The Universe in Motion

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"Does energy reside in space?" I asked the most distinguished scientist at the conference. "Most certainly! And I demonstrate it thusly." Then she opened her hand, dropping the pen she was holding. I watched it accelerate to the floor.[1]

Go outside on a sunny day for another demonstration. Energy from the sun travels about 93 million miles through a vacuum to be seen as light and felt as heat energy on your skin. Evidently, energy not only resides in space, but it also propagates itself in a vacuum. Robert Kerr and many others seek a causal explanation for transfers of energy:

> [A]lthough energy transfer through space can be expressed quantitatively, there—so far—is no generally accepted concept which can account for the mechanics involved.[2]

The demonstration with a pen allows opposing concepts: an exchange of energy is fundamentally mechanical, *or* an exchange of energy is fundamentally electrical. The *mechanical portrayal* has been spread by such great scientists as Aristotle, Epicurus, Newton, and Feynman.

Propagation of energy through the vacuum of space does *not* allow a mechanical explanation since material objects are not present. The *electrical explanation* has been spread by Faraday, Maxwell, Barnes,[3] Lucas,[4] and Bergman.[5]

In order to understand *physical reality*—stationary or moving—one must scrutinize the energy. When an exchange of energy occurs, there is motion and activity.

Motion and activity make heaven and earth marvelous beyond imagination. The visible universe is observed as a snapshot frozen in a moment of time, although it actually consists of things *in motion*. Artists, writers, and photographers give wonderful descriptions of the *structure* and natural *processes* of the universe. These pictures, images, and models of nature are representations of the physical world at a cosmic level*; i.e.,* ordered systems such as galaxies, plants, animals, rivers, *etc.* All such systems, however, are the composite result of individual atoms, their structure and properties, forces between the atoms, movements, and the exchange of energy between atoms. (As used here, "atoms" means the basic units of matter, such as elementary particles and individual molecules.)

Fundamental Process. An exchange of energy between atoms controls both the observable *actions* that take place in nature and the *rate of change,* whether this process is a continuous action or a series of changes taking place in a definite manner. Two fundamental mechanisms have been proposed to explain the exchange of energy that controls fundamental process: *mechanical activity* and *electrical activity*.

I. MECHANICAL ACTIVITY. Three concepts of mechanical process have been proposed to account for transmittal of forces:

- Mechanical contact action, proposed by Aristotle
- Newtonian mechanics, proposed by Isaac Newton
- Quantum mechanics, proposed by Epicurus, Bohr, and Feynman

Mechanical Contact Action. More than two millennia ago, Aristotle (384-322 BC) presented his view that forces are transmitted by mechanical contact.[6] He stated that "every object is pushed, pulled, carried, or twirled by whatever is in *contact* with it." And he argued that "matter cannot act where it is not." He asserted the following axioms to support his belief in force by direct mechanical contact: (1) There are no voids in the universe. (2) Every motion has a moving cause. (3) The mover must be in contact with the thing moved. (4) For every motion there is an unmoved first mover. Aristotle's theory was consistent with the *law of cause and effect,* and even accounted for the flight of birds through the atmosphere. But Contact Action cannot account for the force of magnetism or gravity acting over a distance in the void of space.

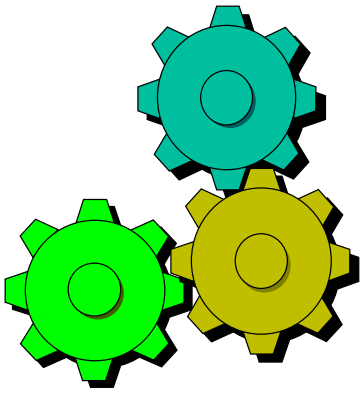

Figure 1
Contact Action

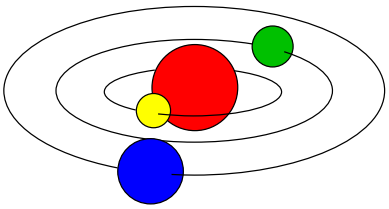

Figure 2
Forces and motions of the Solar System act across empty space

Newtonian Mechanics. Copernicus and Galileo described the heavens as moving in ways that Contact Action could not explain. Isaac Newton (1642-1727) predicted the motions of planets in orbit about the sun by assuming that gravity exerted a force between objects of *constant mass.* He wrote equations of motion and forces based on a general concept of the *conservation of energy.* A material object of constant mass was assigned kinetic energy in accordance with its *velocity* and assigned potential energy in accordance with its *position* in a gravitational field. Newtonian mechanics did not require direct *contact* to transmit a force and offered little to explain the cause of action-at-a-distance.

