SPACE AND THE WAVE-PARTICLE ENIGMA

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Abstract
This paper discusses prevailing theories about the nature and structure of the vacuum space, of matter and of light, and then demonstrates that the wave-particle paradox can easily be resolved if space, instead of electromagnetic radiation, is assumed to be quantized. Electromagnetic radiation is considered to be a pure wave phenomenon and the photon an imaginary concept.

1. The Logical Universe

Science is a valid endeavor for discovering valuable knowledge about the structure and laws of our physical world. In that pursuit, the scientific method has been most successful for analyzing and utilizing the forces of nature. Without it, we would not be able to send a spacecraft to Neptune, we could not communicate globally, and the Earth could not support six billion people.

Should we not consider it an idiosyncrasy of scientific arrogance, however, to demand that all processes in the universe should yield to human logic and mathematical prediction? That we are able to describe a natural process by a mathematical equation, a short-hand notation of a logical statement, is amazing enough. Yet, in accordance with the scientific method, this equation is often treated as a self-consistent reality, to which all related processes should conform. This circumstance makes scientific prediction possible, but we tend to forget that mathematical formulations are by necessity only incomplete descriptions of natural events.

No *a priori* requirement exists for reality to conform to logical thought. Consider an elementary form of logical inquiry, such as: “What is seven times eight?” Every school child knows there are an infinite number of wrong answers, but only a single correct one for such a mathematical proposition. Similarly, we could imagine an infinite number of illogical universes. A universe built on logic, however, will be working with internal consistency and will be able to bring forth complex forms of organization. Besides creativity, logic is seen to be a necessary ingredient, which allows this universe to develop higher complexity. If it were not built upon logical principles, our universe would have self-destructed a long time ago. Thus, logic weeds out unworkable systems, making it the cornerstone of nature and our sciences. There could be no useful science or technology, if this were not so. As a body of descriptive knowledge, science is thus generally self-consistent and stands on its own merits. Despite its success, however, all science is predominantly descriptive. In the last analysis, it explains very little, leaving room for alternative interpretations of such scientific knowledge.

2. Mysteries and Paradoxes

According to accepted science, all material substances are made of atoms and molecules, and these in turn are composed of more fundamental particles, such as protons, neutrons and electrons. Throughout our more recent history, scientists and philosophers have tried to find the fundamental building blocks of the universe. High-energy particle physicists have spent many decades smashing high-energy beams of speeding protons and other ions into nuclear targets, to see if the known nuclear particles could be dissected into more fundamental building blocks. They have succeeded in creating a bewildering zoo of so-called *elementary particles*, such as quarks and mesons; but none are stable for much longer than a billionth of a second. So the question arises, whether these quasi-particles have any meaningful relationship to the internal structure of protons, neutrons and electrons. Physicists have also searched in vain for elusive magnetic monopoles, whose existence is inferred from the apparent symmetry of electric and magnetic effects. Magnetic monopoles would carry magnetic charges in analogy to the unit electric charges carried by protons and electrons. Here is an example, where nature refuses to conform with theory. Similarly, the search for gravitons, which are thought to be needed for explaining gravitational interactions, has so far been futile.

Then there is the neutrino. The simultaneous conservation of energy and momentum in particle dynamics requires the existence of another stable *particle*, the neutrino. The neutrino is believed to have zero charge and zero *rest mass*, and it is almost impossible to detect. It is presumed to move with the speed of light. In many respects, the neutrino has properties similar to those of the photon, except that it carries half a unit of spin angular momentum, compared with the photon's unit spin. We will later on deny particle status to the photon. It is similarly possible that the neutrino is also such an illusionary quasi-particle. And it may also be a vibrational space disturbance propagating at the speed of light, but with no particle actually moving along the apparent path of the neutrino.

As another consequence of the conservation laws, each elementary particle should have a corresponding antiparticle. When a particle is *created* in a high-energy collision, a mirror image of that particle also appears, having opposite spin and charge. We thus have antielectrons (positrons), antiprotons, antineutrons and antineutrinos. Antiparticles can in principle form stable antiatoms, antimolecules and antimatter objects. Matter and antimatter cannot coexist in close proximity, however, because upon contact the corresponding particle-antiparticle pairs will annihilate and transform themselves into gamma radiation. We do not know whether antimatter has negative mass or positive mass, or whether mass is an absolute quantity that can be neither positive or negative. Most scientists believe the latter to be true. Negative mass would lead to the paradoxical inference that a piece of antimatter would accelerate in a direction against an applied force. Moreover, antimatter would be gravitationally repelled from ordinary matter. No such repulsion has yet been observed.

Our physical world, as we know it, appears to be constructed entirely of matter, which brings us to the mystery of the conspicuous absence of antimatter. We can be certain the sun and the solar planets are made of the same ordinary matter. Otherwise we would see our space probes self-destruct in a blinding flash of light and gamma rays, when they land on another planet. And solar wind particles would create an aura of gamma radiation as they strike planetary atmospheres. If creation of the universe followed the same physical laws that we observe today, then equal amounts of matter and antimatter should exist. Where then is all the antimatter? Is every other star made of antimatter, or every other galaxy, or are there anti-universes? We cannot tell from the light received, since antimatter atoms and ordinary atoms give off identical electromagnetic radiation.

