical, does not treat the question of propagation time from one static charge to another. The electrostatic attraction or repulsion is accounted for in magnitude and direction with an unstated but implicit assumption of instantaneous interaction. This, of course, cannot be the case. If instantaneity were the case in this interaction it would be possible to transmit motion and information instantaneously. The speed of light would not be a practical limit for communication speed over a distance. Clearly the time delay is essential for consistency with the rest of physics, and clearly a propagation model is needed to account for a time delay. Of course, in practical experiments over modest distances the very large speed of light results in the appearance of instantaneity because the time delay is so small in those cases.

## *MAGNETIC FIELD*

As the electrostatic field is the direct result, an inherent part of the natural behavior, of electric charge at rest, magnetic field is the direct result of electric charge in motion. The electrostatic field, which has been analyzed so far under the assumption of the charge being at rest, must, of course, exist when the charge is in motion as well, and exist with the same characteristics and effects as when at rest since the charge / center-of-oscillation is still propagating U-waves as it did at rest. The magnetic field is in addition to the electric field; that is, a charge in motion has its "static" electric field and a magnetic field in addition.

The magnetic field effect must be due to the changes in the static field caused by the motion of the charge.

The static magnetic field is the result of a charge in motion at constant velocity. More precisely, the magnitude of the static magnetic field is constant so long as the speed of the charge is constant. The direction of the magnetic field is constant so long as the direction of the charge's motion is constant. A change in the direction of the motion of the charge with its speed held constant produces only a change in the direction of the magnetic field, not its amplitude.

Charge in motion constitutes an electric current. The current is the time rate of flow of charge and thus a constant current is a flow of charge at a constant rate. Current magnitude would be changed in direct proportion to a change in the number of elementary charges flowing at the same velocity, or a change in the velocity of a constant number of elementary charges, or both. It is with regard to current that magnetic field is classically discussed. The characteristics of magnetic field are as follows.

> The magnetic field magnitude is directly proportional to the current and inversely proportional to the distance from the current to the location where the field magnitude is being determined. (Note that it is inversely proportional to the distance, not the square of the distance as for electrostatic field.)
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> Magnetic field only has an effect on another charge if the other charge is in motion relative to the magnetic field. A charge "at rest" relative to the field does not respond to it.
>
> Assuming that the source charges' motion is at constant velocity (constant speed and in a straight line) so that the current is of constant magnitude and in a straight line, then the magnetic field is circular in a plane perpendicular to the current and concentric to the path of the current. If the plane of the field is taken to be a sheet of paper and the current is flowing perpendicular to the paper and out of the paper toward the observer then the direction of the magnetic field is (by convention) counter-clockwise. (This is called the "right hand rule". If the thumb of the right hand points in the direction of the current, then the curled fingers of that hand indicate the direction of the magnetic field.)
>
> The action of this magnetic field on a charge in motion at right angles to the field is a force tending to accelerate the moving charge. The magnitude of the force is the product of the current equivalent to the moving charge and the magnetic field magnitude. The direction of the force is at right angles to both the motion of the charge and to the field. (A second "right hand rule" can be used here. If the thumb and first two fingers of the right hand are placed all at right angles to each other with the thumb in the direction of the current due to the moving charge on which the force acts and the forefinger in the direction of the magnetic field, then the middle finger points in the direction of the resulting force on the moving charge.)

> Just as the electrostatic effect involves each charge having an effect on the other, so also the magnetic effect. A charge in motion in a magnetic field not only experiences a force acting on it due to its motion and the field, it also constitutes a current itself, which current causes a magnetic field and exerts a force on the originally discussed magnetic field generating charge.

While this behavior of magnetic field appears complicated at first, it becomes simple and direct once familiarity with it develops. These rules describe all magnetic effects. They apply in practice even when the current producing the field is not in a straight line, one of the most common configurations being current flowing through a coil of wire so that the individual fields due to each loop of the wire all add together creating a stronger field.