With these concepts, Newton predicted the motions of objects in many important cases: the orbits of planets in the solar system, the acceleration of a rock dropped from a tower, and the paths of colliding billiard balls. In the last example, *mechanical contact action* may be asserted to explain motions of the collision. But in the other examples, Newton's formulas could only predict (but not explain) "actions-at-a-distance" that take place across the vacuum of space.

Quantum Mechanics. Elements of Newton's system of mechanics that proved so successful in describing the solar system were incorporated by Niels Bohr into a model of atoms. In both cases, particles orbiting about a massive central object are held in place by forces reaching across space *without mechanical contact.*

In the years following Bohr's proposal for atomic structure, his followers developed a mechanism for the forces that operate within the atom: *the concept of a force mediated by the exchange of particles.* Quantum Mechanics adopted the hypotheses (1) that point-like material particles called *fermions* spontaneously create and eject new "particles," and (2) that forces between objects are carried by these new "particles called *bosons*, which are generated *spontaneously* and exchanged *randomly* between the fermions.

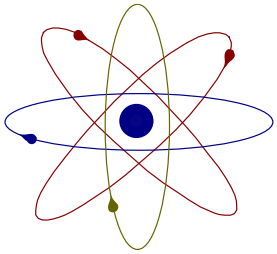

Figure 3

Solar Model of the Atom Proposed by Niels Bohr

In quantum mechanics, emission of a boson not only carries force between particles but also enables a "quantum leap" of an orbiting electron to move from one orbit to another orbit of greater energy. Furthermore, a spontaneous return of the electron to its original orbital path, or a third path, produces radiation called "atomic spectra."

The power to make a "quantum leap" to another orbital path was a refinement of an old idea known as the *swerve of the atom.*[7] More than two millennia ago, Lucretius described the original theory of motion of atoms:

> Here too is a point I'm eager to have you learn.
> Though atoms fall straight downward through the void
> by their own weight, yet at uncertain times
> and at uncertain points, they swerve a bit—
> enough that one may say they changed direction.[8]

Modern Quantum Mechanics was adapted from the ideas of the ancient Greek philosopher-scientists. In the modern version of Contact Action, forces between particles are carried across space by non-material particles: *photons, mesons* and *gluons*. A single particle is supposed to carry the minimum possible energy and account for the least possible "quantum of action":

> At the turn of the century it will be [a] hundred years ago that Planck introduced the finite quantum of action, now universally denoted by the letter *h.*[9]

While quantum effects have usually been limited to the domains of nuclei and elementary particles, recent frustration with gauge theories have led some to make statements about quantum effects in *macro-sized objects*. Robert Walgate describes how bosons are imagined to travel between objects to attract or repel each other:

> Force Carriers. What causes a force between one particle and another at a distance? Modern physics answers: the exchange of yet other particles. Imagine two skaters throwing a ball at one another. The act of giving momentum to the ball in throwing it—and of receiving momentum in catching it—pushes the skaters apart. This accounts for repulsive forces. But in quantum mechanics, which affects small-scale phenomena, there is a strange extension and delocalization of events that allows a seemingly impossible event: one skater throws the ball away from the other, in the opposite direction, but the other skater is still able to catch the ball. A little thought shows that if such events were possible—as they are in the world of elementary particles—they would cause an attractive force between the skaters.[10]
>
> 
>
> **Figure 4**
>
> In Quantum Mechanics, exchange of particles is responsible for forces.
>
> All the "force particles"…that are exchanged between the matter particles…are bosons. This also is significant: it means that photons, for example, can build up in the same state to construct the magnetic field around a magnet, or the electric field around an electric charge.[10]

The assertion of Quantum Mechanics that a particle travels the wrong direction to make contact with a second particle is incredulous.