Whereas we do not know much about the substructure of electrons and protons, we can be fairly certain that, on a coarser scale, atoms consist of protons, neutrons and electrons. The first workable model of the atom was proposed in 1912 by Niels Bohr [1885-1962] and Ernest Rutherford [1871-1937]. It is analogous to the familiar model of the solar system and has planetary electrons orbiting around a massive central nucleus, made up of protons and neutrons. And, as with the solar system, most of the atom is empty. The nucleus and the electrons occupy less than a millionth of a millionth of the atomic volume. We thus find it hard to understand what makes material objects so solid. Electrons *orbit* within their allotted shells at nearly 1% of the speed of light, completing more than 10^{15} revolutions each second, thereby weaving a tightly knit, impenetrable shield, which defines the size of the atom. This explains a person's inability to walk through a wall. The electron shells of the atoms in a person's body cannot readily penetrate the electron shells of the wall atoms. A typical size for an atom is one tenth of a nanometer. Because atoms are so small, we need an incredible number of them to make up familiar objects. For example, a cubic centimeter of solid aluminum contains 6×10^{22} atoms. This number is larger than the number of sand grains on all the ocean's beaches. As small as atoms are, electrons and protons are 20,000 times smaller yet.

Quantum and wave mechanical theories have since refined Bohr's model of the atom. Today's conception of the atom is one in which the electrons are smeared out over entire spherical shells and other symmetric configurations centered around the nucleus. The electron is no longer considered a hard particle, but a fuzzy blob of energy, which might be detected anywhere within the cloud pattern described by a mathematical probability function. And it cannot with any certainty be found at any particular point.

Modern physics recognizes four different forces in nature: gravitational, electromagnetic, strong nuclear and weak nuclear interactions. But the only two forces of nature with infinite range are gravitation and electromagnetism. How these forces can act over large distances has never been explained and is one of nature's best-kept secrets. Theoretically, this action at a distance can be treated mathematically by postulating a force field, a concept first introduced around 1850 by Michael Faraday [1791-1867] for illustrating electric and magnetic interactions. Field theory has since been extended to describe gravitational interactions and fluid-dynamic flow fields.

More recent theories propose that electromagnetic action at a distance is facilitated by an interchange of photons, and similar gravitational action by an exchange of gravitons. However clever these ideas may be, field theories and particle exchange theories are by necessity only mathematical crutches, and neither provides any real understanding for solving the action-at-a-distance mystery. Could it be that we do not understand the forces of nature because we do not grasp the true nature of space and time? We intuitively and unquestioningly accept the concepts of space and time as fundamental. In our Newtonian and Cartesian way of thinking, space and time provide the framework and arena for all material activity and for all our experience. Most of us take it for granted that space and time had to exist before everything else was created.

The advent of the relativity theories by Albert Einstein's [1879-1955] and of the quantum mechanical theories by Max Planck [1858-1947], Erwin Schrödinger [1887-1961] and Werner Heisenberg [1901-1976] shattered the mechanistic underpinnings of science during the early part of the twentieth century. Einstein tied space and time together by postulating a four-dimensional space-time continuum as a reference frame for all world events. Moreover, in his famous mass-energy relation he declared matter to be just another manifestation of energy. He proposed that all energy has mass and that energy is *the* fundamental stuff of the universe, that energy is in fact *all there is*. Space and time were no longer independent of the energy distribution in the universe. Large accumulations of energy in the form of matter were believed to warp the space-time matrix, explaining why light rays bend around massive objects like the sun. Relativistic concepts also demanded that the flow of time could no longer be considered uniform throughout the universe.

Whereas Einstein's theories afforded a fresh look at basic physical interrelationships and processes, they also created a new set of paradoxes, which cannot be resolved philosophically, even though they may be *justified* by mathematical manipulation. We must remember, mathematical description is a useful tool to describe observed reality, but it is not a reality in itself. The paradoxes arise out of the theories' confusion about the nature of space. The classical theory of light as an electromagnetic wave needed an *elastic aether* to carry light vibrations. Experiments designed to detect our motion through this aether of space were unsuccessful. Einstein used these experimentally inconclusive results as the primary axiom for his Special Theory of Relativity, published in 1905. In common language, he postulated that the speed of light measured by an observer is constant, independent of the observer's motion relative to the source or anything else. There could be no preferred reference frame attached to space itself. With this postulate, Einstein denied the existence of a light-carrying aether. Space had to be absolutely empty, a nothingness without any properties. Eleven years later he contradicted himself with his General Theory of Relativity, which unequivocally depends on space being a medium that can be distorted and warped. His Special Theory, however, is what leads the unwary theoretician into absurd contradictions.

The explosive technological growth of the late twentieth century has provided physicists with new powerful instruments and tools for probing and exploring the microcosm and macrocosm. Theorists have been working overtime to deal with many new discoveries in the subatomic world, as well as in the cosmos at large. While their theories are often able to describe newly discovered oddities correctly, they do not add much to our deep understanding of nature. Quantum physics and relativity theories deal with new phenomena by asserting new postulates and by making corresponding adjustments to the mathematical framework. In the subatomic arena, new quasi-particles, like gluons, gluinos and quarks, are conjured up to account for any surplus or missing mass. And if these enigmatic particles do not behave according to theory, new rules are made up to connect their odd behavior with imaginary properties, such as strangeness, color and flavor.

Another trend in making observational data fit theory is to add more dimensions to our baffling world. Enlightened scientists know that a suitably complex mathematical construction can be created to fit any real or imaginary set of observations, provided a sufficient number of arbitrary coefficients and constants are inserted, all adjustable and tunable to fit the data. Modern cosmologists delight in creating such *Theories of Everything, Superstring Theories* and the like, which propose that our world is 10, 11, 15 or 27-dimensional. Meanwhile we are still trying to fathom the enormous complexity of Creation, the wave-particle duality of light, the nature of time and space, electric charge and gravitation, the mysterious action at a distance, the secrets of nuclear structure, the formation of stars and galaxies, and the significance of quasars and black holes.