In an electric generator, conducting wires (ones that readily carry electric current without untoward hindrance) containing "free" electrons (negative charges so loosely bound to their atoms that they can be readily moved about in the material) are so moved that the motion of the wires and their free electrons in the magnetic field created by current flow in another coil of wire produces a force moving the free electrons along their conducting wire. In an electric motor electric current passed through a coil of wire at right angles to a magnetic field formed by another coil of wire results in a force moving the coil (and whatever is connected to it). A permanent magnet results from a significant proportion of the atoms in the magnet material being similarly aligned so that the individual magnetic fields of the atoms (due to the current of their orbital electrons moving in their orbits) are also aligned and add up to a net field rather than the atoms being randomly arranged with their individual magnetic fields cancelling out overall. (This only works with materials having atoms where the magnetic fields due to the individual electrons in the atom do not cancel out overall for the individual atom.)

This review of magnetic field has been only general and cursory. The subject is treated rigorously in section *14 - Magnetic Field*. The important point for the moment is that all of these magnetic effects can only be the natural result of motion of the $+U$ and $-U$ charges / centers-of-oscillation and the consequent effect of the motion on their propagated $+U$ and $-U$ waves. What the change in the waves due to this motion is must yet be addressed, but before that subject can be treated the question of motion itself must be resolved.

The problem to be resolved is, "What is motion, motion relative to what ?" This question was neglected in the case of electrostatic field but is applicable there, also. After all, the Earth and any charge on its surface rotate about the Earth's axis, revolve around the sun, participate in the sun's motion in the galaxy and in the galaxy's motion through space. Thus "static" or "in motion" are terms requiring clarification.

This is the fundamental problem underlying Relativity, and it appears here for the same reason that it appeared historically upon the development of physics' treatment of electromagnetic waves: is there a medium in which the waves exist, and if so is it a "stationary" all-pervasive "aether", a prime reference system to which everything else is relative ? If not, what is the meaning of "static" or "in motion" and what of the motion of things relative to each other ?

The problem and its significance can be understood better by means of an example. We take a straight wire in which positive charge flows at constant velocity (constant speed and direction along the wire relative to the wire). Classically, in terms of magnetic field characteristics as just presented, there is a magnetic field circumferential to the wire. This field will exert a force on a charge moving in the field, that is, moving relative to the wire. Now, we, the observers, take on a velocity identical to the charge moving in the wire, the charge causing the magnetic field. In this case, to us, the charge in the wire is static. It is not moving and there should be no field. (It is true that to us in this case the wire appears to be traveling "rearward", but moving wires are not, in themselves, a cause of magnetic field.) Is there, now, as we view it, a magnetic field ? From the "static", as we view it, charge ? We know that in fact there is.

How do we reconcile this: a charge "at rest" relative to the Earth exhibits to us only static effects even though moving through space at a speed of at least 66,600 miles per hour (the Earth's speed around the sun) and a charge at rest relative to us (the above example of the wire) exhibits magnetic effects ?

Clearly, the entire question of relative motion requires improved treatment. The question has been dealt with comprehensively by Einstein in his treatment of relativity; however, again, the treatment is mathematical and does not address the mechanism. A thorough understanding requires comprehending mechanism and, since motion is of mass as well as charge, the question of mass must now be addressed. After the details of mass and then of relativity have been settled, the discussion can return to the issue of field, settle the several questions just raised and rigorously treat magnetic field.

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Footnote 11-1

The "kernel" idea for this concept of charge and field came from Mr. Donald Santeler, then (1963-1967) of Schenectady, New York, U.S.A. Santeler conceived of a physical model involving oscillation centers as a representation of charge and electrostatic forces. He contended that his concept extended to accounting for matter, other fields, the variety of sub-atomic particles and so forth; but the development of this was not presented and was, I believe, only broad, generally conceptual, and undeveloped in detail, probably because of some fundamental errors and problems in it.

The Santeler model involved standing waves, not propagating ones, in a medium consisting of myriad minute, perfectly elastic, otherwise unexplained particles, with two oscillation phases 180° apart to account for charge polarity.

The concepts in this Universal Physics that derive from Santeler are:

- The need to account for field action-at-a-distance by a mechanism,
- Oscillatory centers, and
- Positive and negative charge represented by some kind of oscillations "opposite" in some sense.

This Universal Physics, as developed in the present work, however, involves:

- A propagation model, which is essential to agree with the limitation of the velocity of light,
- Charge polarity accounted for by two media that are non-particulate, equal and opposite, conserve to zero, and the arising of which are explained, and
- The extensive development beyond that start.