Apologists for Quantum Mechanics were quick to apply the small-scale quantum aspects of quantum force theories to macro-size objects. Walgate claimed that "quantum mechanics, which affects small scale phenomena" also explains the large-scale phenomena of attraction and repulsion between two *magnets*.

Materialists also claim that random events govern the interactions between light and matter. Bosons (force-carrying particles of light) seemed particularly well suited to explain forces over short distances but remain unable to account for events outside the atom. (How can photons of *light* carry forces through opaque objects, as magnetic fields do?)

To make this scheme of energy exchanges work for all the material particles, bosons of various energy are required. In Quantum Mechanics,

- low-energy photons are supposed to carry the force between electrons,
- medium-energy mesons are supposed to carry the force between the more massive protons and neutrons, and
- high-energy gluons are supposed to carry the force that holds quarks together in protons and neutrons.

But, if these assertions are true, which of these bosons has the correct energy to mediate the force between the low-mass electron and medium-mass proton? How does a matter

particle know which of the bosons it should be attracted to? And why do we need a complex theory with multiple particles needed to replace a simple equation known as Faraday's Law?

Unified Theory of Forces. Knowing that multiple force mechanisms abuse Ockham's razor and the scientific Principle of Unity, twentieth-century physicists have attempted to construct a *unified* theory of forces. Figure 5 shows the relationship of fundamental natural phenomena (blocks with white background) and various theories of force transmission (gray background). The chart suggests that more work is required on existing force theories and new ideas are needed.

Modern physics hopes to replace Electromagnetic Field Theory with forces carried by bosons. The boxes with broken lines in Figure 2 show where this effort goes forward.