3. Relativity and Space

Nothing can go faster than the speed of light. Such is the creed of modern relativists. But is this an established fact? Einstein stated in his original papers that, in a relativistic sense, no material body could be *observed* to travel faster than the speed of light. This was perfectly logical, because he used light signals as the measuring stick for all world events, for determining relative motion of objects and for defining simultaneity. He made the speed of light an *absolute* limit only in his later writings. Turning such a relativistic concept into an absolute quantity, however, is contradictory and unjustified. Relativists consider absolute concepts to have no real meaning in any event. We are confronted here with a philosophical problem, stemming from the belief that an observer's sphere of consciousness is limited to a small section of space and time. Those of us, who believe in an ever-present, all-encompassing, eternal spirit consciousness, have no problem with absolute ideas. We can view the entire universe with our mind's eye without being limited by the speed of light.

Cosmologists consider the universe finite but unbounded, like the surface of a sphere. Yet, if the universe is finite, then there must be a center of mass. The latter would conveniently serve as a distinct point of reference for everything else, even if this center lies outside of our observable three-dimensional space and is inaccessible, which may be the case should our world have four or more spatial dimensions. Because electric and gravitational force fields fall off inversely with the square of distance, however, our world must have three spatial dimensions and no more. This is required by the conservation of energy (mass) and charge. A simple mathematical analysis can show these force fields falling off inversely as the cube of distance, if the world were four-dimensional. The laws of physics just do not support the existence of any fourth or higher spatial dimensions.

The impetus for Einstein's theories came from experimental results that failed to prove the existence of a vacuum *aether*, thought to be necessary for the propagation of light waves through space. In 1887, Michelson and Morley[1] (MM) showed that light propagates with the same speed in the direction of Earth's motion as in the opposite direction. In the MM experiment, a light beam was split in two with a partially reflecting mirror positioned at 45^{o} with respect to the beam. The two beams were reflected back and forth between mirrors in mutually orthogonal directions. Then the beams were recombined and made to interfere, so as to produce optical fringes. The fringes were expected to shift, when the apparatus was rotated relative to the known orbital motion of the Earth. No fringe shifts were detected outside of the experimental uncertainty. During the next fifty years the experiment was repeated more than a dozen times with increased finesse and accuracy. Some experimental setups were so sensitive to vibration, that the City of Cleveland agreed to halt all streetcars during one of the experiments. As much as scientists tried to detect an *aether drift*, their results remained inconclusive. The majority of these experiments did not actually measure light velocities, but relied on optical fringe shifts. Thus, the interpretation of the experiments may be questioned, because they did not account for changes in phase and frequency of the light waves reflected from moving mirrors. Then there is the nagging fact, that spinning versions[2] of the MM experiment apparently proved the existence of a preferred reference frame.

The refutation of the aether was not readily accepted by the scientific community. Several attempts were made by theorists to invent compensating effects, which could be used to explain the MM results and save the aether theory. Among these efforts was a proposal by G. Fitzgerald [1893] and

H. A. Lorentz [1895], suggesting that fast moving bodies shorten their dimension in the direction of motion. Instead of a contraction in length, a corresponding time dilation would also serve to explain the MM results. According to this theory, a stationary investigator observing a moving clock would find it ticking more slowly. Neither the Lorentz-Fitzgerald contraction, nor the time dilation effect were successful in saving the aether concept. Instead, Einstein incorporated both ideas into his relativity theories. Einstein's version of the time dilation effect leads to the famous twin paradox,[3] which requires pages of hand-waving arguments to explain.

The Special Theory of Relativity is inconsistent with the concept of a universe functioning according to logical principles. Whereas the theory assumes logic to prevail for all other physical phenomena, it makes an exception for the vector addition of velocities, insofar that the most basic logical truth of 1 + 1 = 2 does not apply here. According to the Special Theory, velocities cannot be added algebraically. For example, consider a spaceship traveling away from the sun at 0.9 times the speed of light. Light emitted from the sun at speed c overtakes the spaceship. A scientist on the spacecraft confirms that the ship is moving away from the sun with 90 percent of the speed of light by measuring the rate of decrease of the apparent diameter of the sun. He also measures the speed of light relative to the ship and finds, in accord with theory, that the light still overtakes him with a relative velocity of c. Hence, he concludes that c minus 0.9 c equals c, a paradoxical result. This illogical, non-algebraic speed difference is also inconsistent with the observation of a Doppler shift in light frequency. The first-order Doppler shift is a classical effect that depends on classical velocity differences. Light passing a moving observer should not change in frequency, if the observer always measures a fixed light speed c, irrespective of his own speed relative to the source.

The best known mathematical relation, associated with the Special Theory of Relativity, is the mass-energy equivalence formula, $E = mc^2$. Popular interpretation of this formula holds that mass can be converted to energy and vice versa. Moreover, nuclear fission and fusion processes are believed to represent dramatic proof of Einstein's theories. Both notions are erroneous.

The correct interpretation of the formula regards mass as a measurable *property* of energy. Energy has mass. In nuclear fission and fusion reactions, energy is conserved, and thus mass is conserved also. Matter energy is being converted to radiation energy and heat energy, but no energy is created, and no mass is destroyed. The celebrated formula can be considered as a mere definition of mass, i.e. $m = E/c^2$, where $1/c^2$ is the proportionality coefficient. Whereas Einstein derived this formula by considering the relativistic mass increase of an electron accelerated to high velocity, it could just as well have been derived from classical and quantum mechanical concepts, without resorting to Lorentz-Fitzgerald transform factors for length, mass and time. Hence, confirmation of $m = E/c^2$ does not in itself validate the Special Theory of Relativity.