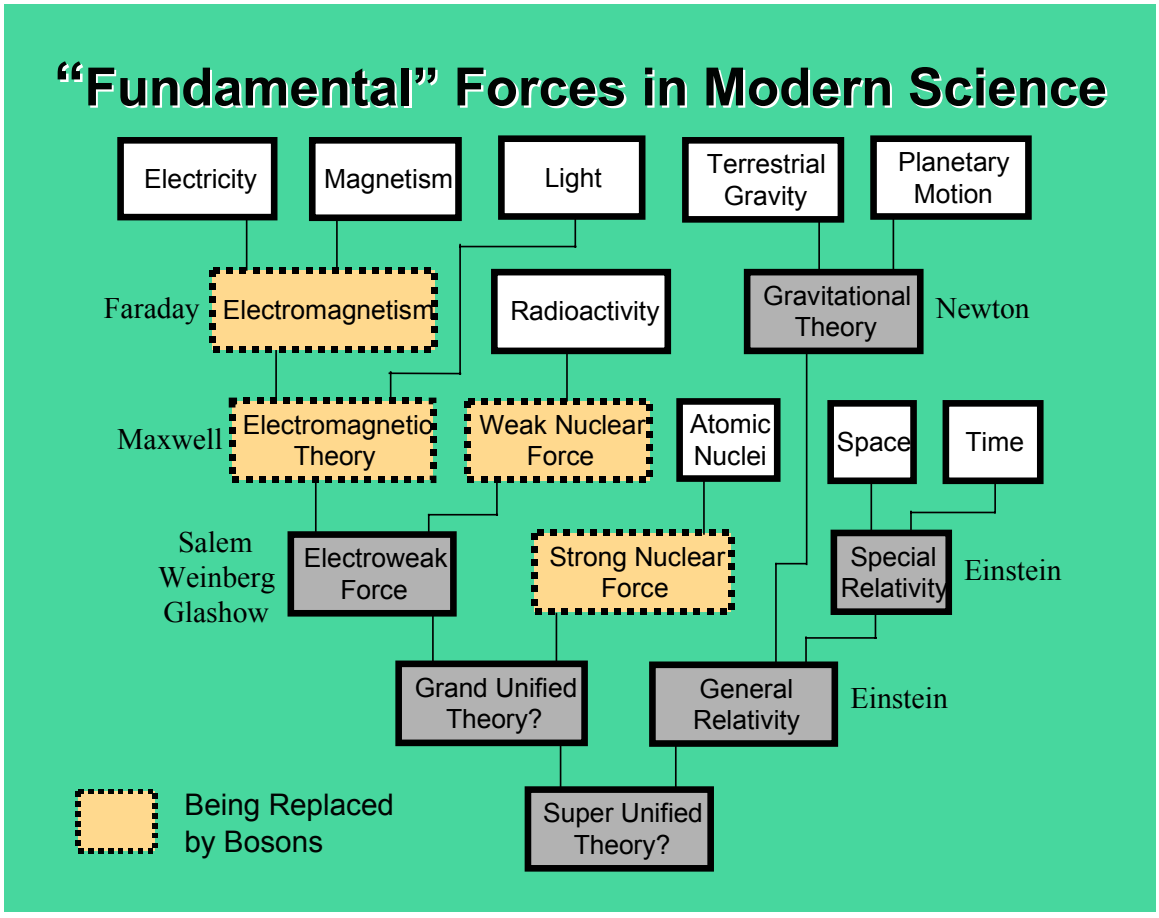

Figure 5

Unification of the Forces of Nature.

The chart shows a popular concept hoped to unify forces that predict fundamental natural phenomena. Evidently, unification of forces is more a goal than an achievement.

II. ELECTRICAL PROCESS.

Empirical Electrical Force Laws. Gilbert (1544-1603), Coulomb (1736-1806), and Ampère (1775-1836) discovered that something caused forces between magnetic poles, between charged particles, and between current elements. Without providing an explanation, the new force laws for these electrical effects specified the precise magnitude of forces acting over a distance between two objects.

Energy Fields. Michael Faraday (1792-1867) and James Clerk Maxwell (1831-1879) investigated and explained the dynamic forces of electricity and magnetism. They introduced new concepts of *energy fields* to explain how "action-at-a-distance" allows one body to attract another distant body. *These electric and magnetic fields contain energy that permeate all space.*

Energy Exchange by Induction. Electromagnetic Field Theory was established upon two force laws of statics described by Coulomb and Ampère, and two force laws of dynamics described by Faraday and Maxwell. As implemented by Potential Theory, all of these laws reflect *conservation of energy.*

Physical reality of material objects (often visible) and radiant energy (sometimes visible) always depends upon the existence, intensity, shape, and location of electromagnetic energy. *Electrodynamics* in Field Theory is based on *electric and magnetic induction* where *time* enters to specify rates of natural processes.

Shape of Electric Fields. An energetic magnetic field proceeds from the poles of a bar magnet. This field has the shape first observed by Michael Faraday when he saw a pattern of iron filings in the presence of a magnet. Neither the iron filings nor the magnetic field of a permanent magnet are changing over time. While the field intensity decreases with distance from a magnetic pole, this magnetic field shape remains constant over time at every location (relative to the magnet that generates the field). Clearly, this field is not waving or oscillating, as long as the magnet itself is not waving or moving up and down.

The electric field between two charged plates (a capacitor) is also a static, non-waving field. However, its shape (intensity at various locations) will be different from a magnetic field for every generating source. Despite claims of unification, the electric and magnetic fields have important differences.

Types of Dynamic Electromagnetic Fields. Dynamic electromagnetic fields can be any of the following:

- Monotonic change in electric field intensity
- Monotonic change in magnetic field intensity
- Oscillating intensity of electric field
- Oscillating intensity of magnetic field

- Intensity of both electric and magnetic fields oscillating coherently (the field oscillations are synchronized with a consistent phase relationship)

Electromagnetic Nature of Light. Common Sense Science claims that light is self-propagating energy composed of oscillating electric and magnetic fields. Unlike material objects, light carries no charge and has no mass. Numerous experiments demonstrate the wave nature of light.