Einstein denied the existence of a vacuum aether of space and asserted space to be a nothingness without properties. Yet space is known to have specific properties, which can be measured precisely, such as its electrical permittivity ϵ_o and its magnetic permeability μ_o. These two quantities define the electromagnetic impedance of space as $(\mu_o/\epsilon_o)^{1/2}$, and the propagation velocity of electromagnetic waves in space as $c = (\epsilon_o \mu_o)^{-1/2}$, two alternative properties of space. And Einstein's assertion of space being empty is strongly contradicted by the phenomenon of vacuum polarization. When an isolated charged particle, such as an electron, is observed in vacuo, it appears to be surrounded by ephemeral particles of opposite charge (positrons). These particles oscillate in and out of existence, here one moment, there the next, like will-o-the-wisps. Their transitory life is very short, even on a subatomic time scale. These *virtual* positrons are thought to be members of electron-positron pairs, appearing out of the vacuum and vanishing again by recombining with each other. During their short lifetime, the positrons are drawn closer to the free electron, whereas their negative partners are repelled to a greater distance. This constitutes an electric polarization of the space around the original electron. The electric charge measured as the charge on the electron may, therefore, not be the real charge of the *bare* electron, but rather the charge of an electron *clothed* in its induced vacuum charges. The actual bare charge of the electron may be significantly larger than its measured value.

When studying ancient philosophy and off-beat scientific theories, we come across a recurring belief in a fine-structure underlying all space and all matter. This fine stuff underlying the atomic order is thought to be linked with spiritual energy. The presence of such a sea of spiritual energy would clarify how thought and spiritual power can control, or even create matter. Many esoteric beliefs and theories consider space, and hence the entire universe, to be made up of two kinds of elementary energy units, opposite but complementary, extremely tiny and virtually infinite in number.

Pre-Taoist philosophers in China distinguished within every natural object two interacting energy modes, the positive *Yang* energy and the negative *Yin* energy. In more recent times, the English physicist Dirac[5] proposed a theory of a sea of virtual electrons, which occupy all space, but are normally undetectable. *Lifting* an electron *out* of this *Dirac Sea* would leave a *hole* that would act like a positively charged particle, the positron. Dirac's theory later served as a model for the positive hole concept in modern semiconductor technology. But the Dirac sea of virtual electrons imprisoned in positive holes, as a model for the vacuum space, was never given serious consideration by established science. More recently, Simhony[6] has revived and expanded the electron-positron model of space. He believes space to be densely populated by actual electrons and positrons, arranged in a three-dimensional lattice, in the same way as negative chloride ions and positive sodium ions are arranged in a crystal of rock salt. Whereas his theory can naturally explain many of the quantum mechanical assumptions and postulates, his papers have been rejected and barred from publication, because his theory would re-establish a preferred frame of reference.

Simhony calls the space lattice *epola* and assumes the electrons and positrons are held in the lattice with a binding energy of $E_b = m_e c^2 = 511$ keV. If this binding energy is simply electrostatic, then the space between adjacent particles in the lattice is approximately five femtometers (5×10^{-15} m). This leaves little room for particles of ordinary objects to pass through space unimpeded, making it hard to accept the epola theory without reservations. It goes against common experience, which tells us that material objects can pass freely through empty space with zero resistance.

If we were to add up all the individual particle masses in the epola, we would determine a mass density of 10,000 tons per cubic centimeter of space. This is ten billion times the density of ordinary matter. So, how could space possibly be so transparent to moving objects? The secret lies in the concept scientists call *binding energy*. Remember, we stated earlier that all energy has mass, and that there probably is no such thing as negative mass. Well, binding energy is the sole exception. It is an energy hole; not just the absence of energy, but an abyss that swallows energy. Binding energy is negative energy and can be considered to have negative mass.

We can best illustrate this negative energy by examining the atomic nucleus. The strongly attractive nuclear forces create an energy hole, which keeps the protons from flying apart due to their electrostatic repulsion. Because of this nuclear binding energy, the mass of a nucleus, i.e. the total energy in the nucleus, is always less than the sum of the masses of the component nucleons. The nuclei of some elements are more tightly held together than others. For example, a helium nucleus is more strongly bound (more stable) than a deuterium nucleus. So, when two deuterium nuclei are fused into a helium nucleus in a nuclear fusion reaction, there is a net loss in nuclear energy. The energy difference, i.e. the increase in binding energy, is released as radiation and kinetic energy.

In the epola model of space, the binding energy per particle is equal to the matter energy of the particle itself. The electrons and positrons disappear into the energy holes produced by the interaction of their electric charges, making them undetectable from our coarse-matter world. The externally measured mass density of the epola space is thus equal to zero. Having been robbed of their energy, the electrons and positrons in the epola space are therefore unable to interact with ordinary matter and do not resist the motion of objects through the vacuum of space.

The epola lattice constant is probably also much larger than the five femtometers assumed by Simhony. Remember, it may not be possible to measure the bare charge of an electron because of the positive electric clothing induced in the vacuum. If the bare charge of the electron is taken to be 100 times the measured value, for example, then the particles in the epola space will be 10,000 times farther apart. The per-particle binding energy will still be 511 keV, and the epola as a whole would still be massless. It would then be far more transparent to the passage of nuclei and electrons of ordinary objects as they move through space.

So, does the fine-structure of space consist of electrons and positrons, hidden in energy holes of their own making? Or is there a still finer microstructure underlying the electron-positron space? At least one British engineer seems to think so. R. D. Pearson[7] proposes that everything in the universe is ultimately made up of positive and negative *cosmons*, thousands of times smaller yet than electrons. He also believes that these cosmons are akin to spiritual energy, and that the power of the spirit over matter acts at that level.

When we contemplate all theoretical and observational aspects of space, taking into account intelligent speculation and ancient wisdom about the structure of the universe, we should seriously consider a vacuum space made up of oppositely charged energy units, too small to detect, but underlying everything there is. We will call them energy units or space elements, rather than particles, because particles imply a solidity that does not exist at this ultra-microscopic level. Solidity is an illusion of our everyday material world.

4. The Wave-Particle Enigma

Light is an electromagnetic oscillation of space, propagating with a constant velocity c in a direction perpendicular to both the oscillating electric and magnetic field vectors. We use the term *light* here in a generic sense, so as to include all electromagnetic radiation from radio waves, to microwaves, to visible light, to x-rays, and on to gamma rays.

The fundamental nature of light is wavelike, and its electric and magnetic manifestations are accurately described by Maxwell's Equations[4], which form the foundation of classical electromagnetic theory. In Maxwell's theory, the propagation of electromagnetic waves depends directly on the properties of a highly elastic *aether*, believed to be filling all space. The wave picture of light could easily explain most optical phenomena, such as diffraction, interference, refraction, internal reflection, polarization and birefringence. And so everything was well until the year 1900, when Max Planck introduced the first quantum mechanical concept with his *Distribution Law*. The latter was an empirical fit to the emission characteristics of a *black body*[a] heated to a known temperature. Fitting a theoretical curve to the frequency dependence of the measured intensities became feasible only, if he assumed that radiation was emitted in discrete quanta, and if the quantum energy was proportional to the light frequency. The proportionality constant h is known as Planck's Constant. Five years later Einstein used the quantum concept to account for the photoelectric effect. Photoelectric emission of electrons from a metal surface occurs only if the light frequency is above a certain threshold. Below that critical frequency, no electrons are emitted, no matter how high the light intensity. This strange behavior could be explained by considering the impinging light flux to consist of individual energy packets, called photons, each with an energy of hf, and each one interacting individually with an electron at the metal surface. By transferring all of the photon's energy to the electron, the forces that bind the electron to the metal matrix could be overcome, liberating the electron. Photons were believed to be similar to the light particles hypothesized by Isaac Newton more than two centuries earlier.

After Einstein published his Special Theory of Relativity and derived his famous mass-energy relation, scientists started to consider seriously the possibility of converting photon energy to matter energy. Perhaps fundamental particle-antiparticle pairs could be *created* with high-energy gamma rays. Indeed, by 1932, Carl David Anderson showed that gamma rays of sufficient photon energy ($> 2m_ec^2$) could produce electron-positron pairs under certain conditions. This discovery reinforced the belief in light photons. Since then, light has been considered to have a dual nature, wavelike as well as particlelike, depending on the phenomenon under investigation. The photon theory is typically applied to explain photochemical reactions, whereas the wave picture is used for elucidating optical refraction, diffraction and interference effects. The shorter the wavelength of light, the more it seems to behave like a stream of particles. Modern quantum physicists consider photons to be real particles, moving with the speed of light in the direction of the light ray. Particle physicists list the photon as one of the unique elementary particles that make up the universe. This notion makes the photon the weirdest elementary particle known. It does not have a unique energy or mass, it ceases to exist unless it moves at a fixed speed c, and it is its own antiparticle. Calling the photon an elementary particle forces it into a category into which it does not belong. It cannot be a real elementary particle in the same sense as the electron.

The interpretation of light as speeding bullets of energy has created an unresolved paradox, which cannot be reconciled with the more readily observed wavelike nature of electromagnetic radiation. If we accept that this universe is based on logic, then we need to challenge this photon concept. To this effect, we will describe three situations that demonstrate the inconsistency of the photon concept

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[a] A nonreflective bit of matter (gas, liquid or solid) in radiative thermodynamic equilibrium with its temperature

with observation and logic. We will temporarily assume that the Special Theory of Relativity is correct, and that the wave-photon duality of light is a valid representation of reality.

Example 1: The Capricious Photons

Now there are five, then three, and then perhaps two point seven.

Light intensity is proportional to the square of the electric, or magnetic wave amplitude, E_o or B_o, and the photon flux passing through unit area in unit time is intensity divided by the photon energy, hf. Consider now a steady stream of collimated light of frequency f_o (a laser beam, for example) emanating from a distant star system and passing an observer in a spaceship. The latter is initially at rest with respect to the light source. He will measure a light intensity of $\epsilon_o c E_o^2$ and a corresponding photon flux N_o. Each photon carries an energy of hf_o and passes him with speed c.

Then let the space traveler fire up his rockets and acquire a constant velocity v away from the star, where v is significantly less than c. According to the Special Theory of Relativity, the light waves still pass him with a velocity of exactly c. But does he still measure the same photon flux? One of the axioms of relativity theory requires Maxwell's equations of electrodynamics to be valid in all frames of reference moving at different, but constant velocities. Applying this condition, the electric field amplitude in the light wave, as measured by the moving observer has decreased by a factor of (1 - v/c). The wave intensity has decreased by the square of this factor. In addition, the light frequency has decreased by the same factor (1 - v/c) due to the Doppler effect,[b] so that the new photon energy is (1 - v/c) hf_o. Consequently, the space traveler will now observe a photon flux density of (1 - v/c) N_o.

Hence, he sees a smaller number of lower-energy photons passing him than before. Where did some of the photons go? He could not have outrun them, because all photons still appear to fly past him with velocity c. If he were moving towards the source, he would see additional photons. Evidently, photons are being destroyed or created, depending on the motion of the observer. This paradox would disappear, if we would allow the photons to have a variable velocity relative to the observer. Hence something is wrong with Einstein's postulate, which says the propagation velocity of light is independent of the motion of the observer, and/or the concept of discrete photons moving with the wave at speed c is incorrect.

Example 2: The Mysteriously Accelerating Photons

When elastic waves (seismic waves, for example) pass from a material of low density to one of higher density, the waves slow down. When they pass back into the lower density medium, they speed up again. The same behavior is observed with electromagnetic light waves passing through an optically denser material, such as a glass lens. The change in wave speed at the boundaries accounts for the phenomenon of refraction. The index of refraction n of an optical material is defined as the ratio formed by the speed of light in vacuo divided by the speed of light within the material.

Now let us inspect this from the photon point of view. As the photons emerge from the far surface of the lens, they must suddenly speed up with almost infinite acceleration. We may ask: What force

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[b] For simplicity, the classical relations are used here. Using relativistic expressions would not change the argument.

at the rear surface of the lens accelerates the photons? There is no answer to this question. Again, we must suspect the validity of the photon concept.