This wave theory of light accounts for experimental data, rejects the inconsistency of a dual nature, and most importantly, provides a mechanism for the interaction of light and matter by *electrical* and *magnetic induction.* In Electromagnetic Field Theory, the exchange of energy between matter and the electromagnetic fields of light is based upon a relative velocity of *c* between a spinning charged ring and radiant flux. The *law of cause and effect*—implicitly embedded in the *laws of electromagnetic induction*—permits scientific explanation rather than assumption for the exchange of energy in the interaction.

Electromagnetic Process. Backed by considerable theory and extensive experimental measurements, electromagnetic induction based on *conservation of energy* appears not only to be an established fact but also the means of implementing the *law of cause and effect* in all physical interactions. Electromagnetic induction proceeds from the basic view that field energy is real and plays a role in all natural processes.

The Shape of Matter. Natural process requires physical models of matter than can absorb and release energy by a process of changing size, shape, density or other physical means. Without a physical mechanism, the point-like objects assumed in some modern theories are well-suited for mathematical theories and predictions but are incapable of providing *explanations* of physical phenomena.[11] Nine decades of research on Quantum Mechanics by skilled mathematicians has not simplified physics—but instead has shown the difficulty of developing a scientific theory of interactions between light and matter without a physical model of either.

By adopting a physical model of matter, with particles of finite size, physicists can make predictions of what happens when matter and fields interact. For example, radio and antenna engineers have long understood that large antennas can absorb and emit more energy than small antennas; and no electrical engineer would attempt to exchange energy between a radio wave and a point-like antenna. Electric and magnetic induction can only occur in an *extended object* able to capture electromagnetic flux.

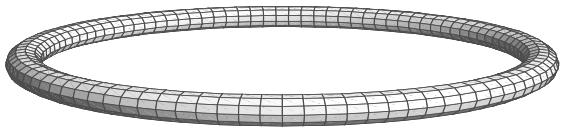

Figure 6

Spinning Charged Ring Model of Electron
A Ring of Charge

Electrostatic charge spread in a thin layer at the surface of the ring rotates with velocity *c*, giving the electron a magnetic moment with flux ϕ and surrounding electric and magnetic fields.

A particle's influence extends to regions beyond the boundaries of its charge location by virtue of the electric and magnetic fields that the charge generates around itself. By means of the surrounding fields, a charged

particle exerts force and pressure on another charged particle that is physically separated—a mechanism known as "action-at-a-distance."

Interaction of Fields and Matter by Induction. The spinning charged ring model of elementary particles,[12] Figure 6, is a physical model of finite extent that can exchange energy with space and other particles by the absorption and emission of field energy. Faraday's *law of magnetic induction* provides a precise prediction for the interaction of a magnetic field and a spinning charged ring:

$$\mathsf{E} = \frac{d\phi}{dt} \qquad (1)$$

where $\mathcal{E}$ is the electromotive force (*voltage*) induced on charge in the ring, ϕ is the magnetic flux that the ring encloses, and t is time. *Process rates depend upon* time*, a fundamental quantity of physics, that is the independent factor in the induction laws of electrodynamics. Time* is defined in a previous issue of FOUNDATIONS OF SCIENCE.[13]

Examples of Fundamental Process. A few examples are presented to explain the fundamental interactions of matter and electric fields:

Magnetic Induction by a Moving Magnet. Michael Faraday discovered magnetic induction in a series of experiments during the fall of 1831,[14] fulfilling a goal to "convert magnetism into electricity" written in his notebook in 1822. Figure 7 shows his simple and direct method of demonstrating magnetic induction. "On 17th October, he produced a current by sliding a cylindrical bar magnet into a long coil or solenoid connected to the galvanometer."[14] The current produced was caused by the *relative motion* between the magnet and the coil, while the magnetic flux produced by the magnet remained constant in *time*.

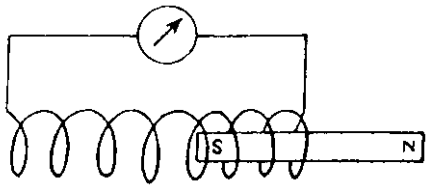

Figure 7
Magnetic Induction

Magnetic Induction by a Current Loop. Actually, he had demonstrated magnetic induction earlier, on the 29th of August, by the use of two wire coils wound on a soft iron core ring (see Figure 8). "He connected the ends of one coil to a galvanometer" and observed that "a current was produced in the second coil only when the current [supplied by a battery] was switched on or off. There was no effect on the second coil when the current in the first was flowing steadily. Here was the key to it all—a changing current in one coil produced a current in the other."[14] Both *electric induction* and *magnetic induction* occurred in this experiment:

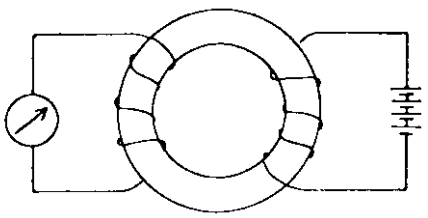

Figure 8
Electric Induction

- Electric induction. A changing current in the primary coil (right side) induced magnetic flux in the iron core—a simple electromagnet.

- Magnetic induction. The changing magnetic flux in the iron core induced a current in the secondary coil—a simple generator.

Emission of Starlight. Most starlight originates in hydrogen—the most abundant material in stars. Specifically, the light comes from the electrons of the hydrogen molecule. Figure 9 shows an electron excited to a high energy level (excited state seven) with seven loops of charge around the circumference of the ring. The electron achieved this temporary energy of quantum state $k = 7$ by the addition of external energy such as an electric arc, pressure, radiation, *etc.* A small perturbation of the electron, however, will release some quanta of energy as the electron emits radiation (oscillating fields of electricity and magnetism) and settles into a lower energy state; *i.e.,* $k = 1$-6.[15]

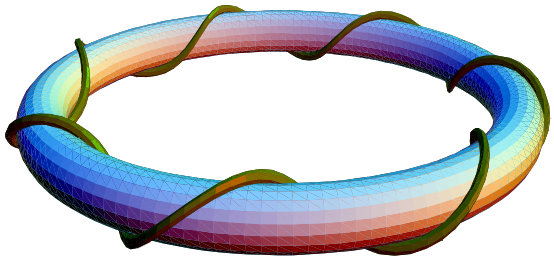

Figure 9

One of the electrons in a hydrogen molecule with seven loops of charge, excited to energy level $k = 7$. (The toroidal form is *not* part of the electron.)

Both electric and magnetic induction control the exchange of energy from the material electron to radiant energy. As electric and magnetic flux leave the ring in the form of light, corresponding changes occur in the shape and motions of the ring leading to its new shape with fewer loops of charge. Figure 10 shows the electron in the lowest energy state ($k = 1$) following emission of light.

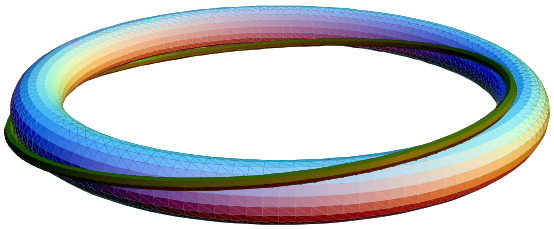

Figure 10

Electron in lowest energy state ($k = 1$)

According to the laws of induction and the known properties of radio antennas, the light emitted from an excited electron will be concentrated in the direction of its spin axis. Whatever angular dispersion is present leads to a reduction in intensity with distance as specified by the well-known inverse square law.

By analogy to the theory of broadcasting radio waves, the electron acts as an antenna with properties of "antenna gain"—an ability to concentrate radiant energy along the antenna axis. The amount of "antenna gain" and concentration of energy depend upon the antenna size (area enclosed by the ring electron) and the emitted wavelength (a multiple or sub-multiple k of the electron circumference).

Propagation of Light. The light leaving a star in the previous example proceeds away from its source with a great velocity. With a repeated exchange of electrical and magnetic field energies by the processes of induction, the radiant energy propagates away

from the *source electron* with velocity $c = 1/(\varepsilon\mu)^{½}$ where permittivity ε and permeability μ are the force constants for electrical and magnetic forces, respectively (not properties of space).