Example 3: How Large or Small is a Photon?

One moment as large as a galaxy, at another as small as a molecule of silver bromide.

Next consider the well known two-slit interference pattern (see Figure 1). When a light wave is passed through two narrow and parallel slits, the emerging light acts as though it was coming from two coherent line sources of light. Along certain directions, the waves are 180^{o} out of phase and cancel each other out, causing zones of darkness. Along other directions, the waves emanating from the two slits are in phase and reinforce each other, creating zones of brightness. All aspects of this interference pattern can readily be explained by means of the wave theory of light. However, this did not satisfy the quantum physicists. They repeated the experiment with extremely low levels of

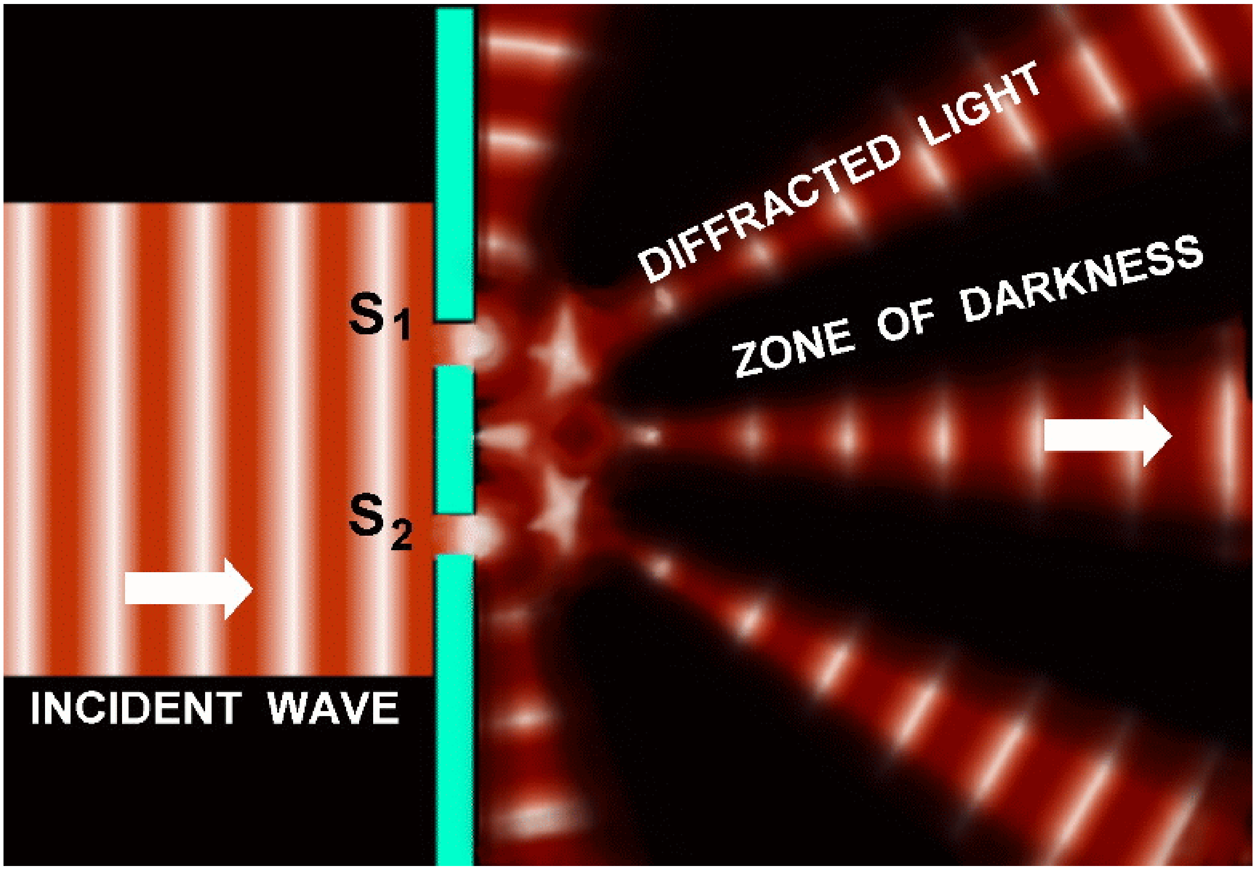

FIGURE 1. Two-Slit Diffraction and Interference Pattern

light; so low, that according to their theory, individual photons would arrive at the two slits at distinctly different times. Photon counters, placed in the *dark* and *bright* zones of the two-slit interference pattern, produced photon counts that mimicked the pattern expected from the wave nature of light. The photons avoided the detectors in the dark zones, but were counted in the bright zones. A photographic film, exposed for a long time, still showed the customary fringe pattern. When the detectors were placed at the slits, S_1 and S_2, they confirmed that no two photons arrived at the two slits simultaneously. They were detected only at one slit or the other. The conclusions from this experiment were:

- Individual photons still carry their wave characteristics.
- Photons interfere only with themselves.
- A single photon would have to pass through both slits to follow the interference pattern, but can only be detected at one slit when intercepted.

This is illogical enough, but consider now enlarging the experiment to cosmic proportions. Assume two imaginary slits thousands of light-years apart, but millions of light-years away. Light from a supernova in a distant galaxy or from a quasar, perhaps billions of light-years away, passes through the two openings and is observed here on Earth. The angular geometry is such that wave optics would predict a giant interference pattern, through which the solar system may move, slowly passing through alternate *bright* and *dark* fringes in the course of millennia. Such a phenomenon may actually be observed in the cosmos. Some recently detected, distant quasars[8] may be brightened[9] by such an interference effect, caused by the light being gravitationally deflected around two sides of an intervening galaxy. If it should be confirmed that interference effects occur on a cosmic scale (besides the more commonly observed lensing effects), can we then assume a photon to be smeared out over tens of thousands of light years, as it passes around both edges of the galaxy? Yet when it is detected on a photographic plate, it suddenly contracts to a fraction of a micron, since the entire energy of the photon is needed to photochemically interact with the small grain of silver bromide. Again, logical thought cannot account for this behavior of the photon.