The self-interactions of electric and magnetic flux depend upon the phase relationships of the two energy components within a ray of light. But without phase synchronization of oscillating field energy intensities, a superposition of field energies occurs without a significant interaction. *Electromagnetic waves pass through each other* with no noticeable effect when matter is absent. As reported in SCIENCE, "Two laser beams traveling side by side in a vacuum do not interact irrespective of how closely they approach."[16] Propagation and expansion of radiant energy are not affected by other electromagnetic fields in the same volume of space.

Coherent Radiation. Under special circumstances, the radiation from electrons of many hydrogen molecules may be phase synchronized so that wave peaks all occur together. This would be expected, for example, if a strong magnetic field aligned the spin axes of the electrons (called *polarized electrons*). In this physical arrangement, oscillating electromagnetic fields of one electron would interact with the charge of other electrons to synchronize charge oscillations. In this situation, electron emissions can be coherent (as produced by lasing in lasers).

Absorption of light. On average throughout the universe, radiant energy travels a distance of about one light-year [17] before an encounter with matter (usually a hydrogen molecule) when the energy is absorbed by induction. Magnetic fluctuations of the incoming light ray induce currents into the larger particles of hydrogen (electrons) by transferring energy from the field to the ring, in accordance with *the law of electromagnetic induction.* This excites the electron to a higher energy state with more loops of charge (see Figure 9); and, at the same time, the ring conserves total energy in the exchange by absorbing (by feedback cancellation—"back emf" for electrical engineers) the incoming electromagnetic energy. The process of absorption is the reverse process of emission described above.

Reflection of Light. In order to present an antenna cross-sectional area that absorbs incoming electromagnetic energy, an electron spin axis must be pointed toward (or away from) the incoming light. The effectiveness of the antenna depends upon the area it presents to intercept propagating energy. Depending upon light wavelengths and angular alignment, the electron "antenna" can absorb quanta of radiant energy to excite the electron one, or more, energy levels. But if the angle of incidence exceeds a critical angle, absorption of a quantum of energy cannot occur, and the light will be totally reflected in the same way that microwave energy traveling in a cavity reflects off a conducting wall.

Transmission of Light. Assuming an electron was approximately aligned to absorb incoming light and the process of absorption has already occurred, an excited electron holding more energy will release the stored energy along its spin axis, allowing light to continue propagation after some delay governed by the rate of process imbedded in

induction laws. Thus, transmitted light may be scattered somewhat even while favoring the light's original direction.

Furthermore, the *elapsed time* taken to first absorb and then emit light explains why light passing through material propagates more slowly than light in a vacuum. Thus, the *index of refraction* used to specify velocity of light in a material actually is an indication of the time interval for the material to process the income energy by first absorbing and then emitting the light.

Light that is absorbed and then remitted by an electron will lose its original phase, frequency, and velocity characteristics. Measured Dopplar effects and redshifts depend upon the last (rather than the first) source of the emitted radiation.

Bending of light. Some aspects of the processes just described have been used previously to explain bending of light that occurs in the heated air of a desert. A mirage occurs when a plane wave of light is "bent" by different light-speed through materials with different density. Sears explains that

> Another phenomenon produced by atmospheric refraction is the mirage, illustrated in Fig. [11]. The conditions necessary for its production require that the air nearer the surface of the ground shall be less dense than that above, a situation which is sometimes found over an area intensely heated by the sun's rays. Light from the upper portion of an object may reach the eye of an observer by the two paths shown in the figure, with the result that the object is seen in its actual position, together with its inverted image below it, as though a reflecting surface lay between the object and observer.[18]

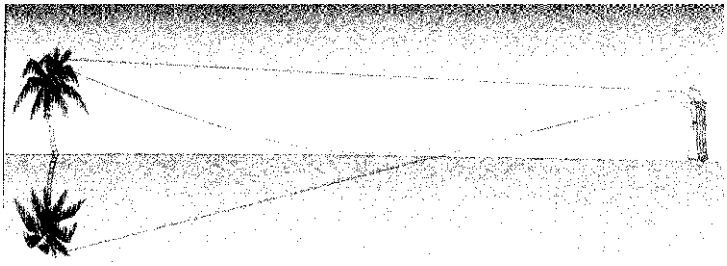

Figure 11. The Mirage

Bending of Starlight. The earth, unlike the moon, has sufficient gravity to hold an atmosphere. This atmosphere is most dense at the earth's surface. Flying at an altitude of 33,000 ft above sea level, a jet airplane must create a cabin atmosphere suitable for passengers because the outside air at this altitude is "thin."

Stars also have an atmosphere with decreasing density at elevations from the surface. The stellar atmosphere is composed mostly of hydrogen gas which bends starlight by the same process that bends light in the earth atmosphere.

General Relativity Theory was accepted largely on a prediction that starlight would bend when coming around a large gravitational mass:

> Einstein's general theory of relativity is essentially a description of the geometry of space and time. According to Einstein, a hunk of matter such as a star bends

> spacetime like a bowling ball perched upon a rubber sheet. The result, described in relativistic terms, is gravity.[19]

But bending of starlight can be explained by Electromagnetic Field Theory as shown above. And General Relativity Theory has problems with *time*[20] and cannot be integrated with other theories to create a Unified Theory (see Figure 5).

Photoelectric Effect. Under certain conditions, an electron will be dislodged by illuminating metal with light. The effect occurs when the frequency of light is in a certain range of frequencies—no electrons are dislodged if the frequency is too low, and no electrons are dislodged if the frequency is too high (as reported for illumination by certain lasers).

The operative process seems to be the *incident field energy acting upon a charged particle,* the electron. Of course, this is the well-established premise of Electromagnetic Field Theory: a force is exerted on a charged particle by the presence of an electromagnetic field. The reversals of the incident fields cause alternating "push" and "pull" forces on an electron which is loosely bound to the metal. When frequencies are too high, the "pull" period that removes an electron is over before complete removal, and then a "push" period moves it back. Thus, too high a frequency does not dislodge electrons.

On the other hand, Einstein, Quantum Mechanics, and Ring Theory all agree that a sufficient energy level of incident light is necessary for the photoelectric effect to occur. All parties agree that the energy level of incident light is given as $E = h\nu$ where E is energy, h is Planck's Constant, and ν is the light frequency.[11, p. 10] The energy transferred from a beam of light to a ring electron bound in metal is proportional to the light frequency, because induction effects are proportional to the rate-of-change of the light's electromagnetic fields (see equation 1).

Clocks. *Clocks measure elapsed time* in order to quantify the rate of other processes. Regrettably, most clocks do not depend upon a fundamental electromagnetic process. Examples of clocks depending upon secondary processes are the hour glass and the pendulum clock. The most accurate clock will be one that measures a fundamental process of electromagnetic induction. The author proposed a clock based on magnetic induction in a previous issue of this journal.[13]

Summary. According to modern descriptions of *mechanical* processes, small quantum fluctuations governed by the Heisenberg Uncertainty Principle produce forces and motions by assuming *spontaneous activity* of material particles, *e.g.* electrons. In *electrical* processes, fields—not particles—are the *causal* agents of forces and motions by continuous action in proportion to ambient fields.

In this article, many fundamental actions have been explained by electrodynamics means—*without invoking an aether.* An aether does *not* appear in our fundamental causal explanations or the equations that predict forces and process. Even light

transmission takes place without the presence of a pre-existing aether. *Electric charge and their fields comprise the total of physical reality,* and no other form of energy exists to establish an aether or give properties to space.

Conclusion. The universe operates by electromagnetic processes. Motion and process rates are governed by fundamental electromagnetic energy and force laws. More specifically, the interaction of light and matter is involved in all fundamental processes. Mechanical processes are secondary actions that can be derived from the laws of electromagnetic induction. Mechanical theories can make accurate predictions but cannot account for many fundamental processes.

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