We could find many more such incongruities arising out of the photon hypothesis. Quantum theory has failed to provide any good physical reason for the optical quanta to have energies proportional to the wave frequency. Classical wave theory predicts the exact opposite relationship. A single low-frequency oscillation contains much more energy than a single high-frequency oscillation of the same amplitude. Wave energies vary inversely as the square or cube of the frequency, depending on the dimensionality of the wave.

A way out of this predicament is to deny the existence of the photon as a speeding particle of light. Photons are not quantities of electromagnetic radiation but are a characteristic of space. Space, and space only, is quantized, not the light waves. Light is wavelike, and the wave-particle duality of light is a myth, brought about by our lack of understanding of the nature of space and time. It is noteworthy that Einstein originally considered the photon to be an *imaginary quasi-particle*, useful only for describing the transfer of energy in an electromagnetic wave. We will consider space to consist of a matrix of elementary energy units held together by electric forces. These space elements, called *spacels* here, are not material particles in the common sense. They may be identical to electrons and positrons, or they may be made of finer stuff. When excited by an electromagnetic wave, these electrically charged spacels execute transverse oscillations in resonance with the oscillating electric field vector of the wave. The transverse oscillation is quantized, giving rise to an apparent quantization of the wave itself. This proposition follows closely the views expressed by Simhony[6], who considers the photon as representing the average *per-particle part of the energy transferred in the wave motion* through the electron-positron lattice, which he assumes occupies all space. Whereas Simhony's theory does not make use of *a priori* assumptions for the quantization of angular momentum, we will assume that the transverse oscillations of the spacels are quantized in the same manner proposed for the electrons in Bohr's theory of the atom. We do not claim to understand fully the true nature of space, and we do not claim that Simhony's theory is wrong. The following argument is presented only for showing how the paradoxes created by the wave-particle duality can be removed by assuming that space, rather than light, is quantized.

Suppose these fundamental energy units of space (spacels) exhibit the properties normally associated with electric charge, and suppose they are set into sympathetic harmonic oscillations by an electromagnetic wave, which itself originated from oscillations of the spacels. Assume also that the spacels have conventional mechanical properties, such as inertial mass, momentum and kinetic energy, even though we know there is nothing material about these elements. For space to be neutral, equal numbers of positive and negative spacels are needed. Let us call them F_+ and F_-. These positive and negative elements are assumed to be arranged in a uniform matrix, held in equilibrium by electromagnetic interaction and/or by another unspecified force. The space matrix is equivalent to the elastic continuum assumed by Maxwell. Let us now isolate a typical F_+, F_- pair. Assume the individual elements have a mass m and are being held apart at an equilibrium distance y_e by an imaginary spring with a spring constant k (see Figure 2). The spring represents all forces acting on the pair of spacels. When displaced from their equilibrium positions, the distance between the two elements will increase and decrease in a sinusoidal manner. This model represents an oscillating electric dipole with the properties of a classical harmonic oscillator. The oscillating frequency f which is forced upon the dipole by the wave, is normally well below the natural frequency of the spacel dipole.

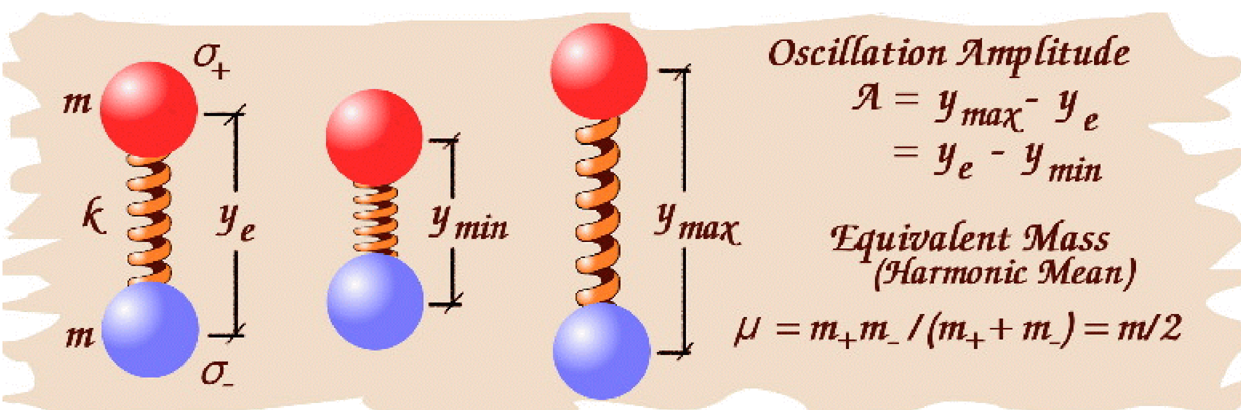

FIGURE 2. Model of Positive-Negative Spacel Pair

The displacement-time curve and the velocity-time curve for the oscillating dipole are shown in Figure 3. The sinusoidal motion can be thought of as being generated by the y-component (projection onto the y-axis) of a rotating vector of length A moving with constant angular velocity 2Bf, as represented in Figure 3(a). The maximum velocity v_o occurs when $y-y_e$ is zero. It corresponds to the tangential velocity of the equivalent circular motion. Except for extremely high-frequency gamma radiation, this transverse oscillation velocity is significantly slower than the wave velocity c.

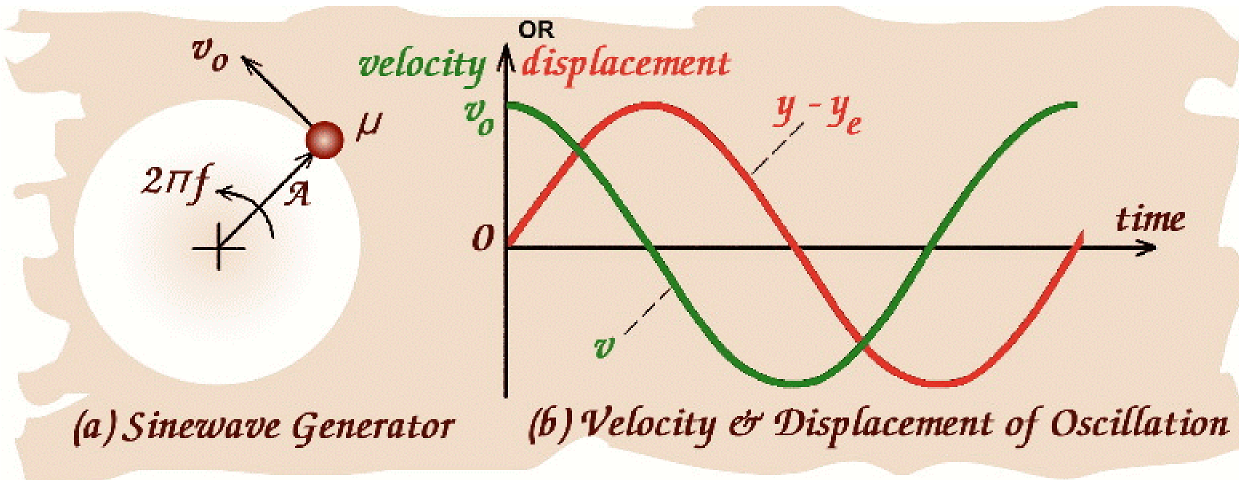

FIGURE 3. Oscillation of Spacel Dipole

We now assume that the angular momentum of the equivalent circular motion is a constant with a quantum value of h/2B, in analogy to the angular momentum of an orbiting electron in the Bohr atom being quantized. As a consequence of this quantization of space, the amplitude of the oscillatory motion varies inversely as the square-root of the frequency;[c] i.e. the higher the frequency, the smaller the amplitude of the resonating spacel. And as a further result, the transverse vibratory energy of a F_+, F_- pair becomes equal to hf; i.e. its energy quanta are proportional to the frequency, just as for traditional photons. This energy is transferred from one spacel pair to the next, as the wave propagates through space at velocity c. The number of spacel pairs participating in the wave motion by sympathetically resonating with it determines the intensity of the wave. Since the number of spacels within the sphere of influence of a single wave oscillation is extremely large, the intensity of the electromagnetic radiation has to become inordinately high, before all available spacels become enrolled into participating. Increasing the intensity of the wave beyond this point may force some of the F_+, F_- pairs to vibrate with energies of 2hf. This could account for *multiphoton absorption* processes seen in extremely intense laser beams.

In the photoelectric effect, electrons are ejected by the quantized transverse oscillations of the space elements. Photons, as physical particles moving at the speed of light, are not needed. Attempts by optics text books[10] to explain double-slit interference patterns in terms of photons passing through one slit or another are futile and nonsensical. Statements like: “photons only interfere with themselves,” or “we do not know which slit the photon has passed through when it arrives at one of the fringe maxima,” are irrelevant, since no photons pass through either slit. No photon moves in the direction of wave propagation, but space elements vibrate transversely to it. The photon is a

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[c] This condition may be derived directly from considerations of forced sympathetic vibrations in a matrix of coupled oscillators without resorting to quantum-physical concepts; e.g. by selecting suitable properties for the spring and coupling parameters.

hypothetical concept, which only has meaning when electromagnetic radiation interacts with matter to liberate electrons or break chemical bonds, or when it interacts with the substructure of space to produce electron-positron pairs. In all these circumstances, a minimum vibrational energy of space elements is needed to overcome the binding energy of the particles liberated.

In summary, let us consolidate the ideas expressed in this paper. In discussions on the fine-structure of space, we showed how binding energy can reduce the externally measurable mass density of space. The externally measured mass m_x of a spacel is $(E_m - E_b)/c^2$. If the binding energy E_b of the spacel is equal to its matter energy E_m, then the mass density of space is zero and, according to elastic wave theory, the velocity of wave propagation would be infinite. But our model of electromagnetic waves does not strictly fall into this elastic bulk deformation wave category (Here we differ from the wave model of Simhony[6]). In our model, the aether waves consist of quantized local oscillations of the spacels. These elements oscillate individually within their potential wells, created by their electric binding energy. At that microscopic level, each spacel unit has an inertial mass equal to E_m/c^2, unaffected by the binding energy. The elastic forces holding the spacels together in a F_+, F_- pair are the same forces that couple neighboring pairs to each other. In terms of microscopic quantities relevant to our model of space, the wave propagation velocity v_p can be shown[11] to be equal to $c(E_b/E_m)^{1/2}$. If the binding energy of the spacel is equal to its *matter* energy, then the wave speed is equal to c, consistent with observation.

Certain experimental observations, such as vacuum polarization and vacuum pair production by gamma rays, suggest a luminiferous aether consisting of an electron-positron matrix, meaning F_+ may be a positron and F_- an electron. If there is a primary spiritual microstructure underlying space, consisting of cosmons, or the like, then one might expect the binding energy of these micro-units to exceed their *matter energy,* so that in this spiritual realm, signals can travel at speeds far in excess of the speed of light. Such speculations, however, lead to new contradictions which cannot easily be resolved with present-day science. More of the author’s viewpoints, which resolve conflicts in the description of our physical reality, and which integrate material and spiritual aspects into a self-consistent world view, can be found in a recently published book[11].

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